

Proceedings of the CENTERIS 2009

Conference on ENTERprise Information Systems

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Editors:

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Luís Alfredo Martins do Amaral, University of Minho, Portugal

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Preface

CENTERIS – Conference on ENTERprise Information Systems is an international conference addressing the largely multidisciplinary field embraced by the Enterprise Information Systems (EIS), from the social, organizational and technological perspectives, promoted by the Polytechnic Institute of Cávado and Ave and the University of Trás-os-Montes e Alto Douro.

The CENTERIS'2009 edition, focused on *aligning technology, organizations and people*, was held in Ofir, Portugal. This was the place where, from 07 to 09 October 2009, under the *leitmotiv* of Enterprise Information Systems, academics, scientists, IT/IS professionals, managers and solution providers from all over the world had the opportunity to share experiences, bring new ideas, debate issues, introduce the latest developments, from the social, organizational and technological perspectives, in what was the first edition of a conference that was here to stay.

EIS design, implementation, management, ... are not easy tasks, as we all know! Its success relies on an extensive array of tools, approaches and solutions, as one is able to understand from the wide range of papers presented and discussed in CENTERIS 2009.

More than 110 manuscripts were submitted to CENTERIS, coming from the five continents. There were selected 56 papers for presentation and inclusion in the conference proceedings and 11 were accepted as posters, with the publication of an extended abstract. The 56 papers and 11 extended abstracts herein included represent 178 authors from academe, research institutions and industry, representing 26 countries.

The conference was organized in nine major topics that were used also to organize the current proceedings: EIS design, application, implementation and impact; EIS adoption; IT/IS management; social suspects of EIS; organizational knowledge; Collaborative, Networked and Virtual Organizations; Business Process Modeling; e-Business and Enterprise Portals; and Information Systems Architectures.

The high quality and interest of the contributions received makes we believe that CENTERIS is on the route of the IT/IS scientific events.

Please enjoy your reading!

The editors,

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Organizing a conference is a very hard but compensating and enriching experience, as it involves a complex set of different activities, from the design of the conference, the establishment of the scientific commission, contacts with authors, organization of the review process, discussion and exchange of ideas and experiences, process management, organization and integration of contents, and many other, with the permanent objective of preparing an event that meets the participants expectations. And this task cannot be accomplished without a great help and support from many sources. As conference co-chairs, we would like to acknowledge the help, support and believe of all who made possible the creation of CENTERIS.

We are grateful to all the authors who have chosen CENTERIS'2009 to present their work, thank you, you made the conference happen! Our gratitude goes also to all the authors that submitted their proposals but were not able to see their work accepted, due to several constraints.

The Scientific Committee of CENTERIS integrates 125 individualities, most of them who shared their knowledge and gave their constructive comments indispensable to the decision-making associated with the selection process, to whom we express our gratitude.

The conference sponsors played a very relevant role. We are grateful to Microsoft Portugal, GESITI network, TAP Portugal, to the Municipalities of Barcelos, Esposende and Guimarães and to the scientific journals who offered the chance to publish enhanced versions of selected papers: the *Information Resources Management Journal* (IRMJ), the *International Journal of Enterprise Information Systems* (IJEIS), the *International Journal of Information Technologies and Systems Approach* (IJITSA), the *Journal of Theoretical and Applied Electronic Commerce Research* (JTAER), the *International Journal of Human Capital and Information Technology Professionals* (IJHCITP) and *Information and Communication Technologies for the Advanced Enterprise: an international journal* (ICT'ae).

Finally a word of appreciation is due to the members of the organizing committee for their prompt and friendly support.

The editors,

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EIS design, application, implementation and impact

How to Transform the Information Infrastructure of Enterprise into Sustainable, Global-oriented and to Monitor and Predict the Sustainability of Civilization: The Organizational and Social Aspects

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Abstract: The evolution of the Classic Enterprise Information Infrastructure into Sustainability and Global Enterprise Information Infrastructure is defined. However, it is not the end of evolution. Since the ES operate within larger entities, such as Local, National, Global Information Infrastructures and these ones create the Civilization Information Infrastructure. The latter is the foundation for modern civilizations, and furthermore is the foundation for the emerging Global Civilization with its repercussions for lower level infrastructures as well as for the World Civilization. If such civilization wants to survive it must be able to monitor and predict its sustainability in relationship with enterprises. In conclusion some recommendations will be addressed for the pathways to a sustainable future.

Key words: Enterprise Information Infrastructure, Enterprise Systems, Business Intelligence, Sustainability Intelligence, Global Intelligence, Civilization Intelligence, Key Performance Indicators, Management Dashboard, Civilization Monitoring and Predicting Systems.

1. Introduction

The purpose of this study is to define a concept how to transform a classic enterprise into sustainability and global-oriented enterprise, which will be economically vital, environmentally accountable, and socially responsible. Furthermore, such enterprise's intelligence system should be integrated with national and civilizational levels of the Monitoring and Predicting Systems. The approach to solve these issues is based on graphic modeling the mentioned systems. As a result of this study, the pathways to a sustainable future of an enterprise and civilization are offered.

2. Classic enterprise information infrastructure

The Classic Enterprise Information Infrastructure (C-EII) is illustrated in Figure 1. It contains 7 specialized layers, where the 6th and 7th Layer are the most visible for the end-users. A set of applications is evolving along with the development of IT concepts and business needs. In the 2000th it is based upon work from the office via in building, local, metropolitan, and national networks/infrastructures (LAN, LII, MII, NII) and from a home via a home network/infrastructure (HII) for tele-work. The 7-Intelligence Layer is also an application layer, which specializes in managing of the whole enterprise with the support of Knowledge Management System, composed of Enterprise Datawarehouse, Data Mining, Knowledge Database, and Management Dashboard, also known as business intelligence.

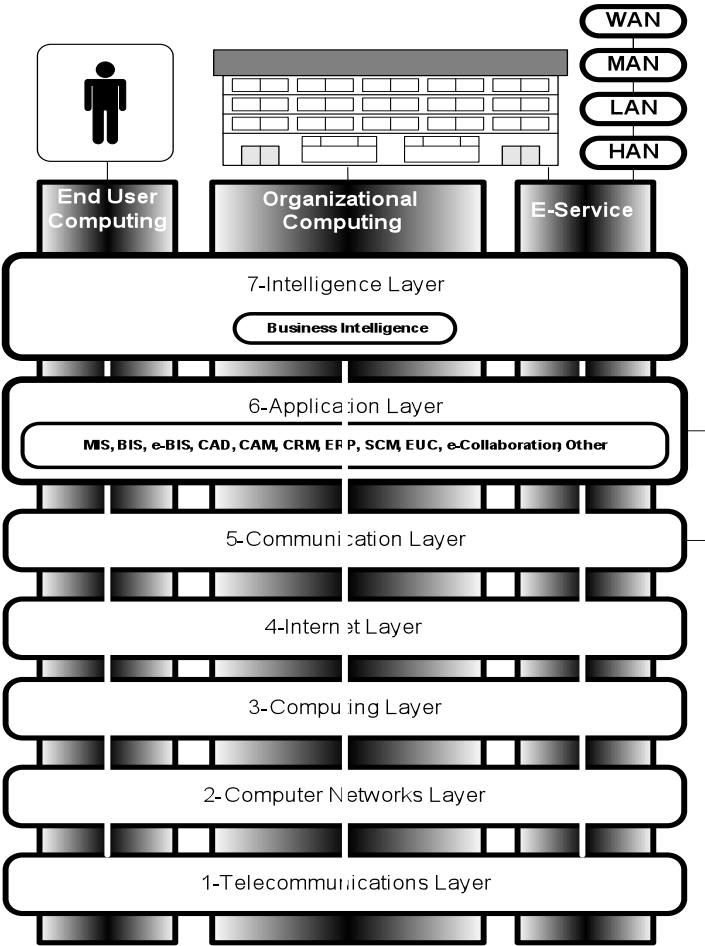


Figure 1 – The Classic Enterprise Information Infrastructure Architecture

3. Global enterprise information infrastructure

The Global Enterprise Information Infrastructure (G-EII) is the extension of the C-EII through the Global networks/infrastructure, as it is illustrated in Figure 2. The user-visible Layer 6 has applications more complex than applications of a classic enterprise, since they have to cover that enterprise geographic presence around the Globe and must comply with a given set of nations' legal rules. This requirement is particularly important in the Human Resources Applications, which must comply with each country's rules. In the G-EII new applications are in demand, such ones as; e-Collaboration, e-CAD/CAM. The e-Collaboration allows for simultaneous team or teams work in a virtual space, including virtual reality, saving on the costs of trips to be in meetings. E-CAD/CAM is particularly applicable in off-shore outsourcing of manufacturing processes. Also e-Library is a convenient application, particularly for remotely located users, without a limited access to good libraries.

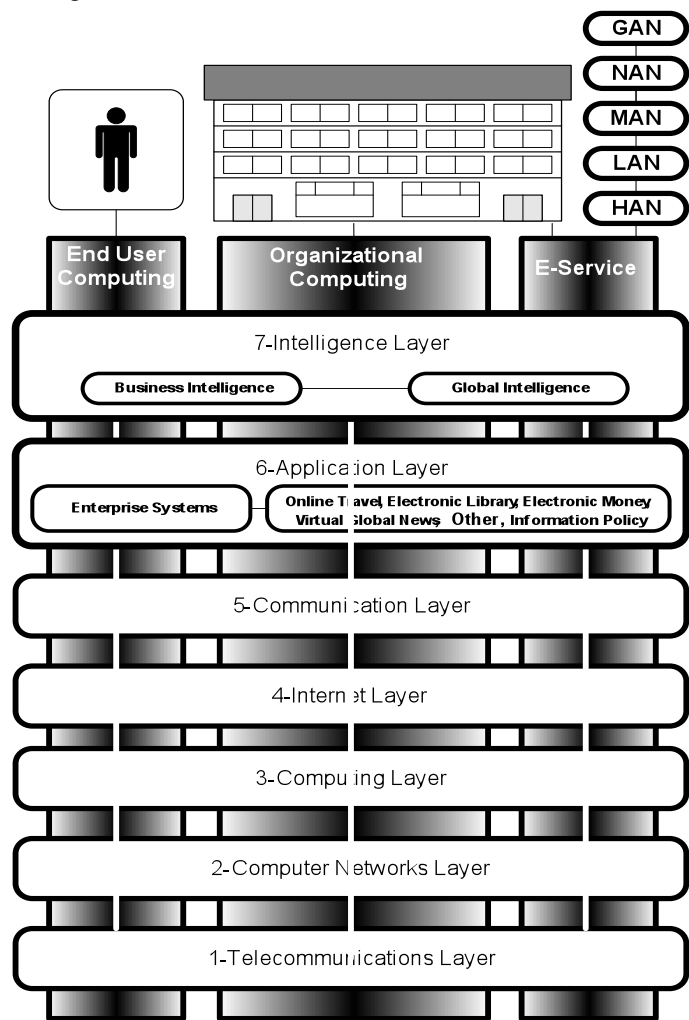


Figure 2 – The Global Information Infrastructure Architecture

The 7-Intelligence Layer contains two intelligence-oriented systems, the classic business intelligence and global intelligence. The difference between BI and GI is in their content; the latter analyzes business processes in the global platform and traces the Globalization Index to be aware of a given enterprise's global operations.

4. Global civilization and global enterprise

The current third wave of globalization takes place on the threshold of the third millennium and is the most extensive to date. Globalization refers to a multidimensional set of social processes that create, multiply, stretch, and intensify worldwide social interdependencies and exchanges while at the same time fostering in people a growing awareness of deepening connections between the local and distant (Steger, 2003). The World is shrinking fast and comes together as a Global Civilization, which shapes our lives and changes politics, work, and families.

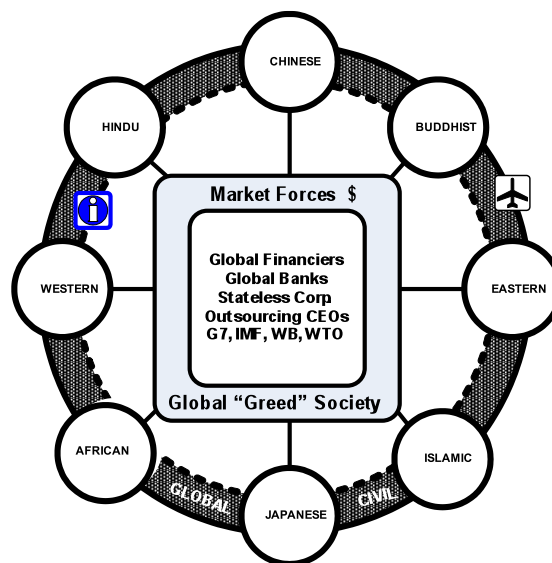


Figure 3 - The Solar Model of Global Civilization in the 21st Century

A model of Global Civilization is shown in Figure 7-2. This model indicates that the Global Civilization is possible because the Internet and global transportation systems and is driven by market forces only, which in many opinions are driven by stateless corporations' greed and unregulated policies, since their strategies and operations are very difficult to regulate by international organizations. In other words the Global Civilization is getting out of social control and while it can be stopped, it cannot be the only solution for the World Civilization's progress and survival.

The notion of "globalization" and its universality is perceived by many as a Western value only. According to United Nations statistics, most of the people in the world do not have running water, most are illiterate, most have less than a high school education, and many are malnourished. Similarly, the "Silicon Valleys" of the "Third World," in places such as Bangalore, are sensationally displayed as further evidence of this globalism, when just a few blocks away from the internet cafes and computer shops in Bangalore (which themselves occupy only a few

blocks), rural India in all its traditional manifestations resumes its predominance. Thus, with the exception of the Group of Eight industrialized countries (G8) – all of which except one are Western – the majority of people on this globe do not truly and meaningfully benefit from, nor form a crucial part of, that globalization.

Through the time from 4,000 B.C. till 1800 A.D. our civilization was growing 3 percent per 1000 years and the budgeting of strategic resources was not the issue (Maddison 2001). Since the Industrial Revolution in the 19th century, civilization was in the Accelerated Growth and in the 21st century it entered the Growth Trap period, when the Accelerated Growth is even intensified by the growth of population and managerial/global or even super capitalism, which looks for tremendous growth in executive benefits and replaces voters by lobbyists.

We used to think and act in terms of a local community, nation, region, even a group of nations, but now we need to take these considerations in a broader – planetary context, if we want to sustain our social life. The planet is so large for every individual but for the population is becoming smaller and smaller. In the last 200 years the population grown from 300 million to 6.7 billion (Figure 9) and is still growing. We have about 4.7 acres of available footprint but we use 5.4 acres in terms of calculated resources. “We are living beyond our ecological means. The planet is shrinking, because we are running out of resources. We are using the planet with such intensity that it is unable to restore itself” (Steffen 2008:16).

The global-oriented enterprises are mostly stateless corporations which promote the following business practices:

1. The sky is the limit in business? Really, what about depleting resources and inequality?
2. Growth-centered business? Starbucks around each corner?
3. Enlarge the market share? 200 new Wal-Mart stores every year in the U.S?
4. Efficiency obsessed business? What about the environmental destruction--200,000 acres of cropland under a single manager? But smaller farms produce much more food per acre (in tons, calories and in dollars)
5. Only business effectiveness? Only minimized cost is the most important factor? Neglecting environment and community costs.
6. Getting business moving? But where business is moving is less important, at \$2.5 billion/day foreign trade deficit, and exporting debts is it the American business direction?
7. Globalization is better than localization? To satisfy stateless corporations. Perhaps the truth is vice versa.
8. If you “do not fit it is your fault, re-skill.” Government advises, go to community colleges and be another craftsmen? What about university graduates?
9. We teach “information and knowledge” but what about teaching “wisdom”? Can we differentiate knowledge from wisdom?
10. We teach short-term decision-making? Long-term sounds like central planning? No vision is plus?
11. Human resources of the 1960-70s vs. of the 2000th. Workers are strategic resources (past) vs. disposable commodity (today).
12. Anti-Fordism, factories without workers? It is possible but necessary?
13. Social cohesion and economic forces are splitting apart, but we are irrelevant in teaching about it.
14. The “football strategy”-the leader (CEO) takes all? What about the other stakeholders?
15. From individualism to super-individualism (there is no such thing as “society,” only individuals and families (M. Thatcher)?
16. Only leadership is important in autistic business of isolated individuals?
17. Stay at home and virtualize? Since it is possible but is it necessary?

18. An urban core giving way to an urban prairie. It is what we strive in advanced civilizations?
19. We in Western Civilization cannot compete with others, therefore we have to accept the decline of our level of living? It is not true, since we compete with sweatshops and this is not fair competition.
20. Other.

These questionable business practices lead to the necessity of developing a sustainable and global enterprise which will (Princen 2007):

1. Mitigate the super-consumerism by promoting “cautious consuming”
2. Promote the rational principle of “sufficiency” in the context of the strategic resources depletion, since the economy cannot operate as if there is never enough and never too much. Sufficiency is contrary to modern society’s dominant principle efficiency.

5. Sustainable and global enterprise information infrastructure

The footprint methodology determines humanity’s total impact on the planet in terms of being within or exceeding the earth’s biocapacity. Today, the earth has just over 15 hectares of bioproductive land per person, but the average per capita footprint is 22 hectares. It means that each person on earth (on average) is using about 6 more hectares of productive land than is available. This is known as overshoot. Since this extra land is not technically available, the figure of 6 hectares is a way to represent the fact that human demands on the environment are greater than the earth can support.

The opposite of overshoot is “sustainability” – living within the limits of the environment. Sustainability it is “progress that meets the needs of the present without compromising the ability of future generations to meet their needs” (The Brundtland 1987). In broad terms, business sustainable practices mean that the current generation’s moral obligation is to ensure that future generations enjoy at least as good a quality of life as the current generation has now (Pezzey 1989). In order to do so the current generation must apply the following strategies:

- Economic vitality
- Environmental accountability
- Social responsibility

According to Dow Jones measuring business sustainability or corporate sustainability is a business approach that creates long-term shareholder value by embracing opportunities and managing risk deriving from economic, environmental and social developments. Several types of sustainability indexes measure a given corporation’s ability to run a sustainable business. The architecture of the Sustainable and Global EII is shown in Figure 4.

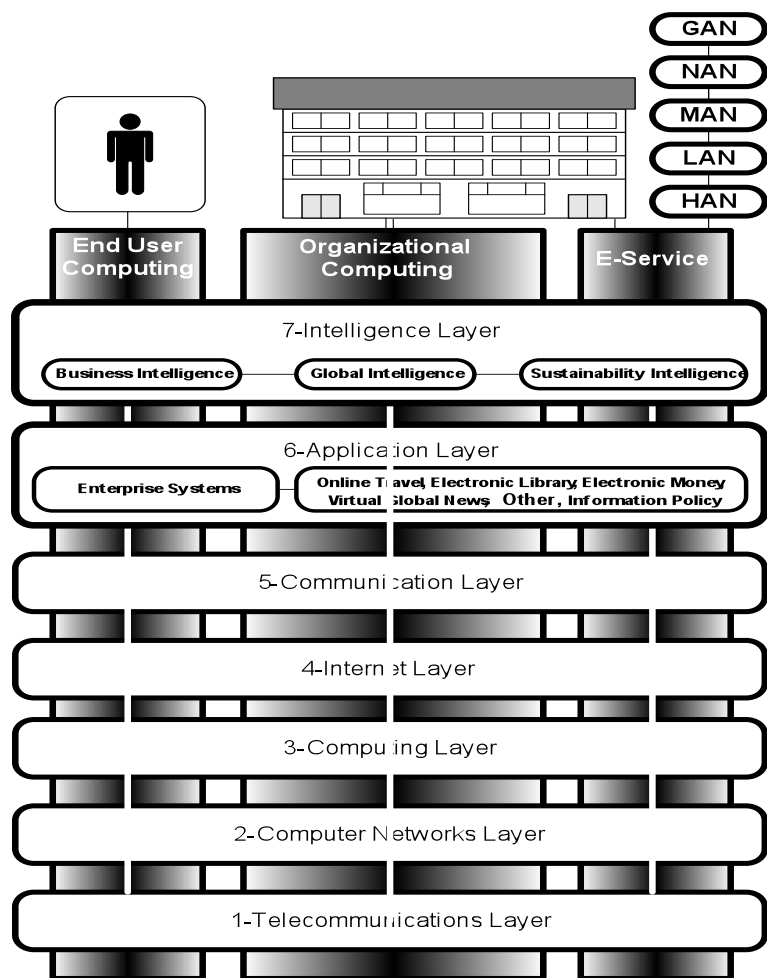


Figure 4 – The Sustainable, Global Enterprise Information Infrastructure Architecture

Figure 5 defines the content of the 7th Intelligence Layer. The main component of the 7th Layer is a set of key performance indicators (KPI) monitored by the systems of Business Intelligence (BI), Global Intelligence (GI), and Sustainability Intelligence (SI). The BI's Key Performance Indicators belong to the well established Balance Scorecard.

These three sets of intelligence should be coordinated into one composite Management Dashboard.

The sustainable, global enterprises operate within the civilization boundaries and either protect or destroy civilization. Therefore its place must be noticed in the civilization monitoring system, and vice versa.

6. Monitoring and predicting systems of sustainable global civilization

The current level of the world affairs on the one hand is tending to deemphasize the meaning of a state for the sake of larger organizations such as EU or NAFTA, on the other hand more and more the political and economic competition in the world is taking place at the level of a civilization. Samuel D. Huntington (1993) argues that the clash of civilizations characterizes a new world order after the Cold War (1945-91). Civilization is a larger in space and time entity composed of humans (society), their culture and infrastructure. In the last 6,000 years we had about 30 civilizations, which nowadays are: Western, Eastern, Chinese, Japanese, Hindu, Islamic, Buddhist, and African, oriented by religion and emerging Global Civilization driven by business (Targowski 2009).

The future of world civilization is bleak, since the combination of Population Bomb, Ecological Bomb, and Depletion of Strategic Resources Bomb creates the Death Triangle of Civilization which about 2050 will be very evident Targowski 2009:404). Its first symptoms are evident nowadays, under the form of the overcrowded Planet, deforestation and land degradation, greenhouse effect, floods, drought, shrinking strategic resources, and so forth. The financial and economic crisis in 2008-09, which was triggered mostly by the global, stateless corporations, shows the relationships among the enterprise and civilization levels must be established for the sake of the humans' survival, even in the perceived future.

The relationships among Intelligence Systems of Sustainable, Global Enterprises and a given civilization such one as the Western Civilization and the World Civilization is depicted in Figure 6. The Civilization Monitoring and Predicting System (CMPS) is the set of the following components:

- Aggregated KPIs of the Enterprises (sustainability, globalization, and business),
- Population Index
- Living Planet Index
- Biophysical Index
- Wars and Conflicts Index
- Well-being of Nations
- Eco-efficiency Index
- Resources Index
- Societal Index
- Globalization Index
- Genuine Progress Indicator
- Other
- Aggregated Index of a given civilization
- Aggregated Index of World Civilization

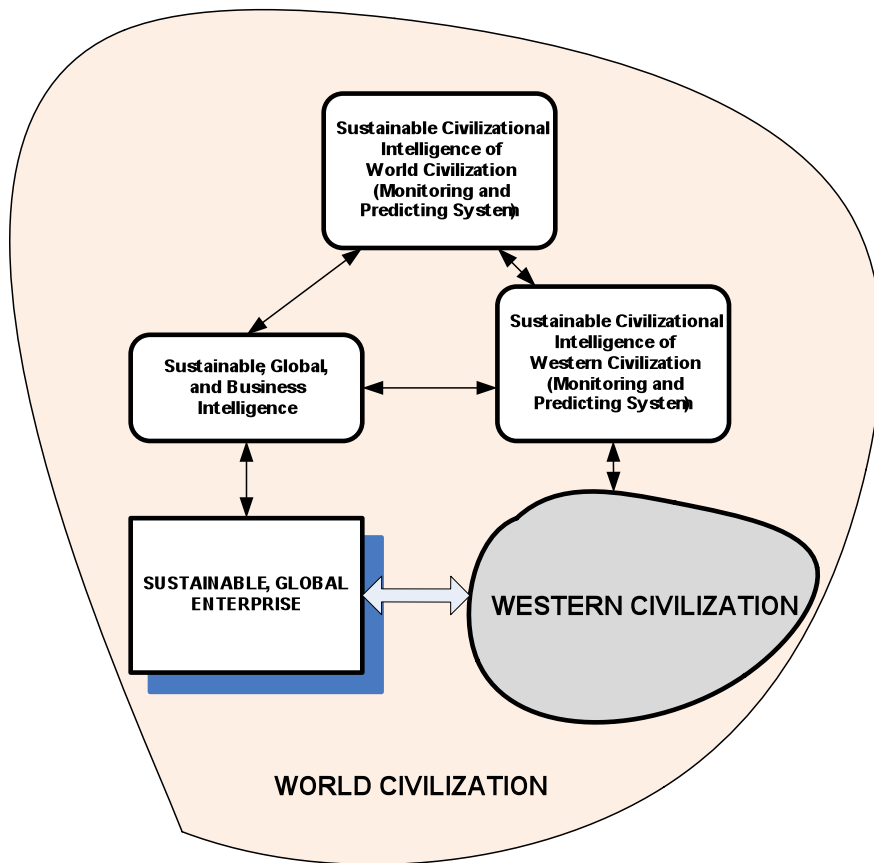


Figure 6 – The Monitoring and Predicting Systems of Civilizations (An example limited to the Western civilization)

There are about 20 different indexes which measure the dynamics of civilization but there is no one aggregated index which could easily monitor and predict the Planet's status and impact of humans behavior and develop sustainability spirit among institutions involve in developmental activities.

7. Conclusion

The pathways to a sustainable future of civilization depend upon the following activities:

1. Expanding the number of sustainable, global enterprises (SGE)
2. Establishing the relationships among the SGE level and national, and civilizational levels
3. Embedding strategies of sustainability in development-oriented organizations
4. Strengthening national and civilizational coordination, leading to:
 - a. Improving livelihoods on fragile lands
 - b. Transforming policies associated with the use of land, water, energy
 - c. Getting the best from cities
 - d. Other

5. Strengthening the institutions to solve global problems
6. Other

Figure 7 defines a model of the Sustainable, Global Civilization, which perhaps has chances for more rational development.

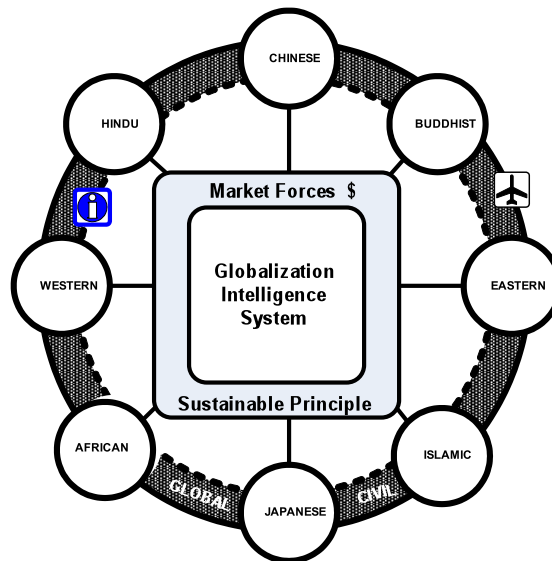


Figure 7 – The Solar Model of Sustainable, Global Civilization in the 21st Century

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Workforce Dynamics Simulator in Service Operations Scheduling Systems

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Abstract: For service enterprises, changing their organization becomes inevitable to comply with new work or environment regulations, to incorporate new technologies while remaining competitive. In order to anticipate the implication of these changes, it is important to understand the dynamics between workforce and work allocation systems. This paper talks about using dynamic scheduling systems to simulation the behavior of the workforce in the context of Telecommunications service operations. The simulation environment described here relies on a multi-agent system coupled to optimization algorithms. It enables the impact of changes in organization and working practices to be assessed so that the benefits and risk of different alternatives can be investigated in advance of implementation.

Keywords: simulation, workforce dynamics, dynamic scheduling, multi-agent systems.

1. Introduction

With the growth of the services sector in the past decades, systems for service management (Fitzsimmons & Fitzsimmons, 2001) are becoming increasingly important for companies, to achieve good productivity and customer satisfaction and to remain competitive. This includes systems for designing and launching new services and advanced planning and scheduling solutions for automating and optimizing service operations (Voudouris, Owusu, Dorne, & McCormick, 2007). The effective planning and scheduling of resources is critical to optimal service delivery in service organizations. This is no different in principle to Manufacturing Planning and Control (MPC) (Vollman, Berry, Jacobs, & Whybark, 2004), however the focus in services is on people and assets rather than materials. Most often the people are highly mobile, offering services across a large geographical area. The completion of the workload then depends on how the organization that provides the services is structured and the interaction between the work allocation system and mobile fleets and in general the ways of working. To remain competitive and comply with the new Carbon emissions regulations, service enterprises are interested in transforming the way they manage their workforce. An important step in the transformation of workforce management in a service enterprise consists of identifying the strategies of resource management that suit to the business. These strategies have also to meet constraints like legal regulations, transport capacity and the privacy of employees. This implies

also predicting the return on investment and assessing the impacts (benefits and risk) of the working practice change on the productivity and the dynamics of the mobile workers.

1.1. Workforce scheduling in service operations

In the context of service provision, scheduling of work consists of allocating (in the most optimal manner) the geographically distributed service activities (jobs captured from customers' orders, maintenance tasks), to resources (multi-skilled engineers, vehicles, assets) such that the operational cost is minimized and on-time completion of jobs is maximized. In other words, it is about assigning the right job to the right resource in the right place at the right time with the right equipment. A schedule is the ordering of job assignments into time sequences and routes. The execution of a schedule processes the delivery of services to clients over a horizon of one day to several weeks.

As an example, BT has more than 150,000 tasks to be allocated to 30,000 field technicians every day. This Workforce scheduling challenge is a multi-objective optimization problem of resource scheduling, similar to a Vehicle Routing problem, under constraints and in a dynamic context (Liret, Lesaint, Dorne, & Voudouris, 2007). To reduce the complexity of the problem, it is decomposed into sub-problems. Each sub-problem represents a geographical area (with its associated jobs) to which engineers are assigned each day (Figure 1). These working areas determine the geographical zone and types of jobs (for instance, Private Service, Broadband, Transmission, Frames) the engineers can be assigned to. Jobs are split into two groups, Provision order and Repair job; however technician resources can perform both at the same day so the problem cannot be split into provision work scheduling and repair work scheduling sub-problems. As explained in (Borenstein et al., 2009), the underlying problem be thought of as a generalization of the Vehicle Routing Problem with Time Windows (VRPTW) with dynamic variants (Larsen, Madsen, & Solomon, 2004). However, in our case the fleet of vehicles is not homogenous: technicians have different numbers and types of skills as well as different depots (or home locations). In addition, tasks require different skills, may have different priorities, and the duration of tasks may vary from 20 minutes to more than 2 hours.

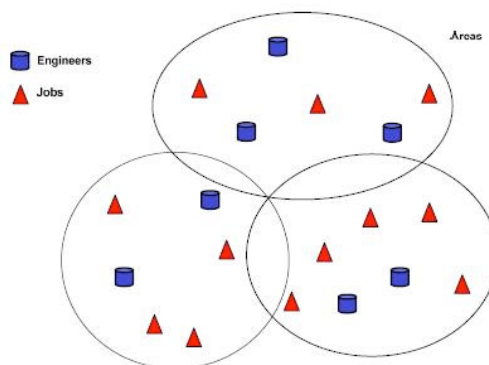


Figure 1 – Generic problem of mobile workforce scheduling where the goal is to allocate tasks (triangle) to resources (cylinder).

Among the many real world difficulties to take into account are that the schedule is subject to engineer's availability and mobility, job constraints (task can be performed only within its time window, may be linked to job to execute in parallel or in precedence), job cost objectives (completion by target times), skill-based productivity, resource constraints (resource can do one task at a time, travel at fixed speed and is unavailable during travel times). The dynamic aspect of

the problem requires modeling task duration by a stochastic variable and tasks incoming in the work allocation system during the day. The Dynamic Workforce Scheduling Problem we consider consists of scheduling a multi-skilled workforce to geographically dispersed tasks in which both tasks and resources are grouped into areas. (Borenstein et al., 2009) details the dynamic aspect of the problem and the uncertainty in data which has to be considered in our case.

One approach for handling real-world dynamic scheduling problems consists of a pre-emptive scheduling system which computes work and route plans, and a work allocation system which assigns jobs to engineers. Pre-emptive scheduling systems look at costs optimization when building the line of work or each resource. Dispatching or work allocation systems have to assign tasks to engineers according to demanding responsiveness constraints; For that reason the dispatching system usually does not look for optimum assignment but rather applies rules to guide toward limited damage in the planned schedule of work.

The system follows the schedule unless real time events occur; causing a disturbance that renders the schedule not “runnable” (Kizilisik, 1999). In which case, the work plan is adjusted by the system (Figure 2). This operation, called schedule repair, can be very time-consuming if performed on the whole schedule, which makes it incompatible with a real-time work allocation process. Indeed, due to the inherently stochastic aspect of the environment, the system has continuously to import new data while minimizing the impact on the current schedule. Field engineers are subject to perturbations (mechanical failure, weather, traffic, sickness), last minute changes on availability. For a complete description of work allocation and scheduling, please refer to (Liret & Dorne, 2008).

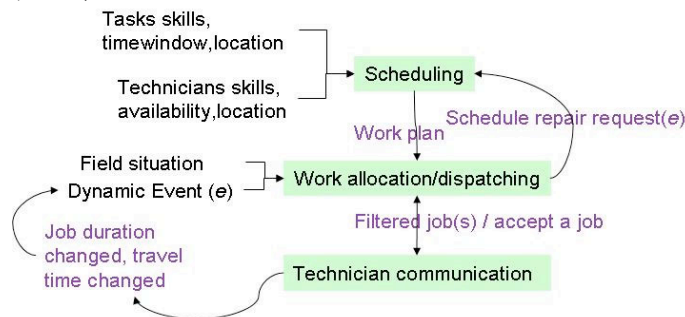


Figure 2 – Typical Dynamic Scheduling problem. An initial schedule is generated based on volume of tasks and technicians availability. The schedule is modified in response to field events.

1.2. Need for a simulation environment

It is very difficult to assess the impact of real time events on the expected efficiency of the workforce. This includes not only the robustness of a pre-emptive schedule but also any estimation regarding the ability of the workforce to accommodate new services that the enterprise might want to introduce. If we could assess the impact of the perturbations on the execution of a work plan in advance, we could adapt the schedule repair algorithms accordingly. Moreover, jobs may be too ‘expensive’ to assign for the pre-emptive scheduler because they are in a working area where no engineer has the required skill. In that case, it would be helpful to investigate what combination of working areas and skills would achieve higher rates of overall job completion and on-time completion, and what improvement in the ratio between traveling time and working time we could get. The Workforce Dynamics Simulator (WDS) is a tool that enables the simulation of various working practices, organizational structures and work allocation scenarios in the light of event-driven perturbations to examine their impact on the execution of work plans based on

historical or generated data. WDS either computes an estimated schedule or takes one as an input, and then runs the travel and execution of jobs by engineers over one or more days, using a rule-based work allocation system if the estimated schedule becomes incompatible with the situation in the field.

It is critical to understand the dynamic between field engineers and work allocation systems to assess the impact of changing working ways or services structure. For instance, should the work allocation system push jobs to engineers or let them choose their next task from a (filtered) list? Should we limit the number of jobs or the type of jobs per engineer? What is the impact of the fact that engineers sometimes cooperate with each other on a given task? Would it be beneficial to motivate them to cooperate, for instance, using the logic of bonus as in Game Theory (Axelrod, 1997)? Can the workforce accommodate a one-hour slot booking facility to customers? Would the engineers' productivity increase if engineers could perform jobs in geographically independent working areas? What would happen if some/all engineers were reserved for high priority job? What is the predicted impact on the performance indexes when training people to do a type of jobs or changing the roster patterns? What would be the quality of service when introducing a new product? The ultimate goal is to simulate accurately enough the behavior of field engineers and interactions with systems so that the enterprise can evaluate scenarios and consequently anticipate the implications of working practice changes and business organization changes.

This paper describes WDS, a simulation environment, based on multi-agents system, which enables users to model these different scenarios, run simulations and record performance for analysis. Section 2 describes WDS. Section 3 outlines the analysis carried out so far. Section 4 presents our conclusions.

2. Simulation environment

Simulation tools have been around for a long time in Telecom network traffic routing, but have not been widely used on the domain of ICT services delivery. Nevertheless, modeling the behavior of people, machines, or organizations in a dynamic context has widely been studied and implements well in the form of multi-agents systems. Multi-agents systems are often used to implement coordination, negotiation models. In particular they help in modeling in a distributed manner multi-objective scheduling problems, for instance (Aknine, 1999) in hospital context. The WDS simulation environment has two distinguishing features: it focuses on people; it makes it easy to devise and run what-if scenarios.

Figure 3 gives an overview of the simulation tool. It takes as an input data about jobs, people, skills, working areas and set of parameters the Field Engineering manager can play with. The data is then interpreted as daily demand and supply and loaded into the simulation model. The tool allows observing and profiling the simulation through the GUI: the simulation can be stopped any time, the simulation board tracks the variation of the task and people status in simulated time. Parameters reflect possible workload and working ways, and include: Area parameter, Job parameters (type, number, time window, skill and geographical distribution), People parameters (type, number, skill mix, potentially roster pattern and location). The current version of WDS simulates the behavior of work allocation systems at the dispatching level. It provides daily performance measures which then have to be compared against the known performance indexes.

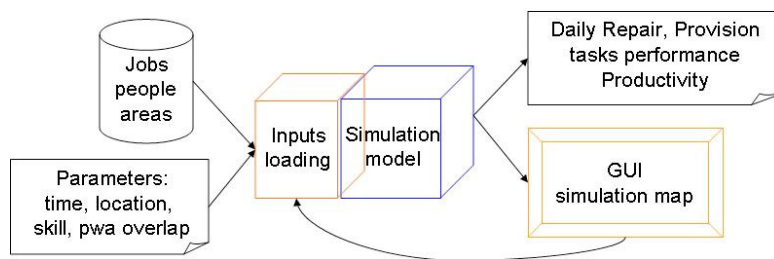


Figure 3 – Overview of the simulation tool

2.1. Description of the model

The WDS model has to reflect the features of the problem, especially the dynamic context, mainly the presence of unexpected perturbations and the uncertainty in data and event properties or occurrence. The system is decomposed into four components. Figure 4 provides an overview.

- **Demand generation and supply generation:** creates the demand (jobs) and supply (resources) from actual, historical or randomly generated data. It simulates the interactions and information expected from a Customer Relationship Management system (new incoming jobs, cancellation of task). To reflect the uncertainty in job duration data, the job duration can be changed by applying a Gaussian distribution function on the historical/actual job duration. The time windows of jobs can also be changed to reflect changing customer appointment times during the day.
- **Work Scheduling and dispatch:** is in charge of dispatching tasks to engineers during the simulated period, and generating estimated schedules. It simulates totally or partially automated work allocation systems. It offers an API to plug in an external scheduler. It allows the impact of various strategies on the engineers' schedules to be tested, for instance "to limit the number of allocated tasks to a maximum of 3 per day per engineer".
- **Orchestration and Multi-agent simulation:** orchestrates the interactions between different actors, work allocation systems, team leader/engineer planner, field engineers, controllers, job process/workflows, etc. It simulates simple human behaviors (reward, motivation, cooperation).
- **Real World Time Estimation:** is an important component that aims to model the effect of real-world uncertainty on the scheduling algorithm. For example, what will be the effect on the scheduler if a task which was assumed to take up to 30 minutes to complete requires, in reality, 60 minutes? It defines a probability distribution for each dynamic event. Two events are considered so far: the duration of a task and the travel duration. The duration of a task is, in principle, a function of the skill, the experience of the technician and the location of the task (i.e., private house, company premises or an exchange building). Travel duration is a function of the distance, the accessibility (i.e., roads) and the time of the day.

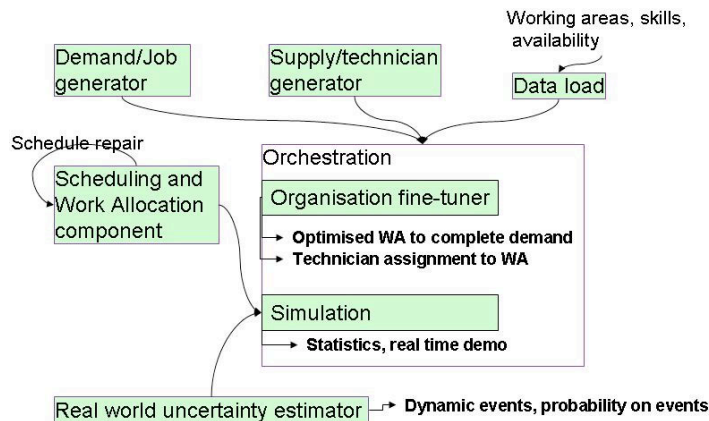


Figure 4 – Overview of the components in WDS

The WDS captures the interaction between three types of agents: “job generation”, “scheduler” and “tech”. The simulation consists of generating jobs, reporting them to the scheduler agent which is then responsible to allocate them to available technicians. Figure 5 gives an example of a scenario.

- The **Job Generation Agent** generates jobs based either on historical, artificial or mixed (historical and artificial) data. A job can be either reported at the beginning of the day, or, in order to simulate incoming jobs, at anytime during the day. This agent is responsible for feeding jobs into the simulation at the time corresponding to the time the job was reported.
- The **Scheduler Agent** receives incoming jobs from the job generation agent. It then allocates them to available technicians. The agent is linked to an interface of a scheduling algorithm which is notified of any event which might affect the scheduling (i.e., new jobs, availability of technicians, delays etc.). The agent can allocate technicians either according to the scheduling algorithm or in an independent manner. Examples of the latter include the rule-based reactive dispatch of jobs or engineer-based job selection from a list (i.e. empowerment logic).
- The **Technician Agent** models the behavior of the technician, i.e. receiving a job from the scheduler agent, traveling to the job location and performing the job, then waiting for the next job. The technician agent reports the completion of each of these steps to the scheduler agent (e.g., arrival at job location, job starts, job ends). The technician agent may receive a list of jobs, in which case it will choose one according to some preference. The technician agent is inactive at the appropriate time to simulate a lunch break, but in the current version of WDS we do not model coffee breaks.

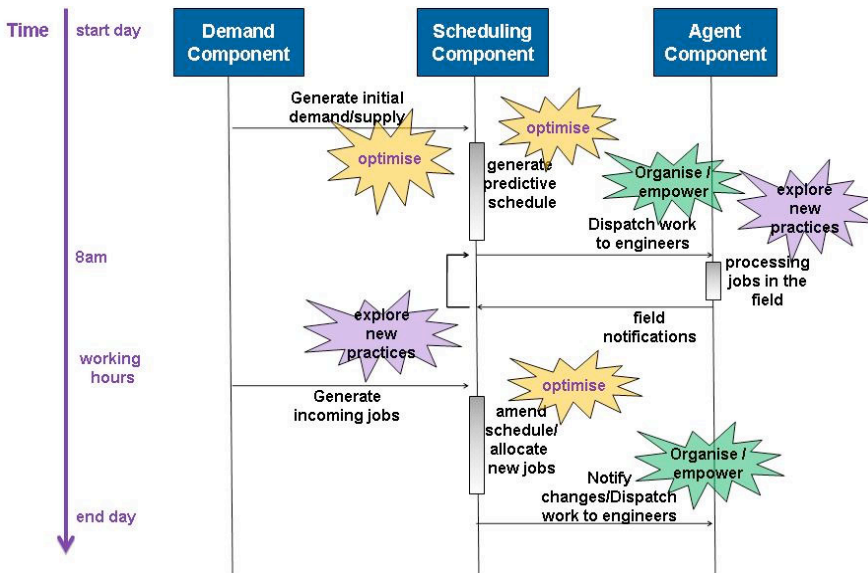


Figure 5 – Sequence diagram of a scenario.

2.2. Algorithms in Simulation

The WDS allows various scenarios to be modeled, thanks to the availability of a large set of parameters relating to problem definition.

- **Clustering of tasks:** group tasks into meaningful sub-areas based on geographical distribution and skills. This allows working areas that strictly follow the location of present tasks to be dynamically defined.
- **Allocation of Technicians to Areas:** assign each technician to one or more working areas. This algorithm partitions the scheduling problem into geographically independent problems. Based on a k-means algorithm, it computes the best technicians-area assignments according to four objectives (available tasks, engineers able to do the tasks, skills the technician can use in the area, number of tasks the technician can complete per day) (Borenstein et al, 2008).
- **Optimization of the working areas partitioning:** obtain the optimal definition for a particular distribution of tasks. Each working area can overlap (or not) with another working area. The algorithm optimizes the location of working areas centers by minimizing the distance between centers and jobs.
- **Scheduling of jobs:** the Scheduler used in WDS can be the internal one based on a fast local search or an external one, such as (Liret et al., 2007).

Figures 6 shows the distribution of working areas in the WDS demo (Red lines) and the technician assignment to working areas; This can either reproduce historical existing data or be optimized by the WDS algorithms. Three type of job dynamic scheduling methods were investigated: rule based system, coupling predictive-reactive scheduling, engineer-based logic.

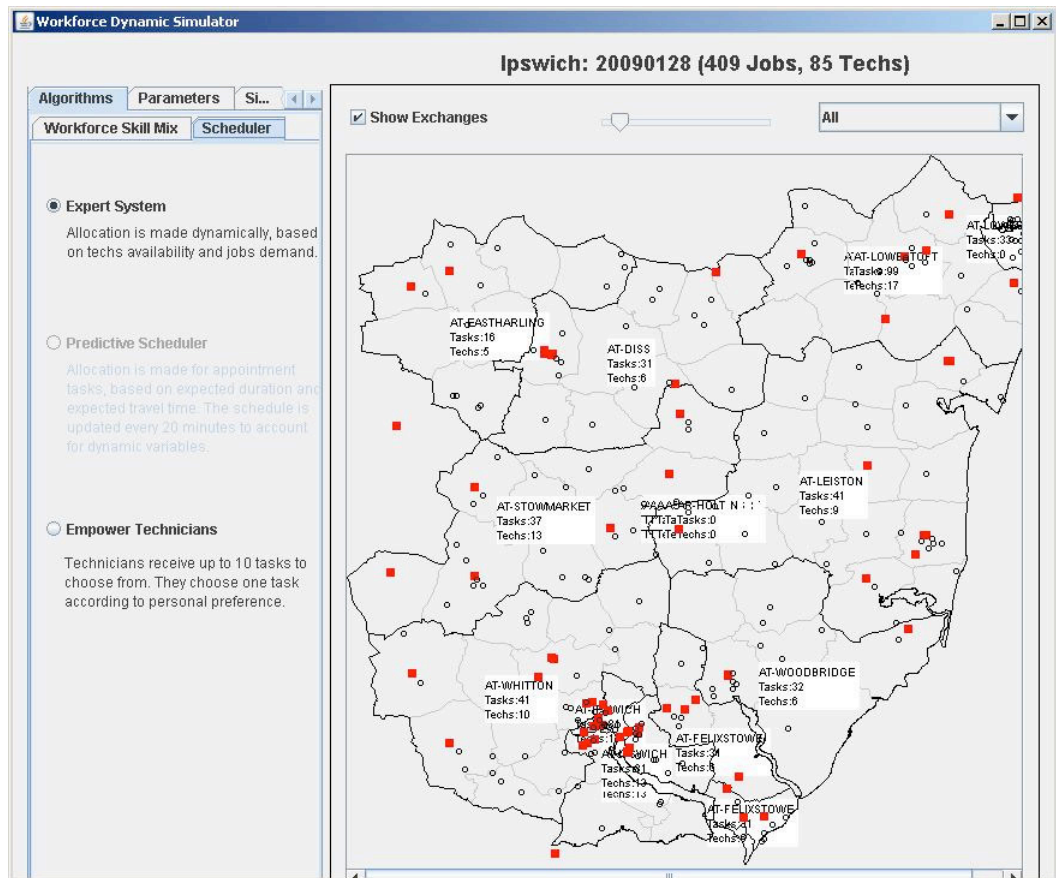
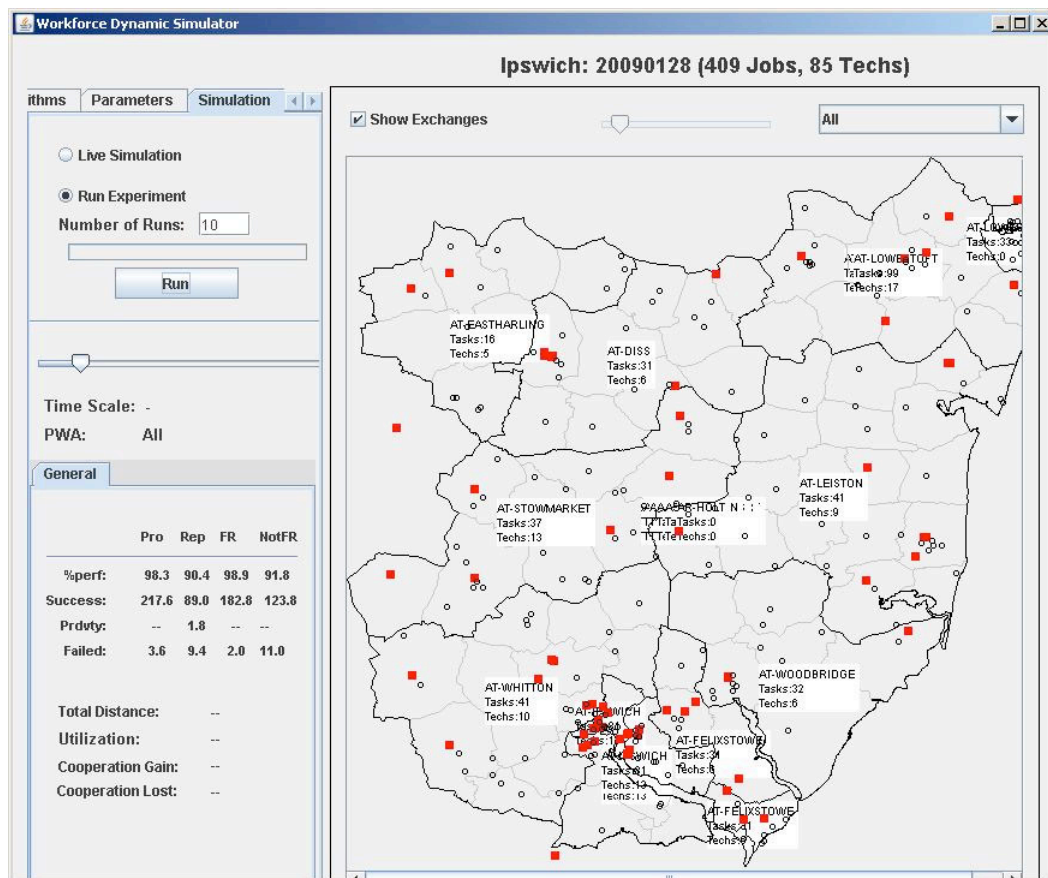


Figure 6 – the distribution of working areas and jobs an people accross areas.

Figure 7 shows the resulting actual work plan as executed by the field engineers in a simulation. Circle points indicate jobs (color based on status). Squares indicate moving resources. During the simulation, a snapshot can be taken at any time. Left part shows performance observations for task types.



2.3. Example

The WDS tool can, for example, help the field engineer managers to make manual decisions (in light of unexpected events). For example, the user can load the data of today in the morning and simulate fast forward work allocation for the rest of the day. From the result of the simulation, the user can, for instance, identify area A where productivity is small and area B where the predicted number of failures in job completion is high. By changing the parameter of the tool to simulate people move from A to B, and re-running the simulation for the rest of the day, the user can check the predicted productivity and the predicted number of failures in a set of areas, and eventually decide to reserve resources for them to work in an area where volume of failures is predicted to be high, by temporarily assigning engineers from an area where the predicted productivity is low.

Example:

The overlapping of working areas consists of redefining the areas by including more job locations. It is determined by a distance from the task to the centre of the initial working areas. A parameter, the average distance $d(\text{task}, \text{area centre})$ can be changed to modulate the jobs which are included in the working areas. It is possible to focus on a particular area or a set of/all areas.

Therefore jobs may belong to more than one working area and the potential number of available engineers increases. However, the travel time may also increase as engineers may go to jobs located in working areas other than the one closest to them. The analysis aims at discovering the tradeoffs between travel increase and performance increase. Figure 7 illustrates overlapping working areas (called PWA here).

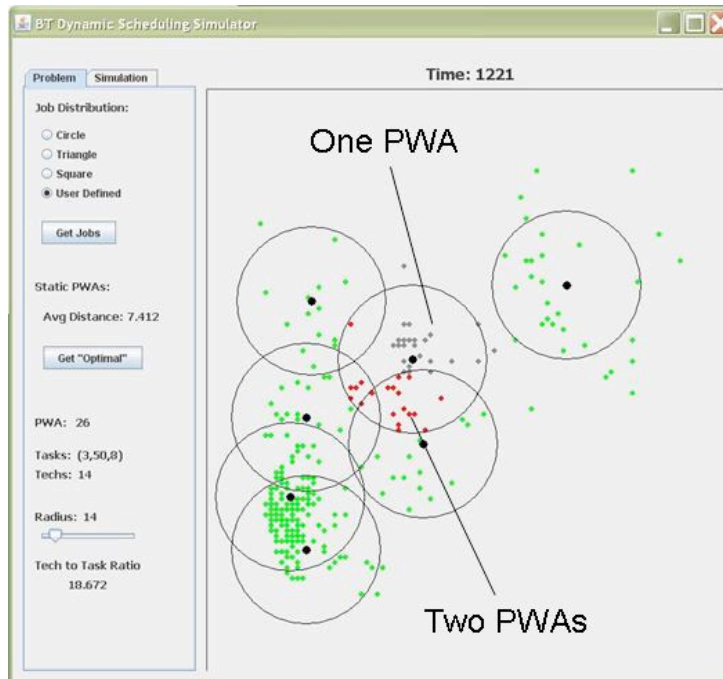


Figure 7 – Case of overlapping working areas

3. Analysis

We first validated the assumptions of the model against what happens in the enterprise. Then we carried out two types of analysis 1) to investigate the organization of skill sets and working areas that gives advantageous results; 2) to investigate empowerment scenarios and the impact of motivating engineers to cooperate to complete a task.

3.1. Validation

The simulation is used as a predictive model. In order to validate the reliability of the WDS tool it is necessary to show that the system can predict the performance given an initial (daily) setup when compared to known measures used by the Field Engineering managers, and with a certain percentage of accuracy. A work on fine tuning/adjustment is needed to calibrate the simulator.

The goal is to calibrate the system by fine-tuning the model so that the simulation of a standard scenario of work from historical and actual data provides performance measures which are comparable to the values seen in the real world. Values are not expected to be the same because the events which are generated in WDS don't systematically match the events which occur in the

real world. Instead we tracked both sets of values over a long enough period to see whether the difference between them was consistent.

What complicates the validation is the inherent uncertainty in live data reported by field engineers during the day, in particular on the actual date of: job completion, actual travel time and actual time spent on site working on the task. We split the tasks into two categories: Provision (service provisioning order type) and Repair (existing service maintenance type). Tasks are measured only on their completion date. Also the difficulty of validation comes from the fact that Provision jobs may contain more than one task, hence requiring tracking the task completion to deduce the job completion.

Compared measures are the following for each category:

- Volume of tasks being reported as completed before their commitment time during the day (success task)
- Volume of tasks being reported as completed but after their commitment time during the day (failure task) this include tasks being failed at the start of the day (due time is past).
- Percentage of successful tasks over all completed tasks
- Productivity: it is a planning ratio of the number of completed tasks -whatever the commitment date- over the number of Equivalent Full-Time Employee (EqFTE). The EqFTE is obtained by dividing the total planned working hours by the agreed duration of a working day (usually between 7 and 8 hours).

We take daily workload and supply data, simulate work allocation over each day and want to show the tracks of measures closely match known Repair and Provision performance and Productivity. In WDS we count the percentage of completed tasks by commitment time (success), volume of successes and failures on a daily basis. Difference on a few days is expected. Figure 8 below shows the comparison of performance percentages and volumes for Provision and Repair with data over three months (60 dates). Chart in Figure 8 draws the tracks of the real and simulated provision productivity. Chart in Figure 9 draws the daily volume of success repair tasks, in reality and obtained with WDS.

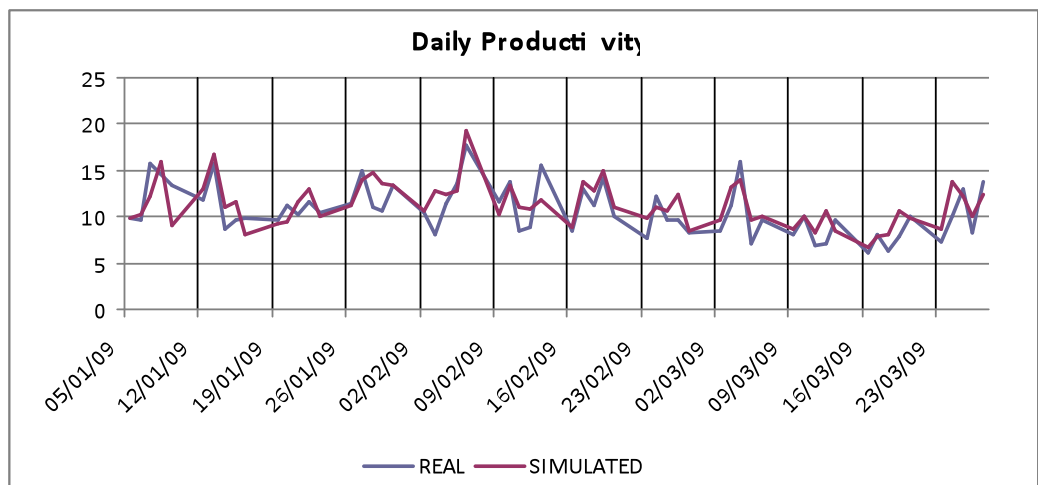


Figure 8 – Real and simulated productivity measures for Provision jobs.

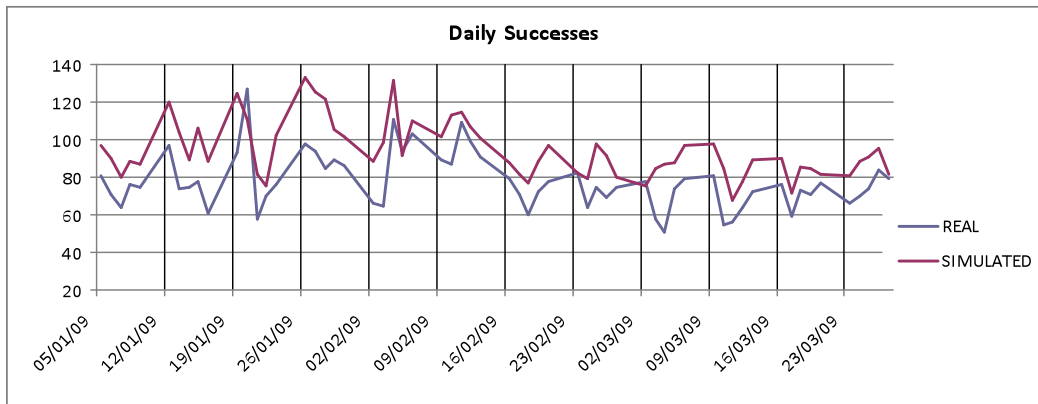


Figure 9 – Real and simulated volume of successes on Repair tasks.

In most of cases the tracks go in the same direction; to evaluate whether the relationship between predicted performance values and know reference real values is significant, we use Pearson correlation statistics to identify relationships on the set of dates. We compute correlation for each month and in total set of the three months. Correlation on Provision productivity measures is 0.76 in total and between 0.6 and 0.8 on monthly data sets, which confirms an accurate relationship between simulated and real productivity. On Repair productivity the correlation varies a lot on each month, with a significant correlation of 0.71 for the third month. The correlation values on each monthly data set consistently show accurate simulated values of the Volume of Repair success tasks (0.72 to 0.81). Correlation on volume of failures is not straightforward to explicit because, as expected, the number of completed tasks having missed their commitment target time is very low both in real measures and in WDS (6 in average for Repair jobs and 4 in average for Provision jobs). All significant correlation values are positive which confirms that the WDS tool goes in the same direction as the real case.

3.2. Impact on the change of organization

From historical data, we can simulate the execution of a job schedule for one day (common historical data) in different situations, redefining the working areas and then analyze the impacts. The graphical user interface of WDS shows routes progressively followed by engineers, the change of status of technicians (busy, available, or traveling) and tasks (allocated non-allocated, delayed, failed, completed, in jeopardy, on-going). For our preliminary tests we used the clustering algorithm for the definition of areas dynamically based on daily demands, the algorithm optimizing the assignment of technicians to areas, the algorithm optimizing the overlapping of working areas, and the rule-based work allocation system. The fourth case corresponds to the case of having only one global working area for the whole region (all engineer can go everywhere).

Among the more interesting preliminary findings, the percentage of increase in travel time (>100%) in the case of each engineer having the same working area covering the whole region confirms this may no be appropriate for services requiring a number of geographical moves, though very few people remain without any jobs. The option of “overlapping areas” has to be tuned precisely as the performance level strongly depends on the distance used to compute overlapping. The optimization of the overlap has a cost but provides an acceptable increase in completed jobs and travel. The option which arises consists on optimizing the assignment of technicians to areas, with an increase of the completed jobs of more than 20% and around 10% of travel increase, Jobs allocation seems to be well balanced among engineers as the number of

people without any jobs decrease of 70%. Table 1 summarizes the cases described, according to performance (completed jobs), potential risk (difference from the initial organization).

Table 1 – Preliminary results for definition of working areas

Method	Performance	Potential Risk
Optimizing the Allocation of Technicians to Areas	1	Medium
Defining Areas Dynamically Based on Daily Demands	2	High
Overlapping Areas	3	Low
Having Only One Area	4	Medium

3.3. Impact of the change of working practices

Productivity strongly relates to engineer behavior when accepting and performing their tasks. Studies on staff empowerment have demonstrated that people’s commitment to work can be improved by delegating responsibility to them in a controlled manner (Wall & Leach, 2002). WDS multi-agent system has been extended with framework for modeling interaction between engineers, empowerment strategies and incentive schemes (Tsang, Virginas, Gosling, & Liu, 2008). So far analysis was carried out on individual empowerment, comparing the traditional approach of work allocation which consists on imposing the next job (Push), and the approach consisting on letting the engineer choosing his/her next job among a filtered list computed by the work allocation system checking skill compatibility, distance to job, job target time, other resources availability. We call this option Pull. (Shah et al., 2009) describes the state of the art in staff empowerment related to this work with WDS.

4. Conclusion

An important aspect of our century is the realization that the environment must be preserved. For example, driving restrictions and regulations on CO2 emissions and the consumption of energy are regularly introduced. Therefore new objectives and constraints should be implemented in the service operations with an impact on the way tasks are allocated and on the dynamics of mobile fleets. In this paper we presented an environment, based on a multi-agent system, which allows simulating the dynamics of mobile resources (engineers here) and their interactions with work allocation systems, which frequently are in place in service chain. WDS assumptions have been validated in the case of BT workforce for a particular geographical area. Validation study shows good predictive accuracy in some areas for both Service Provisioning and Fault Repair jobs. Simulation of scenarios and analysis of performance measures have lead to preliminary investigations of the benefits and potential risk of changing working areas or reserving resources for high priority work. The current model contains features taken from the real-world dynamic workforce scheduling problem that underlies the optimization of the service delivery in service chain. The approach could apply to other service domains, such as field services, construction, utilities, transport and logistics. This work was carried out in collaboration with the Flexible Workforce Management team of University of Essex.

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Production Information Systems Usability in Jordan

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Abstract: The Industrial sector is witnessing huge changes especially in the area of utilizing the capabilities of Information Technology (IT), where technology is becoming the focus of manufacturing firms. Technology is supporting the performance and efficiency of operations and sustaining competitive advantage for firms in an age of value concentration. This work explored the opinions of CEOs and CIOs of few industrial firms and found significant differences regarding the use of production information systems (PIS) and other IT applications. Different views were reported regarding the attention paid to such systems and the commitment to diffusing such systems within organizations. This paper utilized the Innovation Diffusion Theory (IDT), a classical theory extended from the work of Rogers (1983) and later by Moore and Benbasat (1991), where it concluded to major set of predictors that defined the adoption and diffusion rate (rate of adoption) within organizations and they are: relative advantage, ease of use, result demonstrability, image, visibility, trialability, compatibility, and voluntariness. This study addressed firms in the Al-Hasan Industrial Zone in Irbid city in Jordan and aimed at information managers and operations and general managers only. Results indicated that the adoption rate is acceptable and all variables have high means with respect to their evaluation by managers. Also, results demonstrability and ease of use were the most influential factors among all on the rate of adoption. The second part of the study explored the status of IT usage in manufacturing firms using a different sample of managers, where they were asked about the types of systems used and the relationship to some demographics. Results indicated that accounting information systems were widely used and distribution systems and manufacturing aiding systems were the least used. Also, size of firm with respect to sales and number of employees indicated higher computer literacy and higher adoption of diverse systems. Conclusions and future work are stated at the end of the paper.

Keywords: Innovation Diffusion Theory, Production Information Systems, Manufacturing and operations, Industrial firms, Jordan, Multiple Regression.

1. Introduction

The industrial sector in Jordan is one of the main dimensions in the economic life of the country and is a major contributor in local production figures. Statistics indicate a contribution of 21.5% of the local production in the year 2006, which concluded 90% of the national size of exportation (Industrial Chamber Website, 2008). Thus the attention paid to this sector is one of the factors that lead to improving this sector's efficiency and productivity. Statistics also indicated that this sector

employs 15% of The Jordanian workforce, which is a high percentage compared to other sectors (same source).

Research defined innovation as an intellectual performance that leads individuals to problem solutions, or the intellectual effort that leads to non-repetitive or ordinary results (Trairy, 2008). Gnaim (2005) used another definition of innovation but in the higher education quality area, where he claimed that innovation is doing something good and not bad. Finally, Smadi (2001) stated that employee innovation in the manufacturing area in Jordan was more prevalent in small-size businesses than in larger ones, where he explored 870 employees and studied their inclination to adopt the Kaizen model in improving work environment.

One of the most important tools that help in improving this sector is information technology (IT), where its role in this sector ranges from supporting operations to a major role in automation and control of operations. The important role of information technology in manufacturing especially in reducing cost and pushing operations forward, which satisfies firms' objectives and adding value to the manufacturing process. The importance of production information systems (PIS) is becoming vital to all manufacturing firms to gain and sustain competitive advantage. The adoption of PIS is becoming a priority to firms in this sector especially those who work in alliance with foreign (global) firms.

This study reviewed the literature related to the IDT and literature in the area of production systems. Also, this paper will explore the factors predicting the rate of adoption of such systems through the reported opinions of managers in this sector. Conclusions and future work are stated at the end.

2. Innovation Diffusion Theory

IDT is a well accepted model in social sciences as it investigates the environment of adopting technology in organizations. Rogers (1983) proposed his theory as a model that includes the factors influencing the usage and adoption of innovation in firms which was known as the diffusion of innovation theory (IDT). The theory measures three major areas: the adoption rate of technology related to time, where the theory is a suitable tool for measuring the diffusion of innovation in organizations (Brancheau & Wetherbe, 1990). Later, some researchers utilized this theory in studying the gap in technology accommodation (Fichman & Kemerer, 1999). Second, the work of Brancheau and Wetherbe (1990) included demographic factors related to the innovator characteristics that were explored in addition to the original factors proposed in the original theory. Brancheau and Wetherbe concluded that younger individuals were more receptive to technology adoption earlier in the process. Also, better educated individuals (subjects with higher degrees of education) were more open to interacting with the technology and thus were the ones with initiatives and opinion. Finally, the same authors explored the adoption of technology, where they anticipated that adopting a technology would go through four stages: awareness, persuasion, decision and implementation. The work of Brancheau & Wetherbe, coincides with the work of Agarwal (2000) with respect to the four adoption stages reported. Agarwal proclaimed that the IDT provides a better explanation of the adoption process and its interaction with time.

The work done by Moore and Benbasat (1991) is considered one of the important milestones in the life of this theory, where they used Rogers' work to develop a well validated instrument to measure the factors involved in predicting the rate of adoption. Moore and Banbasat built an instrument that explains the rate of adoption with reliable level of measurement. Researchers focused their efforts on the time extension of the adoption process, where they used a longitudinal perspective instead of the snapshot view (cross-sectional snapshot of the data). The model utilized in their work is depicted in Figure 1.

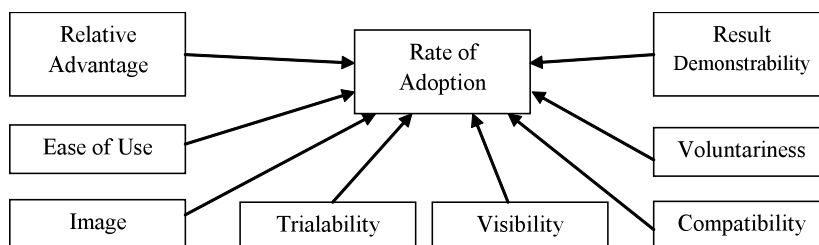


Figure 1: The IDT model proposed by Moore and Benbasat (1991)

Moore and Benbasat built their results on the responses of 540 employees from more than one organization, where the personal work-station was the technology under consideration. The major objective of the study was to build a highly reliable instrument to measure the set of factors used in the IDT. The study included four stages; the first was to review all the literature and the instruments available and used at that time. The second stage, researchers reviewed the items used for each variable in the instrument using a panel of experts. The third stage performed a pilot test on 20 subjects, followed by a test on 66 subjects to improve the instrument and increase its validity and reliability. Finally, the instrument was used on a large scale, where 34 items were the results of this study that measured the variables of the study.

In later studies, Agarwal and Parasad (1998) used part of the variables of the IDT like relative advantage, ease of use and compatibility, to study personal innovativeness influence on the rate of adoption of new technology. The results of the study indicated that personal innovativeness will be a significant moderator in the relationships influencing the rate of adoption of new technology. On the other hand, other studies that depicted the set of factors used in the IDT showed that this theory is stronger in predicting the rate of adoption than one of the widely used models in the area; the technology acceptance model-TAM (Davis, 1989). Results indicated that the IDT explained 45% of the variability in the rate of adoption, where the TAM explained only 32.7% of the variability of the same construct (Plouffe, Hulland & Vandenbosch, 2001). Other studies that adopted some of the variables listed in the IDT and proposed by Moore and Benbasat (1991) went and tested the tendency to purchase on the Internet (Fitzgerald & Kiel, 2002). Using a snowball sampling method, 128 respondents were recruited to complete a survey that included measures from three domains: perceived attributes of use (included six constructs from the IDT and perceived risk), traditional normative beliefs (partner, family, friends, and near peers), and Internet normative beliefs (e-mail, discussion groups, virtual communities, and chat rooms). The mediators in the model were attitude, and motivation to comply with normative beliefs, and the dependent variable was future use intent. The results indicated that attitude was a strong factor explaining the intent to use for both adopters and non-adopters. Also, the major constructs explaining attitude were result demonstrability and risk for adopters, and risk for non adopters.

Mirchandani and Motwani (2001) performed a study related to the usage of e-commerce activities and focused on the relative advantage and compatibility, but added few constructs like: enthusiasm of top manger, compatibility with the company, relative advantage, and knowledge within the firm. Speier and Venkatesh (2002) proposed a comprehensive model to explore the perceptions of salespeople that affected their decision to reject a technology. The study analyzed the responses at two points of time utilizing 454 salespeople across two firms that implemented sales force automation tools. The model tested the interactions between individual characteristics, role perceptions, organization's characteristics, individual perceptions of the technology, professional state, person-fit technology, objective outcomes, and subjective outcomes. Relative advantage was the only significant factor from the set of individual perceptions of the technology

that affected job-fit (at both time measures). Voluntariness had a low effect on the individual perception factors. Finally, the study reported a failure of the sales force automation technology based on the rejection of the salespeople as a result of negative job-related perceptions.

In an integration of multiple models in the technology acceptance area, Hardgrave, Davis, and Riemenschneider (2003) integrated the TAM/TAM2, IDT, and TPB/TRA to come up with a model that consisted of perceived usefulness, complexity, compatibility, social pressure and organizational mandate (voluntariness) as predictors of intention to follow a methodology. The results confirmed the effect of all factors except complexity (ease of use). The authors redefined the model to account for the indirect effects and proposed another model that linked complexity to usefulness, which yielded a significant result. Also, social influence and compatibility kept their significant relations with intention and usefulness.

Finally, in Saudi Arabia, Al-Gahtani (2003) tested a subset of the IDT constructs in a study aimed at computer technology adoption by Saudi workers in 136 organizations. The usable responses were 1190, and the dependent variable was adoption of computer technology. The results confirmed the five proposed constructs adapted from the IDT (relative advantage, complexity, compatibility, trialability, and observability).

3. Production Information Systems

Production Information Systems (PIS) are defined as systems that work with production and operations information. PIS collect information from end terminals (like point of sale terminals - POS, shop floor machines, and operation and factory sensors) and store in transaction processing machines and then feed some management information systems (MIS) or other types of functional systems like: decision support systems (DSS), and enterprise resource planning systems (ERP) (Turban, Leidner, McLean & Wetherbe, 2008). The output of PIS is used to support managers in the process of decision making and to improve the managerial functions in the firm. Many definitions were reported in the literature for PIS like the definition used by Ciurana, Garcia-Romeu, Ferrer and Casadesus (2008) which indicates that PIS are systems that are related to transferring raw material into products with special specifications.

PIS are defined as data processing network systems (Hssain, Djeraba & Descotes-Genon, 1993, pp. 1). It seems that it is a simple definition but, the authors add other components like the input data from process devices (sensors and terminals). On the other hand, the outputs are meaningful information to decision-making. The authors report three methodological requirements related to design of PIS: managing the large volume of data and knowledge compounding the core of the network, coping with high complexity of operations, and providing reliable and available data and knowledge inputs to the PIS. Hsu and Rattner (1990) conclude that to meet these requirements, design of PIS should be a part of a global design approach within total-system architecture.

PIS aim at planning and scheduling and organizing for operations with related issue of work orders to shop floors and production (Ciurana, Garcia-Romeu, Ferrer & Casadesus, 2008). The importance of PIS comes from the role that it plays in facilitating the process of design and production of products, and forwarding it to customers (the distribution function). Research related to PIS focused on the applications related to the theory of planning and production control, where the main objective is reducing costs and risks, this is applied in more than one industry and type (Wang & Hu, 2008). On the other hand, research stressed the importance of providing the correct and timely information through the installation of sensors on the production line, or the use of web-based systems. Research emphasized the importance of synchronization of information systems to guarantee the required reduction of cost and the needed customer satisfaction (Mourtiz et al., 2008).

PIS can aid in the reduction of cost and facilitation (smoothing) of the flow of material in the manufacturing process. Also, the flow of information and material is becoming more vital to the production process when considering the global perspective or the supply chain management concept (SCM). A study that explored mobile communication technology importance in the integration process when transferring information and material between suppliers and customers, concluded that it is very important to utilize the benefits of PIS to reduce cost and gain integration between partners (Ende, Jaspers & Gerwin, 2008). In another study that explored the application of fuzzy logic concepts within a smart agent, solutions were provided for production problems utilizing previous solutions to previous problems (Lu & Sy, 2008). Authors concluded that it is useful in the industrial environment to provide decision makers with information residing in PIS to make accurate and timely decisions.

Finally, a group of Greek researchers studied the manufacturing strategies and the influence of IT on financial performance, where cluster analysis method with VACOR algorithm was used. Results indicated that the usage of information technology in industrial sector would have a significant effect on financial measures especially in organizations utilizing flexible manufacturing and with medium cost. The influence of using IT was higher in organizations that concentrate less on innovation and quality (Theodorou & Florou, 2008).

We conclude that it is crucial to benefit from the capabilities of PIS and IT in the industrial sector to gain competitive advantage in the market through the reduction of cost and the smoothing of material and information flow.

4. To what extent Jordanian manufacturing firms are adopting IT

This paper investigated the extent that manufacturing firms in Jordan are adopting IT as one of the innovation tools that help in the production and operation processes. PIS are considered, for the purpose of this research, the innovation under consideration. This research consists of two tests, where a group of surveys were distributed on factories mainly in the Northern region of the country (mainly in Al-Hasan Industrial Zone). The total collected surveys were 74 surveys that included a number of questions related to the information technology and applications content of the firm and some information about the organization itself. On the other hand, another survey was distributed in Al-Hasan Industrial Zone and only to general managers, information managers and heads of departments. The second survey focused on managers' perceptions about adopting this type of systems and how well they accepted such technology. Total number of surveys collected was 91 usable surveys.

Table 1 shows the demographic details of the sample distributed, where 100 surveys were distributed and 74 were collected (response rate 74%). The survey aimed at collecting data related to managers' opinions on the usage and availability of PIS and other related systems. The main objective was to measure the adoption of PIS in the manufacturing sector in Jordan.

When asking managers about using IT in their operations, 66 factory out of 74 used one or more of the systems listed in Table 2. Also, 8 factories only did not use any type of IT or systems in their operations. Table 2 lists different types of systems and the users among Jordanian factories.

Table 1 – Information related to the factories studied

Number of factories according to number of employees	
Employees	Factories
1-50	31
51-100	7
101-200	7
201-1000	20
>1000	9
Total	74

Number of factories according to sales size (in 1000JD)	
Sales	Factories
Less than 100	10
100-1000	16
1000-10000	13
> 10000	8
No Info.	27
Total	74

Number of factories according to number of computers	
Computers	Factories
Less than 10	36
10-100	22
> 100	10
No Info.	6
Total	74

Managers were asked about the relationship between supply chain management systems (SCM) and the employment of PIS, and how these systems are related to suppliers' capabilities also. Results indicated that 39 factories employ central systems, 13 factories employ distributed systems, but integrated together. Also, results indicated that 20 factories employed enterprise systems that are utilized in many functions and tasks. Finally, only 8 factories have extended systems that reach suppliers, distributors and customers (SCMS or ERP).

Table 2 – Detailed type of information systems used in Jordanian factories

#	Item (question asked)	Number of factories
1	Do you use any type of Information Technology	66
2	Do you use accounting information systems	60
3	Do you use special sales systems	42
4	Do you use production information systems	45
5	Do you use inventory and warehousing systems	47
6	Do you use computer-aided design systems	23
7	Do you use human resource and salary systems	52
8	Do you use quality assurance/control systems	36
9	Do you use Distribution systems	25
10	Do you use procurement information systems	37
11	Do you use manufacturing aiding systems	25

The second part of the survey included items related to the systems used in these factories. 47 managers indicated that they are interested in extending and using part or all of the systems listed in Table 2. Also, the distribution of the source and type of these systems were as follows: 32 factories used locally designed systems, and 33 factories used ready-made exported systems (off-shelf systems).

One of the objectives of this study was to see the relationships between variables like computer diffusion, sales and employee size. This was done through the correlations between those variables to test if any relationship exists between those. Also, to relate demographics with the main objective of this work, we estimated a new construct based on the count of the number

of systems employed by the firm (example: manager of firm XYZ checked yes for using three systems (accounting information systems, HR systems and sales systems), so the total number of systems employed were three). This number (or set of data) was correlated against each of the variables mentioned. The correlations matrix is depicted in Figure 2. The results indicated significant correlations between the three variables and the total number of systems deployed. Also, it is shown that significant correlations existed between all three variables.

	Number of employees	Sales size	Number of computers
Number of employees	1		
Sales size	0.551**	1	
Number of computers	0.636**	0.810**	1
Total number of systems	0.437**	0.394**	0.398**

*** Correlation is significant at the 0.001 level*

Figure 2 – Correlations Matrix of the demographics against the number of systems employed

5. The intentions of managers to adopt PIS

The second objective of this study was to explore managers' intentions to adopt or continue using PIS systems utilizing Rogers' IDT model. In a separate study, the researcher employed a survey that introduced a description of PIS and asked questions related to the different constructs of the model. The main source for the items used in the study was Moore and Benbasat (1991) work. The items were translated to Arabic language and tested using 10 experts for language. The nature of this exploratory study makes it convenient to use such method and the size of data allows for such test. Data used a seven point Likert scale, where 1 indicates a high disagreement to the statement and 7 indicates a high approval to the statement. The total number of surveys collected was 91 surveys from factories in Al-Hasan Industrial Zone (total number distributed = 100).

The survey included 3 items for measuring rate of adopting, 5 items for relative advantage, 3 items for compatibility, 3 items for image, 2 items for voluntariness, 2 items for trialability, 2 items for visibility, 4 items for results demonstrability, and 4 items for ease of use. Table 3 shows some descriptive statistics related to constructs.

Table 3 – Descriptive statistics related to constructs in the IDT model

Variable	Number of Surveys	Min	Max	Mean	Standard Deviation
Rate of adoption	91	1	7	4.762	1.775
Relative advantage	91	2	7	5.777	1.123
Ease of use	91	1	7	5.409	1.334
Image	91	1	7	4.538	1.505
Compatibility	91	2	7	4.597	1.362
Result demonstrability	91	1	7	4.797	1.517
Visibility	91	1	7	4.637	1.540
Trialability	91	1	7	5.588	1.303
Voluntariness	91	1	7	4.654	1.615

On the other hand, correlations between all variable depicted in the IDT model were calculated and they are shown in Figure 3. All correlations were significant except two and as

shown in the matrix (with different levels of significance). Also, all variables were entered to calculate the regression coefficients between the rate of adoption and all variables. Results indicated that a significant correlation exists between the variables and the rate of adoption, where the coefficient of determination $R^2 = 27.6\%$, with a p value less than 0.001 ($F_{8,82} = 5.285$, $p < 0,001$). Results are shown in Table 4.

	RoA	RA	EoU	I	C	RD	V	T	V
Rate of adoption (RoA)	1								
Relative advantage (RA)	.271**	1							
Ease of use (EoU)	.030	.332**	1						
Image (I)	.386**	.397**	.481**	1					
Compatibility (C)	.351**	.269*	.419**	.637**	1				
Result demonstrability (RD)	.440**	.281**	.489**	.579**	.598**	1			
Visibility (V)	.310**	.256*	.367**	.465**	.578**	.495**	1		
Trialability (T)	.289**	.244*	.301**	.292**	.460**	.337**	.635**	1	
Voluntariness (V)	.207**	.156	.390**	.274**	.455**	.422**	.526**	.453**	1

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

Figure 3 – Correlation matrix showing the IDT variables

Table 4 – Coefficients table for the multiple regression test

Variable	Beta	Std Error	Std Beta	t	Sig
Constant	1.334	1.026		1.301	0.197
Relative advantage	0.246	0.158	0.156	1.556	0.124
Ease of use	-0.506	0.148	-0.380	-3.411	0.001
Image	0.269	0.156	0.228	1.720	0.089
Compatibility	0.016	0.178	0.013	0.092	0.927
Result demonstrability	0.444	0.146	0.380	3.038	0.003
Visibility	-0.010	0.156	-0.009	-0.067	0.947
Trialability	0.210	0.164	0.154	1.283	0.203
Voluntariness	0.041	0.125	0.037	0.329	0.743

Dependent variable: Rate of adoption, method: enter

6. Discussion of results

This study tried to answer two questions using an exploratory method. The first objective was to explore the extent to which PIS are used and adopted in manufacturing companies in Jordan. Results indicated that 66 (89%) factories used at least systems related to production and operations. The most popular systems used in Jordan were accounting information systems (60 factories, 81%), and the least used systems were computer aided design systems (23 factories, 31%). Results indicated that PIS were used in 45 factories, and inventory and warehousing systems were used in 47 factories. The results indicated a fair adoption rate for such systems. Part

of the reason for that is the influence of partnership with global firms and international organizations that outsource part of their production within Al-Hasan Industrial Zone.

When trying to explain the results of the correlations between the total number of systems and the number of computers and employees and the total sales, it seems obvious that the size of the firm is a direct influencer (predictor) of the adoption rate of IT. The larger firms will have higher numbers of employees and larger sales and thus they tend to utilize technology to improve operations and gain competitive advantage in the market. Also, it is logical to conclude that the firm size is directly correlated to complexity of operations and thus firms adopt IT to better control operations and improve flow of material and information. Finally, we can conclude that firms with higher sales will have larger tendency to invest in IT and thus buy more computers and adopt more types of systems.

The second objective was to explore managers' intention to adopt such systems. Results indicated a high intention to adopt PIS because of two main reasons: results demonstrability; the ability to see tangible results out of the system, and ease of use; where the complexity of the system is a huge obstacle to using it. Results might have some limitations as the IDT have 8 predictors competing on the variance in the rate of adoption and this might limit the ability to explain the dependent variable well. The regression method used was to enter all variables forcefully and this might be the reason behind this surprising result. As this study is an exploratory one, we can conclude that a larger sample size and a thorough conceptual analysis of the predictors will lead to better utilization of variables and better and accurate results.

It is also obvious that nearly all variables had significant bivariate correlations with the rate of adoption, and this indicates that the method used and the large number of predictors were a limitation. All Pearson's correlations were above 4.53 out of 7, which indicate a high result. The only variable with none significant correlation is ease of use and this supports the limitation of the method. Finally, the highest correlation was between rate of adoption and results demonstrability (0.440**). On the other hand, the IDT model explained 27.6% of the variance in the rate of adoption.

7. Conclusions

This paper aimed at exploring the status of using IT and specifically PIS in the area of production and manufacturing in Jordan. The study utilized two samples for two separate studies; the first was a sample of managers mainly related to IT in a group of factories in Al-Hasan Industrial Zone and other areas mainly in the Northern part of Jordan to explore the usage of PIS and other types of systems in the industrial area. The second study utilized another sample (after four months and from a different set of factories), from the same area and from the Northern part of the country to test the IDT using an instrument translated from Moore and Benbasat work (1991). Results indicated that systems like accounting information systems and HR and payroll systems were the mostly used among firms and distribution and manufacturing aiding systems were the least used among the sample used. The role of IS in production area was highly appreciated and a major conclusion is that the size of firm indicates the high computer usage and the diversity of systems used.

The second study resulted in high and significant indicators in predicting the adoption rate, and most of the constructs used in the IDT were significantly correlated to rate of adoption. But when regressing all indicators on rate of adoption, only two competed on the variance and yielded significant explanation of the variability of the dependent variable and they were results demonstrability and ease of use.

One of the limitations of this research, which makes its generalizability limited, is the usage of two separate samples. This research utilized two different samples, and to relate the real usage

of PIS to the adoption rate, the same sample would have been used. Still the inferred results of this work are valid, but researchers are encouraged to use one sample and extend the size to improve the statistical generalizability. The second limitation of this study is the instrument used; this study used a translated instrument from the original one used in Moore and Benbasat (1991) in English, and thus researchers are encouraged to use the instrument in Arabic to improve the language and improve content and face validity of the instrument. Finally, research related to PIS and the factors influencing the adoption of such systems is not highly popular, which resulted in high competition between variables. The IDT needs a larger sample or dropping some of the variables based on conceptual bases.

This research is needed in this area and considered a first step in validating the instrument and testing factors influencing the rate of adoption. It is highly important to continue such research using longitudinal settings to explore the adoption and check the validity of results.

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Flow-Shop Scheduling: A Multicriteria Optimization Problem

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Abstract: Quality is, in real-life, a multidimensional notion. A schedule is described and valued on the basis of a number of criteria, for example: makespan, work-in-process inventories, idle times, observance of due dates, etc. An appropriate schedule can not be obtained unless one observes the whole set of important criteria. The multidimensional nature of the scheduling problems leads us to the area of Multicriteria Optimization. Thus considering combinatorial problems with more than one criterion is more relevant in the context of real-life scheduling problems. Research in this important field has been scarce when compared to research in single-criterion scheduling. The proliferation of metaheuristic techniques has encouraged researchers to apply them to combinatorial optimization problems. The aim of this paper is to present a review regarding multicriteria flow-shop scheduling problem, focusing on Multi-Objective Combinatorial Optimization theory, including recent developments considering more than one optimization criterion, followed by a summary discussion on research directions.

Keywords: Scheduling Theory, Flow-Shop Scheduling problem, Multicriteria Optimization, Combinatorial Optimization, Metaheuristics.

1. Introduction

In this paper we consider a scheduling problem for which, after more than 50 years of scientific research, there is an important gap between theory and practice. Flow-shop problem results in several contexts, where machines are used to represent the resources and different operations must be carried out with them. So, the aim is to find the schedule that optimizes certain performance measures. To the complexity that naturally arises in these problems, considering only one criterion (Garey & Johnson, 1979), we have to add the additional complexity that comes from the multivariant condition of corresponding alternative schedules. In fact the description and valuation of alternative decisions are not naturally accomplished by only one criterion, but by several (*e.g.* makespan, flow-time, completion-time, tardiness, inventory, utilization, etc.). This is certainly the natural framework of the Multicriteria Decision Making discipline (MDM). A solution which is optimal with respect to a given criterion might be a poor candidate for another. The trade-offs involved in considering several different criteria provide useful insights for the decision-maker. Thus considering Combinatorial Optimization (CO) problems with more than one criterion is more relevant in the context of real-life scheduling problems.

Most of the multicriterion approaches applied to scheduling problems are based on Multi-Objective Optimization (MOO) models. Of course, to expect to find the “Optimum” schedule

must usually be discarded. We would be satisfied to find the set of non-dominated, also called Pareto optimal, alternatives. (A feasible solution is Pareto optimal if there is no other feasible solution better according to at least one criterion and as good as it according to the rest of criteria). At this point we have to let some subjective considerations intervene, such as the decision-maker preferences. It is actually an MDM problem, and at the present time, there is no other rational tool to apply to discard alternatives. MOO was originally conceived to find a set of Pareto optimal alternative solutions. Only with the breakthrough of metaheuristics in solving CO problems, did researchers begin to adapt them to solve Multi-Objective Combinatorial Optimization problems. Then, the acronym MOCO started to appear in the scientific literature to refer to Multi-Objective Combinatorial Optimization problems and the techniques specially developed to deal with them. Research in this important field has been scarce when compared to research in single-criterion scheduling. Until the late 1980's, only one criterion was considered in scheduling problems. Furthermore, until the 1990's, most work in the area of multiple criteria scheduling consists of bi-criteria studies of the single machine case (Hoogeveen, 1992). In this paper an effort has been made to review the publications, from the late eighties to the most recent papers, giving attention to the results that have not been surveyed until now and suggesting directions for future research.

The aim of this paper is to present, after a review regarding the flow shop scheduling problems, the MOCO theory and a survey on recent developments considering more than one optimization criterion (the detailed theorems and proofs have been omitted to avoid a huge paper). In the next section, the classical flow-shop scheduling problem statement is presented. We will briefly introduce multi-objective theory and notations and general multicriteria optimization methods (section 3), followed by a survey on multi-criteria algorithms devoted to scheduling problems (section 4). We conclude, in section 5, with a summary discussion on research directions.

2. Permutation Flow Shop Scheduling Problem

In the classical permutation flow shop scheduling problem, there are n jobs and m machines, or stages. Each job needs to complete one operation on each of the machines during a fixed processing time. So, the aim is to find the schedule, or job sequence, that optimizes certain performance measures. In this paper we focus attention on the permutation flow shop situation, where all jobs must pass through all machines in the same order (Potts et al. (1991) presents a comparative study of permutation versus non-permutation flow shop scheduling problems).

The scheduling process involves just finding the optimal job sequencing. Nevertheless, the computational complexity usually grows exponentially with the number of machines, m , making the problem intractable. This problem, like almost all deterministic scheduling problems, belongs to the wide class of CO problems, many of which are known to be NP-hard (Garey & Johnson, 1979). What it means is that it is unlikely that efficient optimization algorithms exist to solve them. Only a few scheduling problems have been shown to be tractable, in the sense that they are solvable in polynomial time. For the remaining ones, the only way to secure optimal solutions is usually by enumerative methods, requiring exponential time. The investigation has focused on two approaches: developing approximation algorithms, and optimally solving restricted, more tractable, cases. Thus, heuristic methods have been developed, some of them showing an acceptable performance.

Many real life problems can be modeled as permutation flow shop scheduling ones. On production lines, it is common to find multi-purpose machines carrying out different products. Our experience has been with the ceramic tile manufacturing sector, however many problems could be mentioned when we speak about scarce resources, or machines, dedicated to the production of some goods, or jobs.

2.1. Notation

We will use the notation that follows:

- J : set of n jobs J_i ($i=1, \dots, n$)
- M : set of m machines M_j ($j=1, \dots, m$)
- p_{ij} : processing time of job J_i on machine M_j
- d_i : due date of job J_i , time limit by which J_i should be completed
- r_i : time at which the job J_i is ready to be processed
- w_i : priority or weight of job J_i
- C_i : completion time of job J_i
- C_{max} : the maximum completion time of all jobs J_i (this is the schedule length, which is also called *makespan*)
- F_i : flow time of job J_i , $F_i = C_i - r_i$, if $r_i = 0$, then $F_i = C_i$
- L_i : lateness of job J_i , $L_i = C_i - d_i$
- T_i : tardiness of job J_i , $T_{max} = \max\{L_i, 0\}$
- E_i : earliness of job J_i , $E_{max} = \max\{-L_i, 0\}$

The optimal value of any criterion is denoted with an asterisk, e.g. C_{max}^* denotes the optimal makespan value.

We will use the three-parameter notation, $\alpha / \beta / \gamma$, introduced by Graham et al. (1979) and, extended for T'kindt & Billaut (2006) to Multicriteria scheduling problems. The first field specifies the machine environment (F represents general permutation flow shop); the second, job characteristics; and the third refers to the chosen optimality criterion for single criteria models, and it extends to cover multicriteria as well as methodology.

2.2. Definition

Consider a set of n independent jobs J_i ($i=1, \dots, n$) to be processed, each of them on a set of m machines M_j ($j=1, \dots, m$), that represent the m stages of the production process. Every job requires a known, deterministic and non-negative processing time, denoted as p_{ij} , for completion at each machine. Each machine processes the jobs in the same order, thus knowing the order of jobs the resulting schedule is entirely fixed. Any feasible solution is then called *permutation schedule* or *sequence*. In a single-criterion problem we look for the permutation of jobs from set J that would optimize the performance criterion, while for more than one criterion the objective is to find out the set of Pareto optimal solutions. The most used criterion is the minimization of the makespan. But there are many performance criteria to be considered when solving scheduling problems.

2.3. Criteria

French (1982) presents the following classification:

Criteria based upon completion time measures:

- $F_{max} = \max\{F_1, F_2, \dots, F_n\}$, the maximum flow time
- $C_{max} = \max\{C_1, C_2, \dots, C_n\}$, the maximum completion time
- $\sum F_i / n$ or $\sum F_i$, mean flow time or total flow time, respectively
- $\sum C_i / n$ or $\sum C_i$, mean completion time or total completion time, respectively
- $\sum w_i C_i$, weighted completion time

- $\sum w_i F_i$, weighted flow time

Flow time is applied as a criterion when the cost function is related to the job standing time. Completion time reflects a criterion where the cost depends on the finish time. In the event of all ready times being zero, $r_i=0, \forall i$, completion time and flow time functions are identical. Maximum criteria should be used when interest is focused on the whole system. When some jobs are more important than others, weighted measures could be considered.

Criteria based upon due date measures:

- $L_{max} = \max\{L_1, L_2, \dots, L_n\}$, maximum lateness
- $T_{max} = \max\{T_1, T_2, \dots, T_n\}$, maximum tardiness
- $\sum L_i / n$ or $\sum L_i$, mean lateness or total lateness, respectively
- $\sum T_i / n$ or $\sum T_i$, mean tardiness or total tardiness, respectively
- $\sum w_i L_i$, weighted lateness
- $\sum w_i T_i$, weighted tardiness
- $\sum U_i$, total tardy jobs. The indicator function U_i denotes whether the job J_i is tardy, then $U_i = 1$, or on time, then $U_i = 0$.

When maintaining customer satisfaction by observing due dates, or any other *just in time* concept has to be considered, measures related to the notion of how much is lost by not meeting the due dates are applied. If the penalty is applied only to the delays, tardiness measures are used. When there is a positive reward, or penalization, for completing a job early and that reward/penalization is larger the earlier a job is completed, lateness measures are appropriate. In the case where all the due dates are zero, $d_i=0, \forall i$, tardiness or lateness are identical to completion time functions.

All of the above mentioned criteria are regular in the sense that they are non-decreasing functions of job completion times. French's classification includes some non-regular criteria, such as measures based upon the inventory and utilization costs. For example, to measure the idle time of a machine, the following criterion is used:

- $I_j = C_{max} - \sum_{i=1}^n p_{ij}$, total time during which machine M_j is waiting for a job or has finished processing jobs, but the total process of jobs has not finished yet.

In the literature, the most common criterion is the makespan. Only a relative few published works are devoted to flow time and tardiness measures.

2.4. Computational Complexity

Since the early algorithm due to Johnson (1954) that solves $F2//C_{max}$ in polynomial time, only a few restricted cases have been shown to be efficiently solvable. Minimizing the sum of completion times is still NP-complete for two machines (Garey & Johnson, 1979). Only the following cases have been shown to be polynomially solvable:

- $F/p_{ij}=1,intree,r_i/C_{max}$
- $F/p_{ij}=1,prec/C_{max}$
- $F2/chains/C_{max}$
- $F2/chains,pmtn/C_{max}$
- $F2/r_i/C_{max}$

- $F2/r_i, pmtn/C_{max}$
- $F3/C_{max}$
- $F3/pmtn/C_{max}$
- $F/p_{ij}=1, outtree/L_{max}$
- $F2/L_{max}$
- $F2/pmtn/L_{max}$
- $F2/\sum C_i$
- $F2/pmtn/\sum C_i$
- $Fm/p_{ij}=1, chains/\sum w_i C_i$
- $Fm/p_{ij}=1, chains/\sum U_i$, for each $m \geq 2$
- $Fm/p_{ij}=1, chains/\sum T_i$, for each $m \geq 2$

For further information about deterministic scheduling and flow shop, considering only single-criterion problems, we refer the reader to the books of: Blazewicz et al. (2007); Brucker (2004); Pinedo (2002); or the survey papers of: Lawler et al. (1993); Dudek et al. (1992) and Monma & Rinnooy Kan (1983).

3. Multi-Criteria Analysis for Combinatorial Optimization problems

Quality is, in real-life, a multidimensional notion. A schedule is valued on the basis of a number of criteria, for example: makespan, work-in-process inventories, idle times, observance of due dates, etc. If only one criterion is taken into account, no matter what criterion is considered, some aspect of the quality of the schedule will result regardless. The multidimensional nature of the problem at hand leads us to the area of Multicriteria Optimization (see Ehrgott & Wiecek, 2005, for a state of the art).

Considering only one regular criterion, general scheduling problems have been shown to be NP-hard, and to belong to the CO field (except for restricted special cases). The complex nature of flow shop scheduling has prevented the development of models with multiple criteria.

Even though MDM, as well as CO, have been intensively studied by many researchers for many years, it is surprising that a combination of both, *i.e.* Multi-Objective Combinatorial Optimization (MOCO), was not widely studied until the last decade, as it is not long since interest in this field has been shown (Ehrgott & Gandibleux, 2002). The proliferation of metaheuristic techniques has encouraged researchers to apply them to this highly complex problem.

In this section we will present a brief introduction to MOCO problems, including a general problem formulation, the most important theoretical properties, and the existing methods for dealing with this kind of problem.

3.1. Formulation of a MOCO problem

A MOCO problem is a discrete optimization problem, where each feasible solution X has n variables, x_i , constrained by a specific structure, and there are K objective functions, z_k , to be optimized. Without loss of generality we can formulate the problem as follows:

$$\text{Min}_{X \in D} z_k(X), k = 1, \dots, K$$

where functions z_k are the objectives, X is the vector that represents a feasible solution (a sequence for the flow shop scheduling problem), and D is the set of feasible solutions: a discrete set.

The criteria (reviewed in the previous section) are of two different kinds:

- sum function: $\sum f_i$
- bottleneck function: $f_{\max} = \max\{f_1, f_2, \dots, f_n\}$

We call a feasible solution, $X^{(e)} \in D$, efficient, non-dominated, or Pareto optimal, if there is no other feasible solution $X \in D$ such that,

$$z_k(X) \leq z_k(X^{(e)}) \forall k$$

with at least one strict inequality. The corresponding vector of objective values,

$$z(X^{(e)}) = (z_1(X^{(e)}), z_2(X^{(e)}), \dots, z_K(X^{(e)}))$$

is called non dominated vector. The set of feasible Efficient solutions, $X^{(e)}$, is denoted by E, and the set of non-dominated vectors by ND.

3.2. Some theoretical concepts

A general result for Multi-Objective Linear Programming (MLP) problems is that the set of efficient solutions for the MLP problem,

$$\min\{cX : AX = b, X \geq 0\}$$

is exactly the set of solutions of

$$\min\left\{\sum_{j=1, \dots, K} \lambda_j c_j X : AX = b, X \geq 0\right\},$$

where

$$\sum_{j=1, \dots, K} \lambda_j = 1, \lambda_j > 0, j=1, \dots, K.$$

It is important to point out that we are dealing with a CO problem, which means that the transformation of the objective functions into a linear function (aggregating into weighted sums) does not transform the problem into a Linear Programming one. Except in some special cases, *e.g.* preemption allowance, or where idle time insertion is advantageous, for which Linear Programming can be applied, the discrete structure of a MOCO problem persists. An important consequence is the fact that the previous result for MLP is not valid, so there could be some efficient solutions not optimal for any weighted sum of the objectives. The set of these solutions are named Non-supported Efficient solutions (NE), whereas the set of the remaining ones are called Supported Efficient solutions (SE) (Ehrgott & Gandibleux, 2002).

The cardinality of the NE set depends on the number of sum objective functions. For a problem with more than one sum objective function, NE has many more solutions than SE.

Despite these results which constitute the essence of the difficulty of MOCO problems, many published works ignore the existence of NE.

Concerning computational complexity, in obtaining the set of efficient solutions MOCO problems are in general NP-complete. Results are presented by Ehrgott (2000). The cardinality of E for a MOCO problem may be exponential in the problem size (Emelichev & Perepelista, 1992), therefore algorithms could determine just an approximation of E in many cases. Thus, methods may be exact or approximate, and metaheuristics are nowadays being applied intensively to MOCO problems.

3.3. Multicriteria Optimization Methods

The “minimization” concept in the above formulation is not restricted to one meaning. The MDM always assumes that subjective considerations, such as the decision-maker preferences, have to intervene. Besides the classic classification for optimization methods between exact or

approximation, it is usual to distinguish the MDM methods according to when the decision-maker intervenes in the resolution process, as follows:

- *a priori*: All the preferences are known at the beginning of the decision-making process. The search for the solution is carried out on the basis of the known information.
- *interactive*: The decision-maker intervenes during the search process. Computing steps alternate with dialogue steps. At each step a satisfying compromise determination is achieved. It requires the intensive participation of the decision-maker.
- *a posteriori*: The set of efficient solutions (the complete set or an approximation of it) is generated. This set can be analyzed according to the decision-maker preferences. The choice of a solution from the set of efficient solutions is an *a posteriori* approach.

If the problem criteria show a hierarchical structure, more important criteria should be minimized before less important ones. Thus, optimization methods can be classified as hierarchical or simultaneous.

In bicriteria models, if z_1 is more important than z_2 , then it seems to be natural to minimize with respect to z_1 first, and choose, from among these optimal solutions, the optimum with respect to z_2 . This hierarchical approach is called lexicographic optimization, and is denoted by $\alpha/\beta/\text{Lex}(z_1, z_2)$.

In a general case, lexicographic minimization consists in comparing the objective values of a feasible solution X , with respect to another Y , in a lexicographical order, denoted by $<_{\text{lex}}$. Objective functions are ranked according to their importance. We say $X <_{\text{lex}} Y$, if, and only if, there is a j such that $z_j(X) < z_j(Y)$, and there is not any $h < j$, such that $z_h(Y) < z_h(X)$. This means that the first objective function index, $i \in \{1, \dots, K\}$, for which $z_i(X)$ is not equal to $z_i(Y)$, $z_i(X) < z_i(Y)$.

Simultaneous optimization has to be applied when there is no dominant relation among the criteria. Optimizing with respect to one criterion at a time leads to unbalanced results. It is common, in a case such as this, to use a composite objective function with the original criteria. It gives rise to another classification, because we can generate solutions by means of scalarization and non-scalarizing methods.

Scalarization is made by means of a real-valued scalarizing on the objective functions of the original problem (Wierzbicki, 1980). Well known examples of scalarization methods are the following.

The Weighted Sum approach consists in building a new objective criterion with the original ones (Isermann, 1977). This composite function can be linear (in the majority of cases), where the scalar coefficients represent the relative importance of every criterion, or it may present a more complex composition. Despite the apparent simplicity of the methods, it conceals two difficulties:

1. The difficulty of expressing the decision-maker preferences by means of a function. Interactive approaches overcome this drawback, e.g. Analytic Hierarchy Process (AHP) could be useful (Saaty, 1980).
2. The computational complexity of minimizing the function in a direct manner.

The set of all supported efficient solutions can be found considering a wide diversified set of weights (Parametric Programming may be used to solve this problem). Selen & Hott (1986) and Wilson (1989) apply this technique, considering a linear combination of makespan and flow time. Shmoys & Tardos (1993) proposes a linear combination of the makespan and a total cost function, for unrelated parallel machine models.

The distance to the ideal point approach (Horsky & Rao, 1984) consists in minimizing the distance to an ideal solution. The ideal point is settled according to the optimum of each individual single-criterion. It is also known as the compromise solution method.

The ϵ -constraint (Chankong & Haimes, 1983) and the Target-Vector approaches are scalarization as well as hierarchical methods. A constraint system representing levels ϵ_i of satisfaction, for some criteria, is established, and the objective is to find a solution which provides a value, as close as possible, to the pre-defined goal for each objective. A single-objective

minimization subject to constraints of levels ϵ_i for the other objective functions is formulated. The formulation is solved for different levels ϵ_i , to generate the entire Pareto optimal set. Some authors consider that the main criteria must be fixed by constraints, others put the main criteria in the objective of the formulation by turn. It would depend on the mathematical programs to solve. Leung & Young (1989) and Eck & Pinedo (1993) present algorithms to minimize the makespan, subject to a determined flow time level (the first one is devoted to preemptive job models). González & Johnson (1980) proposes minimizing the makespan, subject to a bound on the number of preemptions. Sin (1989) considers the problem of minimizing the makespan and the number of preemptions, for a set of jobs, constrained to due dates.

When a set of goals for each criterion is known, the target vector approaches are appropriate. The most popular is Goal Programming (introduced by Charnes & Cooper, 1961), for which the minimization of the deviation from the specified goals is the aim.

Non-scalarizing approaches do not explicitly use this kind of scalarizing function. For example, Lexicographic and Max-ordering are non-scalarizing approaches.

Max-ordering chooses the alternative with the minimum value of the worst values. After a normalization process, z_j is the worst value of X , if and only if,

$$z_j(X) = \max(z_1(X), z_2(X), \dots, z_K(X))$$

Then, X is the best alternative, if, and only if, there is not Y such that $z_{j(y)}(Y) < z_{j(x)}(X)$.

Only a few algorithms have been developed based on branch and bound techniques for MOCO problems (Ehrgott & Gandibleux, 2001).

The *two phases* method Ulungu (1993) consists in determining the set of supported efficient solutions by means of a weighted sum scalarization algorithm, and then, in the second phase, searching for the non-supported ones, following a specific problem-dependent method.

Approximation for MOO is a research area which has gained increasing interest in recent years. Multi-Objective Metaheuristics seek an approximate set of Pareto optimal solutions. The main question is how to ensure that the obtained non-dominated set covers the Pareto front as widely as possible. In the beginning, methods were adaptations of single-objective optimization. Nowadays they have their own entity. They are initially inspired by Evolutionary Algorithms (EA) or neighbourhood search. Furthermore, recent developments are more hybridized, given rise to Multi-Objective Hyperheuristic methods. A hyperheuristic can be thought as a heuristic method, which iteratively selects the most suitable heuristic amongst many (Burke et al., 2003).

The problem of obtaining a uniformly distributed set of non-dominated solutions is of great concern in Pareto optimization. The specification of the search direction, by tuning weights, is the method that directly attempts to drive the current solution towards the desired region of the trade-off frontier. Hyperheuristic approaches attempt to do it by applying the neighbourhood search heuristic that is more likely to drive the solution in the desired direction. This technique can be applied to single-solution and population-based algorithms.

Most of the published works in MOO are a priori methods since they assume that the decision-maker preferences can be expressed. The hierarchical approach penalizes too much the less important criteria, while setting a criterion as the most important one. In reality, the decision-maker preferences are usually smooth, giving less importance to the main criterion and more to the less important criteria. Considering a composed function of the criteria involved in the problem, it is implicitly assumed that the decision-maker preferences are accurately reflected in this objective function. The decision-maker knows the preferable schedule, but it is not easy to express this preference in a function. In general, a priori approaches give a solution to the problem, which cannot usually be trusted to be the most preferred solution.

To be confident with a particular solution to a problem with multiple objectives, the decision-maker active involvement is required. In interactive methods, she indicates their preferences during the process of solution, guiding the search direction. Agrawal et al. (2008) proposes an interactive particle-swarm metaheuristic for MOO. The approach presented by

Jaszkiewicz & Ferhat (1999) can be placed between the a priori and interactive procedures. The method that this paper presents includes some interaction with the decision-maker, but is based on the assumption that decision-maker preferences are already relatively well-defined at the beginning of the solution process.

For methods that should offer the complete set of efficient solutions (a posteriori approaches), it is guaranteed that no potential preferable solution has been eliminated, but the number of efficient solutions can be overwhelmingly high to warrant proper examination by the decision-maker.

In the following we are going to focus on scheduling and flow shop applications of the MOCO. We refer to (Ulungu & Teghem, 1994) and (Ehrgott & Gandibleux, 2002) for further information on MOCO theory. Landa-Silva et al. (2004) and Jones et al. (2002) present overviews to the metaheuristics applied to solve MOCO problems. Jaszkiewicz (2004) compares metaheuristics for bicriteria optimization problems. For each particular metaheuristics, we refer the reader to the following references:

- For Multi-Objective Genetic Algorithms (MOGA), to Aickelin (1999) and Jaszkiewicz (2004). For general Multi-Objective Evolutionary Algorithms (MOEA), to Zitzler (1999), Coello & Mariano (2002) and Geiger (2007).
- For Multi-Objective Simulated Annealing (MOSA), to Serafini (1992), Ulungu (1993), Hapke et al. (1998) and Loukil et al. (2005).
- For Multi-Objective Tabu Search, to Gandibleux et al. (1997).

3.4. Evaluation of MOO approaches

For the MOO algorithms, the analysis of performance is more complex than for single-objective ones. The goal of multiple objective metaheuristic procedures is to find a good approximation of the set of efficient solutions. It is unlikely that the whole set of efficient solutions (E) is fully known. While the outcomes from compared algorithms are different, they can still be all equally Pareto efficient. Usually, the three following conditions are considered as desirable for a good multi-objective algorithm:

- The distance of the obtained PE solutions to the E should be minimized.
- The distribution of the solutions found should be uniform.
- The larger the number of obtained solutions, *i.e.* the cardinality of PE, the better the algorithm.

The last two conditions present more weaknesses than strengths. If E does not present a uniform distribution, or $|E|=1$, the algorithm that obtains the proper E will not fulfil conditions 2 and 3. Furthermore, an algorithm that just reports a huge number of solutions does not ensure their quality (in terms of efficiency). To have an idea of quality, a reference set of E (R in the following) should be considered. The ideal R is the set E . However, for MOCO problems it is unlikely that the whole E is known (except for small size instances, with non-practical application). A useful practice is having a set R as close to E as possible, then filtering the PE output with R . The obtained net set of non-dominated solutions in the net set is

$$N = \{X \text{ is Pareto efficient in } (PE \cup R)\},$$

and it will be at least as good as R . One can measure the quality of the output as the percentage of solutions in PE that survive the filtering process with the R set:

$$Q_1(PE) = \frac{|PE \cap N|}{|PE|} 100\%$$

Czyzak & Jaszkievicz (1998) presents a quality measure of the percentage of reference solutions found by the algorithm:

$$Q_2(PE) = \frac{[PE \cap R]}{[R]} 100\%$$

Both of the above metrics are cardinal. However, in the case of real-life MOCO problems it may be impossible to obtain, in a reasonable time, a significant percentage of efficient solutions. Obtaining near-efficient solutions would also be highly appreciated. Following Knowles & Corne (2002), a more general and economic criterion may be to concentrate on evaluating the distance of solutions to the efficient frontier. The C metric by Zitzler (1999), and the $Dist1R$ and $Dist2R$ metrics by Czyzak & Jaszkievicz (1998), can serve this purpose. We suggest to use them because they are not difficult to compute, and they seem to be complementary (to each other) with respect to the properties analyzed by Knowles & Corne (2002).

The C metric, also a cardinal measure, compares two sets of PE , A and B . A reference set, R , is not required and it is really easy to compute as:

$$C(A,B) = \frac{[b \in B / \exists a \in A : a \prec b]}{[B]}$$

The following statements can aid the understanding of $C(A,B)$:

- If $C(A,B)=1$, all solutions in B are weakly dominated by A .
- If $C(A,B)=0$, none of the solutions in B are weakly dominated by A .

When two algorithms are compared, $C(A,B)$ and $C(B,A)$ must be computed, because they are not necessary complementary. Unless $C(A,B)=1$ and $C(B,A)<1$, it is not possible to establish that A weakly outperforms B .

As non-cardinal measures we have the $Dist1R$ and $Dist2R$, but in obtaining them, R is required. Their computations, although more complicated than C , do not imply a high complexity. They are based on an achievement scalarizing function:

$$d(X,Y) = \max_{k=1,\dots,K} \{0, \lambda_k (z_k(Y) - z_k(X))\}$$

where $X \in R$, $Y \in PE$, and $\lambda_k = \frac{1}{\left(\max_{X \in R} z_k(X) - \min_{X \in R} z_k(X) \right)}$

$Dist1R$ is defined as:

$$Dist1_R(PE) = \frac{1}{[R]} \sum_{x \in R} \left\{ \min_{y \in PE} \{d(X,Y)\} \right\}$$

While $Dist1R$ measures the mean distance, over the points in R , of the nearest point in PE , $Dist2R$ gives the worst case distance, thus is defined as:

$$Dist2_R(PE) = \max_{X \in R} \left\{ \min_{Y \in PE} \{d(X,Y)\} \right\}$$

The lower the values the better PE approximates R . Moreover, the lower the ratio $Dist2R/Dist1R$ the more uniform the distribution of solutions from PE over R . $Dist1R$ induces a complete ordering and let to weak outperformance relations.

Combining PE yielded by different algorithms, a net set of non-dominated solutions, N , for an instance problem is obtained. The N set is very useful as a reference for many evaluations of new developments. An important contribution is updating the published N set obtained for benchmark instances.

4. Multicriteria Scheduling Review

Starting with the *just-in-time* philosophy, the earliness–tardiness problem becomes one of the most appealing bicriteria in Scheduling Theory. Early completion time results in the need to store the product until it can be shipped. Hoogeveen (2005) presents an extensive review for the case where the due dates have been determined already, which is contrary to the due date assignment model (one has the freedom to determine the optimal due date, at a certain cost), for which we refer to the survey by Gordon et al. (2002).

We refer to Hoogeveen (2005) and Nowicki & Zdrzałka (1990) for a survey of the field of scheduling with controllable processing times, in which the processing times can be compressed at the expense of some extra cost, which is called the compression cost. Hoogeveen (2005) also presents an overview of bi-criteria worst-case analysis.

In this section we will focus on published algorithms devoted to multicriteria flow shop scheduling problems. Minella et al. (2007) and Zitzler & Thiele (1999) are previous surveys focusing on MOEA which include computational comparison for the Pareto approach. For further information on general Multicriteria Scheduling we refer to the following surveys or books:

Ruiz-Díaz & French (1983) provides the earliest survey of papers on multiple-objective scheduling. Subsequently, Nagar et al. (1995), T'kindt & Billaut (2001) and Hoogeveen (2005) have been published, and they present exhaustive surveys of Multicriteria Scheduling problems. Landa-Silva et al. (2004) reviews metaheuristics for general Multi-Objective problems and presents the application of these techniques to some Multi-Objective Scheduling problems.

The book of T'kindt & Billaut (2006) can be useful as a good reference work, and also an introduction to any field of Multicriteria Scheduling.

4.1. Multicriteria flow shop scheduling algorithm's review

Permutation flow shop scheduling research has been mostly restricted to the treatment of one objective at a time. Furthermore, attention focused on the makespan criterion. However, the total flow time performance measure has also received some attention. These two measures, each of which is a regular performance measure, constitute a conflicting pair of objectives (Rinnooy Kan, 1976). Specifically, the total flow time criterion is a work in process inventory performance measure, and the makespan criterion is equivalent to the mean utilization performance measure. While total flow time is a customer-oriented performance measure, the makespan criterion is a firm-oriented performance measure. Therefore, the set of efficient solutions to a bicriteria model that seeks to optimize both measures simultaneously would contain valuable trade-off information crucial to the decision-maker, who has to identify the most preferable solution, according to her preferences.

Solving a bi-criteria model for a general number of machines implies heavy computational requirements, since both criteria makespan and total flow time, lead to NP-hard problems even when they are treated individually. Due to the fact that only the $F2//C_{max}$ problem can be solved in polynomial time, research production concentrates on heuristics and enumerative approaches. The majority of research on bicriteria flow shop problems concerns the two-machine case, in which some combination of $\sum C_i$ and C_{max} has to be minimized.

Since $F2// \sum C_i$ is NP-hard in the strong sense, any lexicographic approach including $\sum C_i$ will be NP-hard too. Rajendran (1992), Neppalli et al. (1996), Gupta et al. (2001) and T'kindt et al. (2003), present heuristics for the two-machine flow shop problem, where total flow time has to be minimized among the schedules that minimize makespan (lexicographical approach). Local search algorithms based on Ant Colony Optimization have been proposed by T'kindt et al (2002). Huang & Lim (2003) presents a technique named Local Dynamic Programming. T'kindt et al. (2003) presents a branch and bound algorithm, which can solve problem instances of up to 35 jobs to optimality.

Nagar et al. (1995) and Sivrikaya-Serifoglu & Ulusoy (1998) present heuristics and branch and bound algorithms for the $F2// f(\sum C_i, C_{\max})$ problem.

For the two-machine flow shop scheduling problem of minimizing makespan and sum of completion times simultaneously, Sayin & Karabati (1999) presents an *a posteriori* approach based on branch and bound.

Daniels & Chambers (1990) presents a branch and bound algorithm for the $F2// f(C_{\max}, T_{\max})$, and a heuristic to approximate the set of non-dominated solutions for the more general $F// f(C_{\max}, T_{\max})$ problem.

Liao et al. (1997) presents branch and bound algorithms for the $F2// f(C_{\max}, \sum U_i)$ and $F2// f(C_{\max}, \sum T_i)$ problems.

Selen & Hott (1986) and Wilson (1989) consider a linear combination of makespan and flow time. Dorn et al. (1996) presents a comparison of four iterative improvement techniques for flow shop scheduling problems that differ in local search methodology. These techniques are iterative deepening, random search, Tabu Search and Genetic Algorithms (GA). The evaluation function is defined according to the gradual satisfaction of explicitly represented domain constraints and optimization functions. The problem is constrained by a greater variety of antagonistic criteria that are partly contradictory.

Ho & Chang (1991) and Rajendran (1995) propose heuristic procedures for the general m machine case, considering $\sum C_i, C_{\max}, \sum I_j$. They are based on the idea of minimizing the gaps between the completion times of jobs on adjacent machines (one of our proposed improvement techniques was inspired by this paper). Yagmahan & Yenisey (2008) applies Ant Colony Optimization to the same problem.

Bagchi (1999) presents a MOGA that improves the previous MOGA presented by Srinivas & Deb (1995). Murata et al. (1996) presents a MOGA considering the makespan, total flow time and total tardiness, based on a weighted sum of objective functions with variable weights. This algorithm belongs to the class of evolutionary multi-objective optimization algorithms and Ishibuchi & Murata (1998) shows that this algorithm can be improved by adding a local search procedure to the offspring. Chang et al. (2007) applies subpopulation GA to the same problems. Artificial chromosomes are created and introduced into the evolution process to improve the efficiency and the quality of the solution.

Talbi et al. (2001) and Arroyo & Armentano (2005) propose Multi-Objective Local Search (MOLS) based on the concept of Pareto dominance, both algorithms considering makespan and tardiness. The first one applies MOLS when a simplification of Genetic Local Search stops. The last one includes preservation of dispersion in the population, elitism, and use of a parallel bi-objective local search so as intensify the search in distinct regions and it is applied to the makespan-maximum tardiness and makespan-total tardiness problems.

Framinan et al. (2002) investigates *a priori* and *a posteriori* heuristics. The *a posteriori* heuristic does not require a decision-maker preference structure and uncovers non-dominated solutions by varying the weight criteria in an effective way.

Chang et al. (2002) proposes a GA algorithm for the $F//f(\sum C_i, C_{\max})$ problem based on the concept of *gradual priority weighting* (the search process starts along the direction of the first selected objective function, and progresses such that the weight for the first objective function decreases gradually, and the weight for the second objective function increases gradually). Varadharajan & Rajendran (2005) applies a similar idea for a MOSA. Pasupathy et al. (2006) presents a Pareto GA with Local Search, based on ranks that are computed by means of crowding distances. Both papers apply the same initial population and improvement schemes.

Bülbül et al. (2003) applies Dantzig-Wolfe reformulation and Lagrangian relaxation to an Integer Programming formulation to minimize a total cost of job function that includes: earliness, tardiness and work in process inventory costs.

Geiger (2007) presents a study of the problem structure and the effectiveness of local search neighbourhoods within an evolutionary search framework on Multi-Objective flow shop scheduling problems.

5. Conclusions

In this paper we have attempted to present a survey encompassing Multicriterion Flow-Shop Scheduling problems. Because they have important applications in Management Science, these models have been intensively studied during the last years. Considerable progress has been made toward presenting effective solutions to practical problems, especially with the proliferation of metaheuristic approaches. Some variants, *e.g.* setup depending on the sequence, have been investigated and well solved by means of *meta* and, more recently, *hyper* heuristic techniques. However, to obtain the exact set of potentially efficient solutions for these problems efficiently is not a plausible accomplishment since the single makespan problem is *NP-hard* in itself.

It is necessary to distinguish between two different questions: the first one is to efficiently solve real problems, whose complexity is ever increasing; the second one is to focus on the rigorous mathematical approaches to find an analytically satisfactory answer to each problem structure.

About the first question, we think that recent published results give support to the hypothesis which states that more hybridized approaches, *i.e.* hyperheuristics, perform better than traditional metaheuristics. Hyperheuristic algorithms combine different heuristic techniques which are selected according to their suitability, at each iteration. It is not realistic to hope for general meta-optimization methods that solve MOCO problems efficiently. Hyperheuristic approaches could constitute a fruitful line of research.

With respect to the second question, the exhaustive theoretical study of the structure and properties of each problem could be one of the most challenging goals of Multi-Objective Combinatorial Optimization.

Due to the complexity of evaluating the quality of different algorithms, we include in this paper a revision of different metrics. In this sense we want to emphasize the importance of the useful practice of reporting a Net set of Potentially Efficient solution obtained for the benchmark problems of Taillard (1993) by the algorithms proposed in the corresponding paper, and suggest to report the following metrics: Q_1 , Q_2 , C , $Dist1R$ and $Dist2R$ to evaluate the different attributes of the proposed methods (see section 3.4.)

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Beyond ERP Implementation: an Integrative Framework for Higher Success

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Abstract: Research about ERP post-implementation and ERP assimilation is very limited. Similarly, scant research investigated ERP experiences in developing countries. Based on a qualitative research methodology grounded in the diffusion of innovations theory, the present study aims at investigating the determining contextual factors for ERP assimilation. A cross-case study analysis of four firms in a developed and a developing country suggest that in both contexts, the primary factor for encouraging a successful ERP assimilation is top management support. Other factors such as post-implementation training and education, IT support, organizational culture, managers and users involvement, strategic alignment, external pressures and consultant effectiveness were also identified as factors that influence ERP assimilation. Several assimilation impediments that should be watched for were also identified.

Keywords: Enterprise resource planning; ERP systems; assimilation; post-implementation; case study; developing country; manufacturing organizations

1. Introduction

Despite the large investments in ERPs, the relatively long experience of companies with these systems and the accumulated knowledge about ERP projects, few firms are efficiently using their systems (Yu, 2005). Similarly, there have been studies reporting cases of initial implementation failure that transformed into success, yielding significant benefits for the business (Jasperson et al., 2005).

Completing the system's implementation is, in fact, not the end of the ERP journey. Like other complex information technologies, once the system is installed, the adopting organization must ensure the effective assimilation of the ERP in order to be able to reap its benefits (Chatterjee et al., 2002). Effective assimilation is achieved when employees' sense of ownership of the system is high, when it becomes institutionalized in the organization's work processes, and when it is efficiently deployed at the various levels of managerial activities (Botta-Genoulaz & Millet, 2005; Cooper & Zmud, 1990). A primary objective of this research is therefore to investigate the factors that could explain why some firms are more successful in assimilating their systems than others.

Moreover, prior ERP research predominantly focused on the North American context (the United States in particular) and, to a lesser extent, the western European context. Scant studies dealt with developing countries (Ngai et al., 2008), despite the valuable lessons that could be

learned from their experiences. Huang and Palvia, (2001) argue that in developing countries, ERP technology confronts extra challenges which are intrinsically connected to several contextual reasons such as culture, economic conditions, government regulations, management style, and labor skills. Nevertheless, studies about ERP experiences in developing countries are scarce. Additional efforts are therefore required to fill this research gap. For our research, we chose Tunisia as the developing country and Canada as the developed country..

This paper is organized as follows. First, we provide an account of the theoretical foundations of the concept of assimilation. Next, we describe the theoretical framework and the methodology that guided our empirical research. In section 4, the cases' analyses and research findings are presented followed by a discussion of the findings. Lastly, we offer some concluding thoughts.

2. Theoretical Foundation

ERP systems are software packages that embed, in their basic architecture, business knowledge and business process reference models as well as the knowledge and expertise of implementation partners (Srivardhanaa & Pawlowski, 2007). All this knowledge, which evolves and increases with each upgrade, must be properly understood and applied in order to support business analysis and decision-making (Shang & Hsu, 2007).

The diffusion of innovation theory represents our primary approach in studying the assimilation process. Roger's diffusion of innovation theory posits that both the perceived attributes of the innovation and the firm's characteristics influence the adoption and use of an innovation (Rogers, 1995). Although it seems to be quite appropriate for studying innovation use, Roger's model has been criticized for being mainly applicable to simple technological innovations requiring individual decision-making. More research has therefore been made, based on Roger's theory, to better explain the diffusion of complex technological innovations. For instance, Tornatzky & Feleischer's (1990) model considers three aspects of the firm's context (technology, organization, environment (TOE)) that influence a complex innovation's adoption and assimilation process. In their diffusion stage model, Copper and Zmud (1990) identify six stages for IT projects, three of which denote the post-implementation phase: acceptance, routinization, and infusion. During the infusion stage, the system becomes deeply and comprehensively embedded in the organization's work system and value chain. At this stage, the firm further integrates the system and extends its functionalities by adding new modules or applications to support new activities and reach external partners (Muscatello & Parente, 2006).

For the purpose of this research, we define assimilation as the extent to which the system is diffused and institutionalized in the organization's work processes and managerial activities.

3. Research Framework and Methodology

Drawing on ERP implementation and IS assimilation literature, we focused on factors within the three main contexts that could influence the ERP assimilation process: technological context factors, organizational context factors, and environmental context factors. The technological context includes the ERP attributes such as ease of use and reliability which may have an impact on the system's assimilation (Hsieh & Wang, 2007) and the IT/ERP expertise. The organizational context comprises top management support, strategic alignment, user involvement, absorptive capacity and reward system. The environmental context includes the institutional pressures, the post-implementation vendor support and the consultants' effectiveness.

The following figure illustrates the research framework that guided our empirical investigation. Since our research was primarily exploratory, we chose not to specify any formal hypothesis that could act as an impediment to discovering important insights and new dimensions during our research.

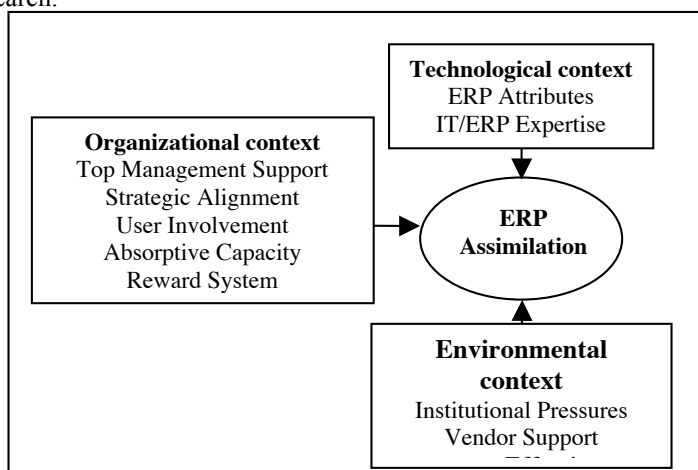


Figure 1 – Research Framework

In this research, we have adopted the in-depth multiple case study approach (Yin, 2003). We used this exploratory approach given that little is known about ERP assimilation and the contingency factors that influence this phenomenon in a developed and a developing country. Four manufacturing companies were chosen: two in Canada and two in Tunisia.

Table 1 – Profiles of Companies A, B, C and D

Characterisitcs	Canada		Tunisia	
	Company A	Company B	Company c	Company D
<i>Industry</i>	Agrifood	Plastic products	Agrifood	Petrochemical
<i>Employees</i>	~ 500	~ 1000	~ 700	~400
<i>Sales (Mln US)</i>	> \$160	> \$160	> \$90	> \$100
<i>Vendor</i>	SAP	JDE	JDE	JDE
<i>Go-live date</i>	1997	2004	2000	1996 then 2006
<i>Implementation Approach</i>	Big-Bang at the headquarters and one plant then phased by site	Big-Bang at the headquarters and 2 plants then 3 rd plant	By module	Big-Bang
<i>Motivations for ERP adoption</i>	Y2K problem; Clients' pressures; Need for a system that evolves with the firm's requirements.	Integration of financial data; Old system is outdated	Data centralization; Insuring tracking and transparency	Part of a wider (pan African) project for business process standardization; Intermediate stage towards a higher performance system

Table 1 provides a brief description of the characteristics of these companies. The primary source of data was the in-depth interviews with at least five managers in each company. The necessary validity and reliability measures were taken through the study in order to ensure its rigor as well as the quality of the design and findings.

4. Case Analysis

4.1. ERP Attributes

All respondents agreed that the level of complexity decreases over time as users get more and more accustomed to the system. Also, according to several respondents in companies B and C, early post-implementation output quality issues such as data accuracy, timeliness, integrity, and reliability negatively impacted the level of users' involvement and deployment of the system and, in many cases, encouraged the use of parallel systems. In spite of the frequent interventions of the IT/ERP experts, many of these issues persisted. The causes were attributed not to the system, as several respondents asserted, but rather to the human factor such as employees' resistance and managers' lack of commitment.

4.2. IT/ERP Expertise

All the companies, except for Company D, had an internal ERP team. Two major problems identified by respondents in companies B and C was the high turnover rate of ERP experts. This issue was justified by the high demand for ERP experts and the external competitive wages of such experts. Evening and night shifts represented a different type of problem for Company A. Most of the evening and night workers received less support and training than their day colleagues. Efforts were made to provide appropriate support for evening and night shifts, but it was insufficient. Another critical point that can hinder ERP assimilation, as noted by respondents at companies B and C, is an organizational culture that values product innovations over IT innovations. They argued that the system's acceptance and assimilation would have been much easier if their organization's culture assigned a higher value to IT innovations, the IT department, and IT objectives and strategies.

4.3. Top Management Support

All the companies reported that they were receiving adequate financial support for upgrades and system requirements from senior management. However, The financial support does not necessarily reflect the real perceptions of top management about the system's value. In Company A, for instance, the CEO was consistently involved in person in the ERP steering committee, and the system was always among the firm's top priorities. On the other hand, top management at Company C lacked interest and trust in the system due to the frequent delays and problems experienced after the implementation of each module. Furthermore, priority was always given to projects with quicker and more tangible returns than those of the ERP system. As a respondent at Company B put it, "*Culturally speaking, priority is given to investments in products and not in IT.*" Indeed, respondents at companies B, and C stressed the importance of the role of top management in supporting the prevalence of an ERP culture, "*a culture of openness, information sharing, doing work on time, real-time, and transparency.*" Moreover, imposing the system's use, strict control of users to prevent them from using parallel systems, and the relocation of

employees who produce parallel reports were examples of policies that respondents suggested top management could apply in order to improve system assimilation.

4.4. Strategic Alignment

Companies A and D exhibited the highest level of strategic alignment. The system was highly valued in these firms by both senior and middle managers, and was always considered to be an institutional tool for the firm's operational effectiveness. The situation was in the process of improving in Company B with the arrival of the new CEO and the new managers, all of whom had experience with ERP systems. One interesting factor that was highlighted by respondents at companies B and D is the reporting relationship between the IT manager and the CEO on the one hand, and the IT manager and other department managers on the other hand. A respondent at Company D argued that the fact that the IT manager was at the same reporting level as the other departments' managers compromised the execution of his recommendations. In fact, these recommendations were seen as emanating from a mere peer rather than serious orders from senior management. Moreover, the fact that at Company B the IT service was supervised by the finance department reinforced a general perception in the company that the function of the ERP system was to primarily serve the finance department and to tighten control over the other departments' operations. These perceptions negatively impacted the system assimilation level in the company.

4.5. User Involvement

The ERP steering committee at Company A presented users with a valuable tool to get their voices heard. During the committee's regular meetings, users' suggestions were evaluated and classified by priority for possible implementation. IT respondents at companies B and C stressed that users' seniority, computer literacy, and ability to express their needs were elements that had a significant impact on the level of involvement with and commitment to the system.

Middle Managers'involvement:

One important factor that was highlighted by respondents in all of the four companies was the level of involvement of managers and its impact on their subordinates' commitment to and involvement with the system. At Company C, the reluctance of middle managers to commit to the system was a result of their "*fear of becoming unnecessary for the firm's functioning.*" For those who had more trust in the system, their limited involvement was attributed to the heavy workload of the daily tasks. At the other extreme of the spectrum, managers at companies A and D had a very high level of system ownership and commitment to the system. Moreover, brainstorming sessions and meetings to discuss changes and exchange experiences were common rituals in the company, including its plants.

4.6. Absorptive Capacity

Among the four companies, only Company D had previous experience with an ERP system, which explains its smooth transition towards developing a high-level ERP system and a high level of assimilation of the system. In addition to their high-quality help desk, the fact that the system permitted interaction with a bigger population of users (pan African) allowed Company D's users to benefit from a wide pool of rich system knowledge. Due to their accumulated learning and long experience with the system, most of Company A's modules were deployed nearly to their maximum potential. Consultants were the major source of knowledge for the four companies

when new modules were to be implemented or assistance was needed concerning the interaction between modules.

Knowledge Management System:

The issue of the absence of a knowledge management system that captures and stores the acquired knowledge and experience was highlighted by several interviewees when discussing ERP knowledge resources.

Pot-Implementation Training:

One other major missing element, according to most respondents, is a formal post-implementation training program. Companies B and C were in fact suffering from varying levels of redundancy and parallel systems, which significantly lowered their system assimilation efficiency. This redundancy was essentially attributed to the lack of training and proper communication during both the implementation and the post-implementation stage. Newcomers, in the case of all the studied companies, were informally trained on the job by their colleagues, learning only the very basic actions needed to do their work. Some respondents highlighted the negative impact of such informal training on the level of understanding and assimilation of the system; this explains the heavy and recurrent need of new system users for IT support, especially when faced with unexpected problems.

4.7. Reward System

In a study evaluating the importance of critical success factors across ERP project phases, Nah and Delgado (2006) found that ERP team skills and compensation were the most important factors for the post-implementation stage. None of the studied firms, however, changed their reward system to encourage and reward ERP system use or to retain ERP experts and trained superusers. While companies B and C suffered from a general high turnover rate, Companies A and D were proud of the high level of loyalty of their employees, especially the IT/ERP team of Company A, which they attributed to the "family-like" ambiance that prevailed in the company and the "good" wages compared to other companies in the industry.

4.8. Institutional Pressures

In all the companies studied, the desire to improve internal efficiency and performance and to preserve a leading position in the market was among the main drivers towards better deployment of the system. There were, however, other external pressures that pushed some firms to use the system effectively. After most of its competitors adopted ERP systems, Company A felt a strong need to surpass its competitors not only by further deploying the system's functionalities, but also by innovating with the system. At Company D, the requirements of the firm's headquarters to master the system and to comply with the work norms of other regions' divisions for further global integration represented a major pressure driving the firm to use the system efficiently. It was mentioned by several members of the ERP teams/units that taking part in ERP conferences, on-line forums, and training sessions motivated them to improve their system deployment. This is in fact a form of normative pressures.

4.9. Vendor Support

None of the three companies A, B and C maintained a strategic relationship with the original vendor. In the case of the subsidiary Company D, there was no direct contact with the vendor because the system was implemented by an internal team of the multinational group, who assist the subsidiaries in installing the system.

4.10. Consultant Effectiveness

Companies A, B, and D needed external expertise intervention when implementing a new module. Respondents from Company A stressed the "*extreme importance*" of the high expertise of the consultant even during the post-implementation stage, because as in the case of the other implemented modules, the company needed to properly learn about the module and its different functionalities. In Company D, respondents opined that even though the virtual help desk was very competent, the presence of the consulting team was essential during the system's stabilization. Unfortunately, this was not possible because the consulting team was responsible for implementing the system at other subsidiaries in Africa.

5. Evaluation of Assimilation at the Studied Companies

The assimilation level varied widely across organizations and within the same country. Company A had the oldest experience with the ERP system. The core system capacity was deployed to over 85%. According to Company A's respondents, the system was deeply embedded in the firm's work routines and provided almost all of the required information to make decisions. Strategic and planning decisions, however, were made outside the ERP system, as it was considered to be too complicated. Efforts to improve the system's effectiveness have not stopped since its introduction in 1997, especially after the widespread adoption of the system in the industry. These improvements included both deepening the functionality deployment of the already-installed modules and extending the system with new modules.

At Company B, the system was at a stabilization stage. Two of the plants were integrated and a project to integrate the third plant was under way. System deployment was limited to the basic functionalities. However, parallel system use, redundancy dissatisfaction among users and managers, and lack of trust in the reliability of the system's outputs were prevailing in the company. Efforts to improve system deployment were being made, especially after the arrival of the new CEO and managers. Despite the challenges experienced, the system represented a main source of data for the company. The system was satisfying most of the finance department's needs, but was only responding to 30 to 40% of the operations department's requirements.

At Company C, several modules were implemented, but they lacked complete cross-functional integration, which hindered the traceability of the products' costs. The system was considered to be a basic source of data for several departments and was believed to serve about 50% of the company's needs. In spite of the numerous problems surrounding the ERP initiative, as discussed in the sections above, significant efforts were being made by the IT department to stabilize the system, integrate the modules, and to improve its deployment.

At Company D, the system was also at a stabilization stage. The transition to the new system was smooth and assimilation was rapidly taking place. The system was diffused across almost all of the company's units and all of the implemented modules were integrated, therefore providing the managers with an enterprise-wide visibility. As the system becomes more stabilized and its outputs more reliable, it will be used for managerial control besides operational control. However,

planning and strategic decisions were being made outside the system using less complicated software.

It is worth noting that several managers praised the fact that ERP decreased the time needed to gather critical information for all levels of decision-making. However, they stressed the importance of the human being's role in making decisions and solving problems compared to a system that produces automated decisions. In fact, most of the interviewed managers thought of the system as being mostly transactional and as being unsuitable for strategic and planning decisions.

6. Discussion

The primary objective of this study was to explore the determinants of a successful ERP assimilation. A relative commonality exists across the studied companies regarding the determining and constraining factors for achieving a high level of ERP assimilation. First, this study affirms that regardless of national differences, top management financial and moral support is strongly related to effective ERP assimilation. Top management's knowledge about the system, its potential for the company, and its requirements should be regularly reviewed and updated. Clear and effective communication is also necessary between the ERP/IT manager and top management in order to dispel any resistance, lack of trust in the system, or confusion resulting from the challenges of the post-installation stage. A main task of top management is ensuring the continuous alignment of the system with the business vision and strategy, and communicating the latter clearly in the firm. In order to reinforce the effective deployment of the system across the organization, top management could reinforce the policies prohibiting parallel systems and redundant data, and a strict control of system use could eliminate deficiencies and force system deployment for at least basic user tasks.

Another lesson learned from this research is that middle managers' involvement and ownership of the system is crucial to encouraging system assimilation in their departments (Yu, 2005). Also, users' involvement during the post-implementation stage is a valuable ingredient for system acceptance and assimilation. With their situated practice, users learn more about the system limitations and start suggesting changes and modifications to satisfy their needs. Elements such as education level, seniority, IT proficiency, and openness to change are factors that could moderate the impact of users' involvement.

Our analysis highlights the organizational culture, as an important factor for promoting assimilation and system success (Ifinedo, 2007). ERP assimilation would be greater and easier if the organizational culture values IT and IT strategies and objectives. Our data analysis also showed that open cultures that promote learning, transparency, knowledge and information sharing, innovation and cooperation are more likely to assimilate the system well than those that lack these characteristics.

Another important insight is that a skilled and competent internal IT/ERP team is a significant success factor for facilitating the system assimilation process (Yu, 2005). The advantage of an internal ERP team is their good knowledge of the organization's processes, their proximity to workers, which enables them to better evaluate the problem and its consequences. With the high turnover rate of ERP expertise and the skill shortage, top management should set flexible human resource policies on pay and contracts, and provide opportunities for career development (Willcocks & Sykes, 2000).

Our data analysis showed the critical value of a formal post-implementation training program (Nah and Delgado, 2006), especially if this activity was overlooked during implementation. Furthermore, in order to cope with the high turnover rate of ERP experts and with the constantly increasing knowledge of the system (from external parties, workers' experiences with the system,

etc.), the use of an ERP knowledge management system was considered to be a highly effective tool to encourage learning as well as knowledge sharing and creation. Unlike in previous research, our findings showed that maintaining a strategic relationship with the system vendor was not essential. Services such as updates and maintenance could be obtained from other vendors. Consultant effectiveness, however, remained an important factor for assimilation.

Institutional forces vary across companies depending on their industries and markets. The strongest forces are government regulations and the pressures from headquarters and external partners to properly assimilate the system in order to be able to provide integrated, detailed, and real-time information. The economic motivation remains, however, the main incentive for properly assimilating the system, deploying its functionalities to the maximum, and continuously optimizing its value in order to fully benefit from its advantages.

The second objective of this study was to investigate the differences between the two groups of companies. It is important to say from the outset that if our findings, as we saw earlier, showed several commonalities between the two groups of companies, a number of constraints were more conspicuous in the Tunisian Company C. One of the main handicaps to assimilation in that company was the persistent reluctance amongst several managers to commit themselves to the system and their strong objection to changing their traditional working methods. No doubt by being so, they caused, among other things, the ongoing lack of integration (and aggregation) of the organization's data and they limited the constructive sharing of information between the different units of their firms. The managers' lack of commitment can be attributed to two main factors. Firstly, for many managers, information is not considered a corporate asset. It is rather, a personal asset which should be shared selectively with other employees in the firm. Additionally, there is the rejection of the plant workers to spend extra time entering data and their perception of the system as merely adding extra load to their duties, controlling their actions and even tracking their mistakes. No doubt, this had badly impacted the quality of the system's data and outputs (i.e. their reliability, accuracy, completeness and precision) which, in turn, had frustrated the managers and discouraged them from using the system.

The lack of users' and managers' commitment and the fear of the loss of power were also problematic in the Canadian company B. It was easier and relatively faster for its IT/ERP unit to limit these problems than in the Tunisian company C. Indeed, the high power distance, in-group loyalty, and competitiveness amongst Tunisian managers discouraged many of them from accepting the IT manager's leadership and dissuaded them from following his/her instructions. Needless to say, such a competitiveness between managers and the resulting fear of appearing incompetent in terms of mastering the system further hampered system assimilation by discouraging inexperienced managers and novice users from benefiting from the experiences of other managers working in another "sister" company and who were more advanced in the system deployment. Therefore, it is incumbent upon the Tunisian IT manager to strive to build strong relationships based on collaboration, trust, mutual understanding and clear communication in order to ensure the involvement and commitment of managers and users to promote the assimilation of the system in the company. These efforts need to be buttressed up by the reduction of the reporting relationship distance between the IT manager and top management. This would put the IT manager at a senior position which would allow him/her to enjoy a higher level of authority in the organization.

Compared to companies C, Company D was in a much better position and exhibited a high level of system assimilation even though its system was still at a stabilization stage. This wide difference in assimilation level can be attributed to several factors. First, Company D had a lengthy, successful prior experience with ERP systems. Second, this company is a subsidiary of a European multinational company that has been established in Tunisia for more than 80 years. Therefore, the values and culture of the European company, including information sharing, open

communication, participation, encouraging learning and motivation, were deeply rooted and clearly manifested in its subsidiary.

7. Conclusion

The present study adds to IT innovation diffusion literature by investigating the long-neglected assimilation stage and ERP assimilation in particular. In addition, it begins to fill the ongoing gap in research on ERP experience in developing countries. Our results show that there are numerous similarities in the success factors deemed to be critical to ERP assimilation in both the Canadian and Tunisian cases. Nevertheless, our findings reveal that there still exist a number of serious barriers that must be overcome in both countries, and especially Tunisia. With the most challenging issue being the human factor, organizations should invest heavily in terms of time and effort to manage properly this resource.

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The creation of value of ERPs in firms: an exploratory analysis

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Abstract: A great number of firms worldwide have invested a lot in the application of ERP systems to modify their business model and be able to offer better processes. When firms implement ERP systems they try to integrate and optimize their processes in what they consider their key areas. The present paper tries to offer a view centered on the main reasons why Spanish firms have implemented ERP systems in the last ten years and what have been their main critical success factors and their main failure factors too. For that, we apply a model that we have previously developed based in 5 main groups of variables. We ask firms about their perceptions and final results provided by the variables affecting their change processes in the ERP implementation. We try to offer a realistic view of what has been taking place in the Spanish market.

Keywords: ERP systems, decision making policy, managerial support, training characteristics, organizational inertia, user satisfaction

1. Introduction

Firms have great invested in ERP systems in the last fifteen years (Wang et al., 2008).

Summer (1999) admits that ERP systems can provide lots of benefits in firms. They allow, for example to compete in a global context, to reduce the warehousing material and the costs of production and the increase in the level of service offered to the customer (Ang et al., 2002).

Akkermans and Van Helden (2002:35) recognise that the ERP implementation demands a great effort and compromise from all the organisational levels. The problems that the firms face when trying a successful implementation have long been explained in the literature review (Holland and Light, 1999, Rosario, 2000, Esteves and Pastor, 2001, Wang et al., 2008).

Trying to find solutions to the problems that the implementation of ERP systems can offer, different academics and consultants have done research on the process of implementation and more specifically, about the determination of the factors that contribute to the success in the implementation, best known as critical success factors (Summer, 1999, Umble et al, 2003, Fui-Hoon et al., 2003, Finney and Corbett, 2007).

In this paper we ask firms about their perceptions and the final results they achieve as a consequence of the ERP implementations processes occurred in the last 10 years. For that we apply the model of critical success factors we have designed (De Pablos and De Pablos, 2008)

based in the analysis of five main groups of variables affecting to the final results in ERP implementations.

1. The decision-making policy of the firm in the ERP selection, implementation and use
2. The training characteristics of the people involved in the ERP implementation and final use
3. The organisational inertia in the firm
4. The final internal user satisfaction
5. The final external user satisfaction

2. Critical success factors affecting to the final results in ERP implementations

2.1. The decision-making policy of the firm in the ERP selection, implementation and use

We include as the main variables explaining this factor the decision-making policy of the firm in the ERP selection, implementation and use, the existence of managerial support, the existence of clear procedures established for the required reengineering of business processes in the firm, the effectiveness of the project management and the existence of a wide commitment in the different stakeholders taking part in the implementation process (vendor support, external services, etc.)

- The existence of managerial support,

Finney and Corbett (2007) stresses in their study how this aspect is one of the most cited in the literature review. Besides in our recent interview with consultants specialised in ERP implementation in the Spanish market this aspect is highly stressed as one of the most important CSFs.

Top management support in ERP implementations offer two main aspects,

- It provides leadership
- It provides the necessary resources
- To successfully implement an ERP system, firms need spend time with people and provide them with the needed resources. The implementation could fail in case that the critical resources are not available when needed.

For achieving success in a project of ERP implementation it is important to involve the managers in the organisation. Managers must involve to the rest of the people in the organisation in the collaboration and support with the project.

For that reason, periodical committees headed by the main managers in the firm must be held. The organisation must be kept informed about the evolution of the project and about the problems arisen.

- The existence of clear procedures established for the required re-engineering of business processes in the firm

It has mainly to do with managing the cultural change, identified by Al-Mashari et al. (2003), Fui-Hoon et al (2003) and Finney and Corbett (2007).

Implementing ERP systems requires the redesign of the existent business processes. Many times the ERP implementations fail because some firms underestimate the extent to which they have to change processes. Motwani et al. (2002) suggested that the organisations should be prepared for fundamental change to ensure the success of the business process reengineering.

The companies must profit from the ERP implementation to optimise their business processes by promoting the change in the management system and the experience in the consultancy teams that take part in the implementation of the new system. Therefore, it is critical

the process of change that accompanies to the project. The focus in the change of the management allows surpass the state of uncertainty that appears in the people working in this kind of projects.

In the management of the change in a project for the implementation of an ERP system, the firm must work on three different aspects: information, training and involvement.

- The effectiveness of the project management

It has to do with the aspects of the change management (Falkowski et al., 1998; Holland and Light, 1999; Rosario, 2000; Sommers and Nelson, 2003), and project cost planning and management (Holland and Light, 1999; Somers and Nelson, 2003).

Project management plans, co-ordinates and controls the complex and diverse activities of modern, industrial and commercial projects. The implementation of ERP systems implies the working of different activities, all involving business functions and requiring a long time effort. There are five main parts to consider in project management

1. having a formal implementation plan
2. offering a realistic time frame
3. celebrating periodic status meetings
4. having an effective project leader
5. including project team member that, at the same time, are stakeholders
 - The existence of a wide commitment in the different areas of the firm

It refers to the existence of a communication plan (Falkowski et al., 1998; Holland et al., 1999; Summer, 1999; Rosario 2000; Mabert et al. 2003) empowered decision makers, and team morale and motivation

Taking into consideration that the ERP systems are enterprise wide information systems that attempt to integrate information across all functional areas in an organisation, it is important to get the needed support from all functional areas in the organisation. Everyone in the organisation must be responsible for the whole system and key users from different departments must have cleared the project implementation phases.

When realising the implementation of an ERP, a previous methodology must be established, where clearly the steps in the project and the involvement of each of the key-users and the consultancy team that takes part in the implementation are specified.

- The existence of a wide commitment in the different stakeholders in the implementations (vendor support, external services)

It is close referred to the selection of the ERP (Sommers and Nelson, 2003; Al-Mashari et al., 2003) and the consultant selection and relationship (Al-Mashari et al., 2003; Motwani et al., 2002).

It is very important for the customer that decides to implement an ERP system in his/her organisation and for the providers, to align the implementation services with the achieving of the objectives fixed for the project. Those objectives must be defined in the design document elaborated once that the analysis and requirements feeding phases have been finished. The design document must contain the situation of the business processes before the implementation and the future situation, once that the business process reengineering effort to implement the ERP systems, has taken place.

2.2. The training characteristics of the people involved in the ERP implementation and final use

It is related to the aspects of training and job redesign, data conversion and integrity (Umble et al., 2003; Sommers and Nelson, 2001, 2004), and system testing Nah et al. (2001). The interviews with the consultants offer us a similar criterion when they refer to the need of establishing training programs for the users.

As we know by the nature of an ERP system, it includes all the material and human resources related to the management of the information in the firms. In this sense, a first vision

distinguishes between both types of human resources in the information system of a firm: the final users and the personal working on them.

Final users are all those persons that take part in the information system of a firm to get the final product, as defined by Garcia Bravo (2000). We can consider that all the members in an organisation are potential final users of the system, since all of them are going to use and modify information.

The role of final users has more relevance in the last years due to the decentralization of these systems. This way, a greater proportion of the people in the organisation are involved not only in the processing of information and the obtaining of a result, but in some other activities as can be the development of the systems.

The personal of the information systems include all the workers in charge of the ERP development, management and maintaining. Traditionally it has been considered that these system technicians are specialised in the information system.

The change in the role of the information systems in the organisations has evolved along time. This way, by considering the ERP strategic role, it has been assumed that the responsibilities in the ERP are not just technical ones but they necessarily include some other functions related to the strategic management or the firm's policy. Additionally, part of these workers must have specific skills in the management of human resources.

For that, we must also consider the differentiation between managerial and ethical skills widely spread.

It is also typical the division of people working on information systems according to the hierarchical order of responsibility assumed. We can consider this way, that the system always includes a top executive of the company, the Chief Information Officer, CIO, directly reporting to the President or the Chief Executive Officer in the firm (CEO); a certain number of intermediate managers, with limited responsibilities, the technical personal, specialised in some tasks and the operations personal, in charge of the performance of structured tasks.

Functions of the workers in ERP systems

Monforte Moreno (1995) refers to the organisation of the ERP systems as a series of functions, independent from the firm's dimension, which we can sum up in the following ones,

Development of the systems, programming and processes of exploitation: it includes the tasks related with the analysis, design, development and implementation of the ERP systems in the firm, together with the programming and maintaining of applications.

Security of the ERP systems, it includes the needed operations to avoid the loss of information, the prevention of physical and logical attacks to the system or the insurance of the buildings facing human or natural errors.

The administration of the ERP information, related with the management of the use of the resources of information systems and the "internal payment" of these services to the departments requiring them.

Standards and system techniques, it refers to the planning in the acquiring of new technologies and their implementation in the firm. One of the main tasks for these aims it is the constant seeking of the technological environment, to analyse the new availabilities of resources for acquisition.

In a similar way, McLeod (2000) propose a scheme of the organisation adapted to the model of the life cycle, reflected in figure 1. The main character is the CIO with a wide group of responsibilities and functions. In the middle level, the author situates a group of supervisors of the different areas of the system, under his/her control. And reporting to these last ones, we can find the technical people and the operators working in each of the functions.

- Human efforts of the ERP implementation and rewards

The strategic management in the human resource area refers to a group of policies that define the strategy of human resources in a firm, this means, the main decisions related to this area. They can have a significant influence over the organisation and the results.

Some of the main human resources policies widely studied have been the following ones,

Recruitment policy: it deals with integrating in the organisation people having the required skills for the development of a group of activities and firm's functions in relation with the ERP system. In this sense, one of the decisions more studied is "to do instead of buying", that faces the internal formation of the new personnel with the search in the market of the human resources containing the proper profile in competencies. It also belongs to this ambient the decision about the factors that must be taken into account when searching new human resources.

Training and development policies, they have to do with the increase of stock of individual skills coming from the human resources in the firm, that can besides contribute to the improvement of collective skills. Inside this ambit, we can consider the decisions around the quantity of training that must be offered on the ERP system.

Policies on the design of the work profile, they mainly refer to the variety of functions and tasks included inside a work profile around the ERP system. Inside this part, policies for job enrichment and level of the desired specialisation are included.

Rewarding policies, related with the rewards that the workers receive from their work. In this sense, we must consider included here all the decisions dealing with rewards, shares offered, holiday programs and any other extra rewards.

These policies will be the main part in the strategy with ERP workers.

Most analysis consider five different configurations in the human resources policy in a firm, policies oriented to the human capital, policies oriented to the tasks (technical people rewarded, work assured and work utility)

It seems clear that the human resources policies of the information system can be varied, especially by having into account the wide number of available tools in this area.

- The ethics and the ERP system

The CIO must be the highest responsible for the computer ethics in the ERP system, and must then supervise and pay attention to the influence of the ERP over society and consider the policies that can be adopted for a correct use of the technology. This preoccupation for the ethics is immediately perceived by people working with the ERP systems, especially for those in charge of the more invisible part of them.

Parker (1988) proposes ten actions to promote the ethical conduct in the employees in the information system of a firm that could be extended to the ERP cases,

- To formulate a conduct code
- To establish the clear acting rules in situations of ethic conflict
- To clearly specify the sanctions applied in non ethic conducts
- To public recognise the ethical conducts
- To develop programs, meetings and recommend readings
- To inform, promote the knowledge of the Acts implied with the proper use of IS and IT at Organisations
- To delimitate the ethical responsibilities if each worker according to their tasks.
- To promote the use of "restructuring programs" for people avoiding ethical norms.
- To promote the integration of workers in the professional associations
- To offer example with the own acts

2.3. The organizational inertia in the firm

It is referred to the aspects of visioning and planning (Falkowski et al., 1998; Holland et al., 1999; Rosario, 2000; Al-Mashari et al., 2003). It is in relation with the need of establishing a responsible for the software implementation referred by the consultants in the interviews.

The organisational inertia has to do with aspects in relation to culture, values and ways of group expression in the organization. Organizational change implies the leaving of some structures, procedures and behaviours and the adoption of other ones, with the main objective of improving the final performance. The management of the change implies the application of concepts, techniques and methodologies that are going to make it possible the complex migration from an initial not desired status to another final desired one.

The management of change must start with the challenge of determining what is going to be changed. We have to distinguish between people; they must make decisions in relation to what it is going to be changed since they have responsibilities in the organisations, and those who are directly related in the process, people who are asked in an informal way and those others who are not even asked for. Once the change has been implemented, there will be people informed and trained in the process and people who have just been informed. These circumstances logically are going to have an impact in the change, in a positive or negative way.

- The process: the main axis for the change

Organisations develop their objectives through processes. A process is a group of tasks allocated in different firm areas and that develop a group of functionalities or specialisations. In this sense, we can say that a process is trans-functional. A process has a point of start and end and around it many different functions are working in different periods of time, in a parallel or sequential way.

The concept of trans-functionality in the process and the consideration of the co-living of different kind of processes in the organisations are very important when considering the organisational change. In the first place, because the effort in the change it is going to promote impact in the whole process, because any of the firm's task is part of a whole business process, and, in the second place, because a change in any part of a process, it does not matter its nature, will have an impact in a process connected with the previous one but of different nature (for example a working process has an impact in a decision making one). In this sense, and just as an example, the automatic feeding of a customer's data by using a corporative Intranet (work process) can allow that any point of selling can directly solve a decision that affects the customer, and in case of not counting with that automatic feed, it will be impossible to develop this process (for example the process of offering a bank loan to a customer).

- Models of change oriented to processes

We offer here some ways of creating an environment of change in the organisations,

- To create a dissatisfaction: by showing lack of skills in the status quo, by communicating relevant variations in the internal profile and the external situation, that show the need of change. For example, the globalisations of the markets have made appeared the need of marketing the products in new geographical areas. For that reason, it is important for the system and the people in the company to be able to work in different languages and currency.
- To reduce the fear for the change: by establishing open discussions, based on the experience of other companies and other parts in the organisation. For example, the resistance to change can be a decisive cause for the failure of a project of ERP implementation. For that reason, most companies apply for the collaboration of external consultancy firms experienced in the same industry, to be informed before starting any project.

- To create energy in the company around the benefits of the change in people from an individual and collective perspective. For this reason the information must be properly managed. It must reach to everyone in the firm and it must help people to be involved and enthusiastic with the new project. The firms can use different channels to offer the information
 - Kick-off: a meeting with all the participants. A starting point in the project with an explanation of the main objectives and the methodology used to achieve them.
 - The information bulletin
 - The periodical information, to publicity the project state of the art
 - The development of the Intranet: public information of the generated documents from the project to the firm's intranet.

To build support for the change: by identifying the persons in charge of the change efforts and work with them. Before starting a project, it is important to define who are responsible of it in the firm that it is implementing the system and in the external collaboration groups too.

- To define specific objectives for the change: in detail and that can be measured in clear deadlines. Work teams are usually established to fix the objectives associated to the different business areas implied in the project and measure the persecution of the objectives and typical deviations.
- To define awards and punishments in the change and their impact in the profiles and work places. In the contracts of collaboration with external providers, it is important to include mechanisms of punishment by both parts (provider and customer). They can be activated in case there are deviations in the final ERP functionality or in the initial agreed deadlines.
- To plan the adequate training and synchronised with change. In the various phases of the project, different training plans are established according to the different users implied on them. As we descend in the organisational levels, the training required is more specific and specialised.
- To communicate the efforts for the change and make participate to the employees in them, etc. Communication matrixes must be defined where the different people's profiles and the related information with the project are informed in each of the project steps.

2.4. The final internal user satisfaction

It is based in the system testing (Nah et al., 2001; Al-Mashari et al., 2003), and post-implementation evaluation (Holland and Light, 1999, Nah et al., 2001; Al-Mashari et al., 2003; Umble et al., 2003). It is highly related with the feedback we have obtained from the consulting firms operating in the Spanish market since they stress that it is very important to check that the software meets the needs of the whole company.

It refers to the participation in the system development and implementation by different representatives of the target groups. System implementation means a threat to users perceptions of control over their work and a period of transition in which users must cope with differences between old and new work systems. User involvement is effective because it offers perceived control by taking part in the whole plan.

Users can be involved twice when implementing an ERP system

- User involvement at a stage of definition of the company's ERP system needs,
- User participates in the implementation of the ERP system.

2.5. The final external user satisfaction (firm's customers)

It is inspired in the client consultation process (Holland and Light, 1999; Al-Mashari et al., 2003). It has to do with the training programs for the users that the consultants surveyed have mentioned us.

A group of variables explaining final customer satisfaction of the ERP deliverables must be taken into account before implementing the ERP system. The ERP system implementation demands of great human and technical efforts to promote a desired situation in which the final external user feels much more satisfied.

Satisfaction and results are considered, variables of the greatest importance when defining different styles of internalising ERP systems in the firms. Maybe the most complete analysis is developed by Ives and Olson (1983) where they reach a complete methodology that allows measuring the user satisfaction in IT use. This approach has been mentioned in various analyses that study the impact of information and communication technologies in firms of different nature. It seems to be a useful tool to be applied to the case or ERP implementations due to the difficulty in measuring such abstract term as satisfaction.

3. The empirical analysis

The present work is part of a wider study supported and financed by The Spanish Innovation Ministry, where we try to analyze the impact of information and communication technologies in different firm's innovation policies. The general model analyses different entrepreneurial and institutional factors that promote the performance of open innovation practices in firms.

In the general study we are developing different techniques of analysis, revision of the literature, interviews with groups of interest, policymakers, and academics, consultancy firms and final user firms operating in the Spanish market.

In this exploratory work we present the perceptions that a group of firms that have implemented an ERP system in the last 10 years on how important they consider de factors we describe in our model as critical success factors in the final results of EPR implementations and if in reality they have achieved the objectives they were searching when they decided the ERP implementation.

Methodology of the study

The design in the research attempted to find out data about firm's expectations and experiences in the use of ERP systems. For the selection of the firms we have chosen the SABI database. SABI is a financial database showing information of the main Spanish and Portuguese companies, elaborated by Dijk Electronic Publishing S.A and distributed in Spain by Informa, Economic Information, S.A. In the SABI version we have used for the analysis (December 2007), there are 982.410 firms. We have selected all kinds of firms differentiating them by the criteria of size and age. The first part of the work consisted in deciding the questions for the analysis. This part has taken place from February till April 2008.

According to the model we have presented, we have decided to ask about these characteristics,

- Characteristics dealing with the decision-making policy of the firm in the ERP selection, implementation and use
 1. Why did the firm decided to implement an ERP?
 2. Did the project have full managerial support?
 3. Did the firm establish clear procedures for the re-engineering of business processes in the firm?

4. Did the firm offer quantitative or qualitative measures to deeply know about the effectiveness of the project management?
5. Did the firm perform a formal implementation plan?
6. Was the firm offering a realistic time frame?
7. Did the firm held periodic status meeting to know about the evolution of the project?
8. Has the firm included in the project team member, firm's stakeholders?
9. Did the project count on with a wide commitment in the different areas?
10. Did the project count on with a wide commitment coming from the different stakeholders in the implementation (vendor support, external services)?
- Characteristics dealing with the training of the people involved in the ERP implementation and final use
 11. Did the firm establish functions in the equipment responsible for the ERP implementation?
 12. Did the firm establish group responsibilities?
 13. Did the firm establish individual responsibilities?
 14. Did the firm train employees in the ERP implementation?
 15. Did the firm train external collaborators in ERP main objectives for the organization?
 16. Did the firm communicate potential users about the ERP implementation?
 17. Did the firm establish a rewarding policy for the workers taking part in the ERP implementation process?
 18. Did the firm formulate a conduct code for the ERP implementation?
 19. Did the firm establish the clear acting rules in situations of ethic conflict?
 20. Has the firm clearly specified the sanctions applied in non ethic conducts?
 21. Has the firm developed programs, meetings and recommend readings in the new ERP system?
 22. Has the firm informed, promoted the knowledge of the Acts implied with the proper use of IS and IT at Organisations?
 23. Has the firm delimited the ethical responsibilities if each worker according to their tasks?
 24. Has the firm promoted the use of "restructuring programs" for people avoiding ethical norms?
 25. Has the firm promoted the integration of workers in the professional associations?
- Characteristics dealing with the organizational inertia of the firm
 26. Has the firm created positive energy in the workers about the change final results?
 27. Has the firm used any mechanism to reduce fear for the change?
 28. Has the firm identified people in charge of the change efforts?
 29. Has the firm defined specific objectives for the change process?
 30. Has the firm establish clear deadlines for the change process?
 31. Has the firm used a proper methodology for the ERP implementation?
 32. Has the firm discussed with final users about the desired improvements in the change process?
- Characteristics dealing with the final internal user satisfaction
 33. Has the internal user been involved at any stage of the definition of the company's ERP system needs?
 34. Has the internal user participated in the implementation of the ERP system?
- Characteristics dealing with the final external user satisfaction
 35. Is there any mechanism in the firm that allows taking information from final external user's satisfaction?
 36. Is the final user satisfied with the new system?

37. Is the firm using any tool to incorporate the feedback received from the final external user into the system?

A questionnaire was elaborated for the firms. It was offered via the web page of the Social Science Faculty, by previously informing to the interested firms via email in the period from May 15th till July 15th, 2008.

As we have just presented, most of the questions we have applied concerning to this analysis, have been suggested by the literature review in some cases, and in others, they have been obtained directly from firms that have directly experienced an ERP implementation in the last 10 years

The greatest part of the questions are waiting for a response in the typical 1 to 5 Likert scale with degrees ranking from 5 “completely agree” to 1 “completely disagree”, and yes/no responses. The SPSS software has been used for the statistical analysis of the obtained data.

We have received a 32% of final responses from the chosen sample. The firms are localized in five different industries: services to firms (22%), production (12%), tourism (34%), education (8%), financial and insurance services (24%). A 36,6% of firms are older than 15 years, and a 54,3% are small and medium size firms.

4. The results

Now we show the percentages of the perceptions that we have collected from the answers received.

Table 1 –What are the perceptions of firms that have implemented ERP systems in the last 10 years on different critical success factors

Scale (5 completely agree..... 1 completely disagree)	5	4	3	2	1
1.	82,6%	12%	4,4%	1%	0%
2.	94,4%	4,6%	1%	0%	0%
3.	57,6%	25,7%	7,9%	4,8%	4%
4.	75,6%	31,5%	6,1%	0%	0%
5.	68,4%	26,7%	4,9%	0%	0%
6.	56,8%	31%	6,7%	3,7%	1,8%
7.	26,8%	29,8%	15,6%	13,6%	14,2%
8.	76,3%	15,6%	8,1%	0%	0%
9.	83,4%	11,1%	5,5%	0%	0%
10.	23,4%	21,6%	36,3%	12,8%	5,9%
11.	16,7%	14,8%	14,3%	31,1%	23,1%
12.	37,8%	26,4%	25%	14,6%	13,2%
13.	30,8%	26,4%	15%	14,6%	13,2%
14.	56,8%	31%	6,7%	3,7%	1,8%
15.	26,8%	29,8%	15,6%	13,6%	14,2%
16.	77%	14,6%	7,1%	1%	0%
17.	85%	9,2%	6,5%	2%	0,5%
18.	23,4%	21,6%	36,3%	12,8%	5,9%
19.	12,8%	11,7%	16,3%	35,1%	24,1%
20.	37,8%	26,4%	25%	14,6%	13,2%
21.	26,8%	29,8%	15,6%	13,6%	14,2%

22.	76,3%	15,6%	8,1%	0%	0%
23.	78,4%	10,1%	4,5%	2,1%	1,5%
24.	37,8%	26,4%	25%	14,6%	13,2%
25.	30,8%	26,4%	15%	14,6%	13,2%
26.	56,8%	31%	6,7%	3,7%	1,8%
27.	26,8%	29,8%	15,6%	13,6%	14,2%
28.	76,3%	15,6%	8,1%	0%	0%
29.	56,8%	31%	6,7%	3,7%	1,8%
30.	26,8%	29,8%	15,6%	13,6%	14,2%
31.	75,4%	16,3%	6,6%	3,2%	0%
32.	73,4%	12,1%	8,5%	4,1%	2,8%
33.	23,4%	21,6%	36,3%	12,8%	5,9%
34.	11,7%	18,8%	12,3%	38,1%	26,1%
35.	23,4%	21,6%	36,3%	12,8%	5,9%
36.	10,7%	12,8%	13,3%	34,1%	26,1%
37.	37,8%	26,4%	25%	14,6%	13,2%

If we compare the obtained responses with the different critical success factors mainly stressed in the literature review (we must remember that Fui-Hoon et al. (2003) and Finney and Corbett (2007) offer a complete revision of the authors offering publications in journals of reference), we see that there is a clear fit between what the theory explains to us and what in reality the firms realities show.

According to the answers we have obtained from firms up to know, we can admit that they consider as most important critical success factors affecting ERP implementations the following ones.

Table 2 – What firms consider most important CSF in the ERP implementation process

Number of the factor	Most important critical success factor
1	The reason why the firm decides to implement an ERP system
2	The managerial support in the project
4	The existence of quantitative and qualitative measures to know about the final effectiveness of the project
9	The commitment to the project offered by different areas
16	The communication of the ERP implementation to potential users
17	The existence of a rewarding policy for the workers taking part in the ERP implementation process
23	The establishment of ethical responsibilities of workers according to their tasks
31	The use of a proper methodology for the ERP implementation
32	The discussion with final users about the desired improvements in the change process

According to the answers we have obtained from firms up to know, we can admit that they consider as less important critical success factors affecting ERP implementations the following ones.

Table 3 – What firms consider less important CSF in the ERP implementation process

Number of the factor	Most important critical success factor
7	If the firm offers periodic status meetings to know about the evolution of the project
11	If the firm has defined functions in the equipment responsible for the ERP implementation
19	If the firm has established the clear acting rules in situations of ethic conflict?
34	If the internal user has participated in the implementation of the ERP system
36	Degree of final user satisfaction with the new system?

5. Conclusions

Firms are each time more involved with the implementation of ERP projects. These projects mean a great effort in planning strategies for managing the change of the business processes and the motivation and training of the employees taking part in the project and final users. There are many risks associated to an ERP implementation process.

In this chapter we have performed a first exploratory analysis by taking into consideration a model we have recently proposed in a previous publication that can help firms to make the best of the ERP implementation and exploitation according to the objectives of the firm. The model is composed by five different aspects, the decision-making policy of the firm in the ERP selection, implementation and use, the training characteristics of the people involved in the ERP implementation and final use, the organizational inertia in the firm, the final internal user satisfaction, the final external user satisfaction-

We have asked a group of firms of different size and age operating in the Spanish market in a variety group of industries about how they have experienced the critical success factors in their own ERP implementation experiences. Amongst the critical success factors that the firms consider most important ones, we can cite, the reason why the firm decides to implement an ERP system, the managerial support in the project, the existence of quantitative and qualitative measures to know about the final effectiveness of the project, the commitment to the project offered by different areas, the communication of the ERP implementation to potential users, the existence of a rewarding policy for the workers taking part in the ERP implementation process, the establishment of ethical responsibilities of workers according to their tasks, the use of a proper methodology for the ERP implementation, the discussion with final users about the desired improvements in the change process.

We have just developed a very preliminary and exploratory analysis, and it implies a great barrier for extrapolating the results of the analysis at this moment. Now we are in the process of obtaining more rich information from the data collected and see if we can find differences according to firm sizes and ages, the industry where the firm is located, the use they are making of the ERP system, the degree of access of different business partners into their ERP system, etc.

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Information Systems (IS) implementation as a source of competitive advantage: a comparative case study

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Abstract : In this work, by using the multiple cases study methodology, it was searched the answer for the following question: may one get competitive advantage in the decision making regarding an information systems (IS) implementation? The results presented come from semi-structured interviews carried out with two software houses. In this interview process was verified which companies organizational levels (software houses) were focused as system developers. At the end, focusing the analyses of the Resource Based View (RBV) viewpoint, it could be evidenced that an IS implementation requires a multidisciplinary team, with deep knowledge of the organizational processes, and with an improved condition for decision making.

Keywords: Decision making, Resource Based View, information systems, system implementation.

1. Introduction

Over the years, the organizations become more experienced in the difficult task of decision making during the process of implementing an information systems (Gonçalves, 2007). However, recognizing how to make coherent and consistent decisions is already a great step for strategic success. With the Information Technology (IT) resources decreasing in prices, it was realized the possibility of taking advantage from the computers in several activities, among them, better decision making.

Simon (1979) explains that managing is making decisions, and points out three phases in this process: search, creation and selection, being the latter, the activity of choice. He defends the model of administrative man, who makes good decisions, instead of the economic man, who makes excellent decisions.

Vroom (2004) elaborates a normative process model which is based in the rational principles, used in the decision making. The effectiveness of a decision is influenced by three groups: quality of the decision making, acceptance or commitment of the subordinate to implement the decision and the required time to make decision. It is proposed a decision model called "tree of decision ". Turban, Rainer and Potter (2005) explain that the "competitive forces

model", proposed by Porter (1989) can demonstrate how the IT will improve the competitiveness of the corporations, analyzing those five forces – bargaining power of suppliers, bargaining power of buyers, threats of new entrants, threat of substitutes and rivalry – as pressures that could limit plans and future market actions.

As an alternative to this theory, comes to light in the nineties the Resource Based View (RBV). Barney (1991) explains that resources are all the assets, capabilities, processes, attributes, information, knowledge, etc., that can be used and are susceptible of control by a company seeking for competitive advantage. They can be divided into three categories: physical capital (technology), human capital (people) and organizational capital (informal planning, control and relations).

According to Wernerfelt (1995), the theory of RBV defends the competitive advantage and the choice of a strategy in light of the possession of resources and central competence of a business. The focus of RBV is in the unique resources and competencies of organizations, which are scarcely copied, and, applying this internal analysis to discover, use, build and classify the strategic choices.

Prahalad and Hamel (1990) introduced the concept of core competencies, attributing to the IT a cornerstone role for the success of the organizations. There is a difficulty to identify which are the real competencies or capabilities of the companies and if these companies understand which are needed just now or for the future.

Kearns and Lederer (2003) based in the RBV model, endorse the IS implementation as resources, that could generate sustainable competitive advantage and promoting the differentiation. The information systems have been created to facilitate the management of the companies, adding the following value to businesses processes: flexibility, automation, end of the redundancies, economy of costs, reduction of the inventories, efficiency, effectiveness and improvement in the quality of the reports, supplying necessary subsidies for making of much more necessary and conscientious decision. Those systems were classified by O'Brien (2004), Turban, Rainer and Potter (2005) and Laudon & Laudon (2007) as: transactions processing systems, collaborative systems, processes control systems, management information systems, decision support systems and executive support system, regarding its application and functionalities.

After acquiring or implementing an information system, the organizations have large expectations and anxiety concerning its implementation. Once implemented with the lowest possible cost, is also expected that the system quickly stimulates the performance in its activities.

In the face of the previous description, this article aims to analyze if there is competitive advantage provided by an information system implementation, using the Resource Based View Model as a study basis. In addition to the bibliographic research in books and articles, it was made a presentation and discussion about results got from a comparative study of cases accomplished in two different software houses and its information systems.

2. Theoretical background

Decision making

The organizational decision making has been considered as an art, a talent. Decision making are taken based on the acquired learning such as: the creativity, the intuition, the experience and trial and error. However, it is known that the decision making process is something much more complex, undergoing interferences from internal and external factors as well from stakeholders (decision makers, enablers, analysts etc), involved in the organizational process.

The decision making process in the organizations

For a conceptual review about the decision making process in organizations, it will be followed three theoreticians: Herbert Simon, Victor Vroom and Chun Wei Choo.

According to Simon (1979), the function of the administration is to allow an organizational environment perception in such a way that one individual who is deciding must understand it as allowed by the rationality. Simon depicts three stages for carry on a process of decision making:

- Search for situations that require decision (activity of intelligence);
- Creation, development and analysis of the possible courses of action (activity of design or project);
- Selection of a particular course of action among those available (activity of choice).

In this way, Simon (1979) considered the model of administrative man. While the economic man makes excellent choices, the administrative makes choices good enough. In the businesses, the people do not seek the maximum return, but the appropriate return, making the businesses world much simpler.

Vroom et al (2004) developed a normative model of processes utilized in the decision making and based on the rational principles. The authors distinguished three groups of consequence that influences in the effectiveness of the decisions making:

- Quality or rationality of the decision;
- Acceptance or commitment of the subordinate to implement the decision;
- Required time to make decision.

FIG. 1 shows the decision tree and the decision model, where problem characteristics are presented in form of questions. The movement starts from left side to the right. The path is determined by the response to the question that is in the top of each column. At the end point, the model determines which of the decision processes should have to be used to achieve, in the shortest time possible, a decision of quality, which will be considered acceptable.

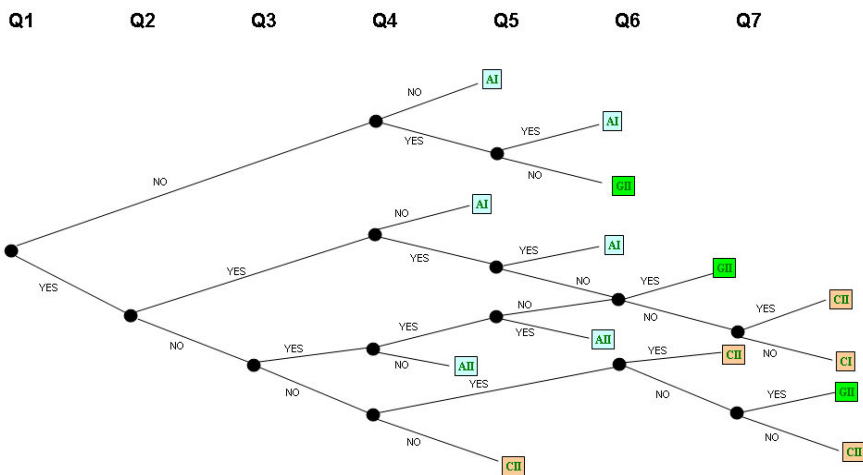


Figure 1: Vroom decision model. Source: VROOM, 2004, p. 158.

In his model, denominated organizational knowledge cycle (FIG. 2), Choo (2006) defines three guidelines in relation to the adequate processing of the information and knowledge in the organizational scope: the creation of meaning, the construction of knowledge and the decision

making. The cycle of the knowledge illustrates how the three guidelines can work together to enable the learning and the adaptation of the organization.

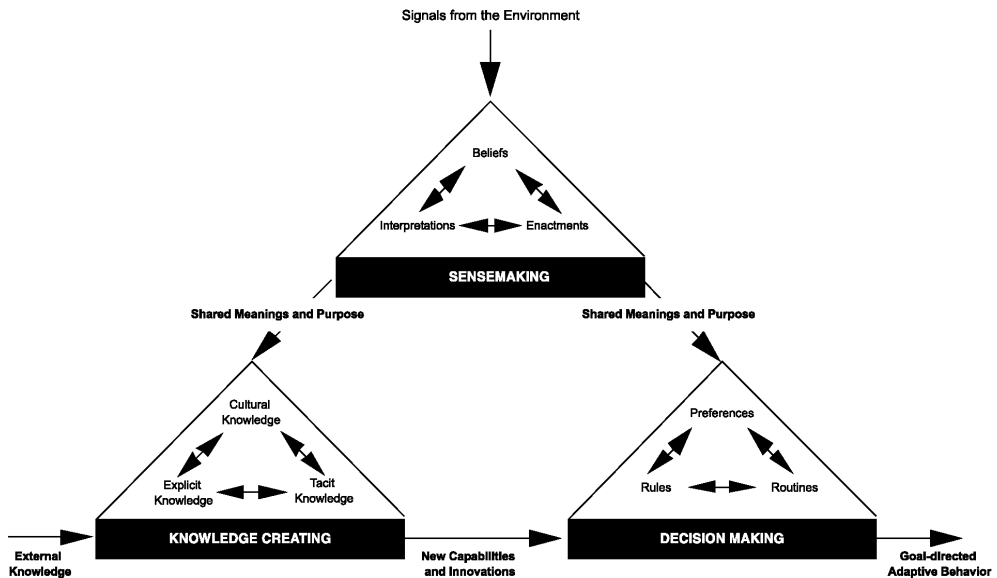


Figure 2 – Organizational knowledge cycle. Source: CHOO, 2006, p. 377.

In the cycle of the knowledge, a continuous flow of information is kept among the creation of meaning, the construction of knowledge and the decision making. Thus, the result of the use of the information in one way offers an elaborated context and more resources for the use of the information in other contexts. (Choo, 2006). He identifies four models of decision making in the organizations:

- Rational Model: the decision making is an act oriented toward the objectives and guided by the problems. The behavior of choice is governed by rules and routines.
- Procedural Model: in this model, the phases and cycles that give structure to the activities of a decision making (on the strategic, complex and dynamic), will be elucidated.
- Political model: the policy is considered the mechanism for decision. Players occupying different positions and exercising different degrees of influence, in accordance with the rules and their bargaining power.
- Anarchic Model: in this model, organizations are considered organized anarchies. Decision making are characterized by problem badly defined and little consistent. The technology is blurring and the processes and standard operating procedures slightly understood.

Choo (2006) elucidates that the creation of knowledge generate innovations and organizational skills, making larger the horizon of possible choices in the process of decision making. This conclusion was confirmed by Carvalho (2006), who explains that "in the context of a market characterized by changes and discontinuity, it is fundamental continually to reevaluate the organizational processes to ensure that the decision making has been guided by assumptions still valid" (p.58).

Uncertainties, risks and confidence

In managerial decisions there are components of uncertainty and lack of knowledge leading individuals to make choices under risky conditions. It is understood that the risk is strongly bound by decisions since it is impossible for individuals to recognize and know all the possibilities and consequences that imply in an act of choice (Passuello; Souza, 2006).

However, when studying the decision making processes, it is needed to pay attention to the question of confidence: the relation between risk and confidence is narrow. When accepting a risk, the individual trusts that one choice is the most appropriate and reasonable, even though he has uncertainties on its act. It is known there is reciprocity in the relationship between risk and confidence: trust is present throughout the act which implies risk, and in the act of trust there is always a parcel of risk.

External environment

In years 1980s, as defended by the school of Michael Porter, the main focus of strategic formulation was the connection between strategy and the external environment. Porter (1989) presented the competitive advantages obtained and supported accordingly to the generic strategies formalized and implemented by the companies. According to the Porter's Theory there is an interactive relationship between the organizations and their external environment, which serve as base for the creation of strategies.

He elucidates that the strategic decisions of the organizations should be based on the five competitive forces, which can be summarized into three generic competitive strategies (FIG. 3): leadership in cost; differentiation and focus.

		Competitive Advantage	
		Lower Cost	Differentiation
Competitive Scope	Broad Target	1. Cost Leadership	2. Differentiation
	Narrow Target	3a. Cost Focus	3b. Differentiation Focus

Figure 3 – Porter competitive strategies. Source: Adapted from PORTER, 1989.

Resource Based View (RBV)

Opposing the school of Porter, come to light the Resource Based View Theory was remembered and discussed in the nineties. This vision was defended by authors such as: Edith Penrose, Jay Barney, Grover S. Kearners, Albert L. Lederer, Birger Wernerfelt, Nelson and Winter and many others, in works discussed, for instance, in Economics, Administration and Technology Information fields.

The neoclassical economic theory, supported by the "growth of the firm" (Penrose, 1959), by the "hierarchy of routines" (Nelson; Winter, 1982) and by the assumptions of the "entrepreneurship" (Shumpeter, 2002), produced the basis of this modern approach of the RBV.

According to Penrose (1959), the company is a set of resources which utilization is organized by an administrative reference framework. This reference frame presents the final products of the organization as representatives of the possibilities for which it can use its set of resources to develop their basic potentialities.

Barney (1991) studied a relation between the traditional competitive forces model and the RBV model, evaluating competitive advantage search by an organization. According to Barney (1991), resources are all the assets, organizational processes, attributes, information, knowledge, etc., controlled by the organizations, which make them able to devise and implement strategies to improve their efficiency and effectiveness. For Barney (1991) and Wernerfelt (1995), the RBV is an interpretation model that makes a connection between the organizational resources and the sustainable competitive advantage. The competitive advantage of a resource is one that makes it valuable, rare, irreplaceable and impossible to substitute.

Barney (1991) still elucidates, that, in the strategic level, the formal systems are imitable, not rare and do not build competitive advantages. On the other hand, the informal systems are emergent and independent, and this makes them imperfectly imitative, resulting as a resource.

Wernerfelt (1995) explains that the analysis of the companies is made under the perspective of the resources, instead of the traditional perspective of products they can deliver (mainly the diversified companies). Resources identification and uses can lead to the higher profits. These propositions indicate that the company's growth involves the balance between the exploitation of the existing resources and the development of new resources. These statements corroborate with the perspectives proposed for Penrose (1959), Nelson and Winter (1982) and Schumpeter (2002).

In accordance with Kearns and Lederer (2003), in the light of the model RBV, one may affirm that the strategic alignment of IS and business confirms the IT and IS usage as resources. Therefore, the IS, seen as strategic applications to represent sustainable competitive advantage, may promote this differentiation.

Types of decision

It is known that the organizational levels are: operational, tactic and strategic. Laudon and Laudon (2007) describe different information needed for each one of these levels in order to support the different types of decisions.

The unstructured decisions are those where the decision makers use common sense, capacity of evaluation and cunning in the definition of the problem. The decisions are unusual and not of a routine type, and there are no procedures understood or predefined to take them.

The structured decisions, by contrast, are repetitive and characterized by a routine which involves predefined procedures that need not to be treated as new ones. There are decisions classified as semi-structured, and for this case only part of the problem has a clear answer and needs. The structured decisions are more current in lower organizational levels, while unstructured problems are more common in the highest levels of the company (Laudon & Laudon, 2007).

The executives of the companies face situations of unstructured decisions, such as: to establish the goals for the next ten years or to make decisions to define in which new market they should compete. Managers of medium level deal with a more structured decision making scenarios, but may contain unstructured components. Operational managers tend to make more structured decisions.

Information Systems and Decision Support System (DSS)

System is a set of parts that are constantly interacting, contributing for the solution of various organizational problems, independent of its type or of its use. It is quite difficult to have a system which does not create some kind of information. Laudon & Laudon (2007)

It can be said that simple electronic spreadsheets, used in specific applications, are tools to decision support, but, the decision support system (DSS) go beyond, approaching decision making of complex problems. Combined in single and powerful friendly software are datum, flexible tools, capabilities to analyze datums and analytical models for decision support. The DSS use datum supplied by other systems, such as transaction processing systems and management information systems. Laudon & Laudon (2007)

Turban, Rainer and Potter (2005) explain that the managers need support from IT for make good decisions, especially using valid and relevant information. The sensitivity analysis, which, as stated by the authors, is the study of how the variation (uncertainty) in the output of a mathematical model can be apportioned, qualitatively or quantitatively, to different sources of variation in the input of a model, is valuable applied over a DSS since it informs how the system is flexible and adaptable to changing conditions found in decision making situations.

When users have an entrepreneurial problem, they evaluate their processes and build a DSS. Datums come from a datawarehouse (DW) as well others sources of datums. In accordance with the authors, these data are inserted in the DSS and provide the answers through internal processing and interaction with other systems, as knowledge management, linear programming and web based applications. As problems are resolved knowledge is accumulated for future consultations. (Turban; Rainer; Potter, 2005).

Concerning a DSS, Ballou (2006) explains that "when methods capable to make analysis of data as well as organizing and presenting them, are incorporated in a IS, this information system is now able to give users the needed support as it were a decision making system." (p.143). In a IS with a well elaborated project, the users can make use of it not only for the preparation of an initial response to the decision making problem, but also by interacting with these systems, providing outputs which enables a practical solution to the problem. This solution may be compared with those eventually presented by using the optimization procedures methods.

In this theoretical frame it was approached that IS are resources for organizations, and the implementation process requires from the managers various decision making. The focus here is about the complex process of IS implementation, analyzing if it results in a source of competitive advantage.

3. The RBV Model as a decision making support for the implementation of an information systems (IS)

Process of an IS development.

According to Paula Filho (2003), Pressman (2006) and Sommerville (2007) the software process is a set of activities, such as: development, maintenance, acquisition and implantation, which lead to the production of a software product.

The organizational processes and the processes of an IS development are in constant improvement. (Pressman, 2006). The software process development can be understood as a structured working method. It has individual and collective management stages with the objective to generate, in a coordinate form, software for a general application.(Pressman, 2006).

About the process of development of strategic applications, Jamil (2006) describes it as a phenomenon that must be aligned with the business strategy. It allows understanding the process

of software development as complex and manageable fact, of strategic need for the organizations, and that keeps perspective of interaction with the others functions of the enterprise management, as well as the proper decision making.

Information System Implementation

O'Brien (2004) describes the process of implementation of IS follows the stages of survey, analysis and project of the cycle of development of systems. The implementation is a vital stage in the development of IT to support the systems developed for a company.

The FIG. 4 presents that the process of systems implementation encompasses: acquisition, development, tests, report documentation and a series of alternatives conversions, as well as training of the final users and specialists who will work with system. Is there an acute necessity of making decision in all these stages.

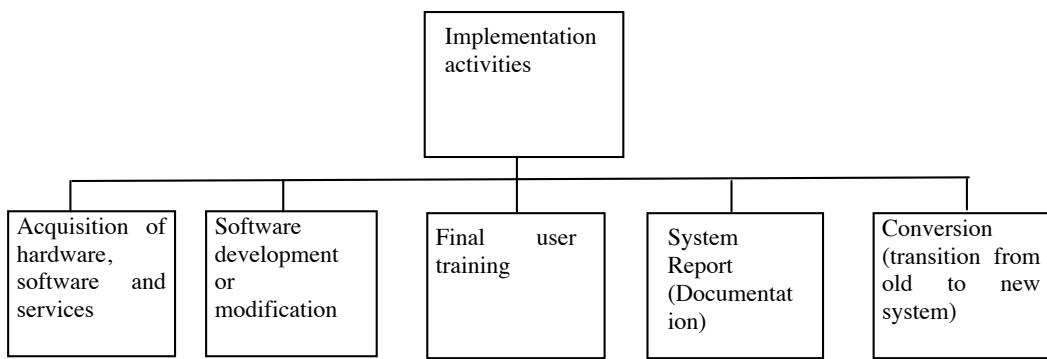


Figure 4 – General view of the implementation activities. Source: O'Brien, 2004, p. 326.

The implementation can be a difficult and prolonged process, with specific deadlines, but crucial for the success of the implementation. The implementation time can be from months until years. There are huge amount of tasks which may depend on diverse factors, such as: size of the company, reworking design processes, availability of resources, etc.

During the accomplishment of the implementation, a reasonable set of information will be gotten after the capture, storage and processing of the datums. For easy dissemination, it is important to keep this information available for the members of the implementation team and for the decision making executives which would need them for modifying, if necessary, the route or even the previously established deadlines.

Identifying how the RBV model may support a decision making in a process of an IS implementation

The biggest contribution of the RBV is to explain that the differences among companies about "long-life profitability" cannot be attributed the different market conditions. According to RBV, such difference is not properly represented by the market participation. (Ubeda, 2006).

The organizational assets (in this case including information systems), regarded as assets, being imperfectly movable, inimitable and irreplaceable would turn into sustainable competitive advantage, as other competitors will have extreme strategic difficulties in order to react to its application.

4. Presentation and discussion: the interview results

It was chosen two Software Houses established in the city of Belo Horizonte-MG, Brazil. The information systems developed by these firms contemplate all levels: operational, tactical and strategic.

Company 1, presented as “EA”: established in Belo Horizonte since the 1980s, was acquired by a multinational of the sector of IT in years 2000. Its portfolio has whole range of IS for most varied sectors. There are professionals working in all areas of development, from help-desk to the software houses.

Company 2, presented as “EB”: Established in 1987, is a multinational company acting in consultancy, *e-business*, integration of systems, with software house offices in several cities from Brazil. A branch of the company develops specifics (customized) projects for special clients and, for this situation their professionals may or may not be allocated in the customer’s office.

For the purpose of verifying the perception of interviewees about the IS developed by their enterprises, it was requested an explanation regarding which organizational level are the IS developed by their companies.

The TABLE 1 summarized the answers. All companies were characterized as developing IS for all levels of the organizations. These results corroborate with Laudon & Laudon (2007): IS attend different organizational levels and encompass organizational higher management until operational works.

TABLE 1

Company/Worker	Answers
Ea-w1	"We produce all kinds of IS, since production line ISs to BI."
Ea-w2	"Yes. In fact more than a level. We have for macro strategies and for more common strategies."
Ea-w3	"I believe that is for the operational level, as well as have resources for helping in the decision making (strategic level). There are interesting modes of if showing the information [graphics, tables etc]"
Eb-w1	"Yes. They are strategic. The project I am right now is more operational and tactician, but for sure we have products for the strategic level."
Eb-w2	"What I operate it is completely for strategic area."
Eb-w3	"I believe it is more for the operational level."

Source: Research data.

Both companies developed systems for all the levels of the organizations levels. Eb-w3 currently does not work in a strategic system project, only operational. Systems to fulfill the strategic goals are a constant in the organizations. This corroborates with the theoretical frame: Stair (1998), O'Brien (2004), Turban, Rainer Jr., Potter (2005) and Jamil (2006).

The strategic application in the systems would be in a context of use of the knowledge towards general strategic decision. In other words, the system assists for the quality of a better strategic decision making (CHOO, 2006), and explain the possible mistakes and other scenarios, added for simulation purposes or further studies.

5. Conclusions

This research aimed to describe, using the model of the resource based view, if a IS implementation can be regarded as a source of competitive advantage.

Organizations are constantly in state of changes, affecting their strategic planning. Resources of the internal environment, apparently stable, can pass to a turbulent state. Such changes tend to be tragic, because interfere in the standards, norms, processes, structures and even in the strategic goals of organizations.

Basing on resource based view model, a research was conducted for the investigation in two software houses of Belo Horizonte, Minas Gerais. Through a semi-structured interview, could be found the three organizational levels in which these firms are working, providing software considered applicable for decision making: operational, tactic and strategic.

It has been evidenced that the information, originated by the implementation, is constantly feeding the DSS. However, there is a concern with the quality of the information, often found in dispersed and not reliable sources. It was concluded that the planning of the implementation, where are developed the plans, procedures and mobilized resources, may be benefited by application of RBV model concepts, assisting in the decision making in the implementation of information systems.

Although this study has been developed and concluded in order to achieve the objectives initially proposed, it did not have the pretension to deplete the reflections on the subject. It is known that with the interviews in only two software houses, the results gotten are little generalized. It is recommended, however, that the theoretical base applied could be used to expand its conclusions, towards a more comprehensive scenario of its findings.

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A Pan European Platform for Combating Organized Crime and Terrorism (Odyssey Platform)

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Abstract: Combating organized crime requires evidence matching and visualization of criminal networks using advanced data mining capabilities. Current approaches only aim to generate static criminal networks rather addressing the issues with the evolution and prediction of the networks, which are inherently dynamic. In this paper we will report on our ongoing research in advanced data mining tools and semantic knowledge extraction techniques. The research of combined semantics and data mining outcomes is the foundation for a platform that captures information that is hidden in the data, and produces applied knowledge.

Keywords: data mining; semantics; ballistic intelligence; crime; knowledge extraction.

1. Introduction

This report presents the background and current developments of the Odyssey project. The objective of the Odyssey Project is to develop a Strategic Pan-European Ballistics Intelligence Platform for Combating Organised Crime and Terrorism. Odyssey is an EU funded project¹ that will develop a secure interoperable situation awareness platform for an automated management, processing, sharing, analysis and use of ballistics data and crime information to combat organized crime and terrorism. The Project will focus on ballistics data and crime information, but the concept and the Platform will be equally applicable to other forensic data sets including DNA and fingerprints.

This paper discusses the potential of the platform developed by the Odyssey project as a standard-setting tool that attempts to catalogue, process and exploit information on ballistics and

¹ The Odyssey Project is co funded by the European Commission, the project partners are, Sheffield Hallam University (United Kingdom), Atos Origin (Spain), Forensic Pathways Ltd. (United Kingdom), EUROPOL - European Police Organisation (Netherlands), XLAB (Slovenia), MIP - Consorzio Per L'innovazione Nella Gestione Delle Imprese E Della Pubblica Amministrazione (Italy), West Midlands Police Force Intelligence (United Kingdom), Royal Military School (Belgium), An Garda Siochana Police Forensics Service (Republic of Ireland), SAS Software Ltd. (United Kingdom) and DAC - Servizio Polizia Scientifica (Italy).

crime. The platform is being developed to allow police forces across Europe to better perform national and international investigation activities. In addition, it aims also to generate an automated "Red Flag" alerting system signalling potential criminal activity on the basis of the information stored and processed by the platform components. The global system entity is a central European repository (CEUR), which holds the necessary software and hardware infrastructure for data processing and exchange. Local authorities connect to CEUR to query available data and to insert new crime data. Each local police force will maintain a local database on crime/ballistic information. In order to connect to CEUR, they must have the Query and Input Data Components, enabling them to access the repository by using standardized Graphic User Interface and data. Furthermore, police forces must have a Security Component, which manages the secure login. An Authorized Sharing Component, which strips data of all sensitive information which should not be shared across national borders will also be utilised. In turn, the platform consists of a series of components, which include the following aspects: Security (Global Security, Global Authorization), Data Components (Query, Query Storage, Semantic Data, and Database Management), Processing Components (Data Mining, Relationship Discovery), Modelling (Model Management) and Alerting (Alert Generation). This paper details the current social and policing context within which the system is being developed and the key technical solutions being employed (Section 2). Section 3 then develops key details of these solutions in relation to the project and prior research.

2. Background

2.1. European Context

The social and economic cost of crime and terrorism to the economy of the EU is extremely high and presents a major problem to economic development, growth, sustainability and social cohesion. As well as direct costs such as victims losing their livelihood, health and property there are indirect additional costs associated with investigation of crime and terrorism defeating commercial growth. In March 2007, the Homicide Working Group at EUROPOL identified this as a fundamental issue for joint resolution across the EU. Policy makers in Security and law enforcement need to take advantage not only of innovative technological advances but also the associated 'industrialisation' that comes from interoperability. Globalisation and the relaxation of borders in the EU not only enabled people to travel freely for pleasure and commercial activity it also made it easier for criminals to travel often in possession of firearms. Currently, linking the use of a firearm used in one Member State to a crime committed in another is ineffective, highly problematic and extremely expensive. It can be done in isolated rare cases but it is not routine and does not capture the rich source of knowledge that can be extracted. Databases are localised to Member States and sometimes to Cities or Regions within Member States. The sharing of ballistics and crime information is, at the moment, not available and is much needed.

The numbers of firearms in circulation across the EU is vast and civilian arsenals of weapons continue to grow. Statistics show that civilian arsenal of firearms grew to 25 million in Germany, 19 million in France, 3 million in Serbia, 2.9 million in Finland, 2.8 million in Sweden and 2.5 million in Austria. Some of these become 'crime guns' as they are circulated amongst the criminal community and travel to different parts of the EU.

Data sharing and interoperability present major strategic and tactical benefits. These are not currently in place at either a National level or at EU level. The benefit is gained by automating the routines of data sharing, correlations, processing and intelligent analytics on a continuous basis. Crimes can be routinely linked, threats can be monitored and situational awareness can be routinely managed with in-built 'Alerts'. Advanced automated and semi-automated processing

and analytical techniques help by undertaking the grading, sifting and sorting of different combinations and correlations security decision makers would like to make. Europol and the UK's National Ballistics Intelligence Service (NABIS) identified that the threat posed to the EU by the criminal use of firearms will not be resolved unless a twin track approach is adopted namely:

- Accurate and cost effective analysis of data and information together with organised use of the information generated (advanced automated information systems support);
- Active automated analysis and knowledge extraction for cross correlation and management of this information to allow knowledge of linked crime to be made available to affected Member States.

The Odyssey project is therefore undertaking innovative research and development that will provide a secure Network capable of facilitating the sharing of ballistics intelligence between EU Member States. This will be within an interoperable trust and security management framework.

Only in very rare cases are comparisons conducted between EU Member States and then the process is laborious and time consuming. Investigators do not know where to begin the search because literally it could involve crimes anywhere. For example, a cartridge case recovered in Paris may be connected to a crime committed in another area of France or another Member State. To discover which the investigator would have to launch investigations with every local database across the EU. To add to this problem, each Member State may approach the comparison using a different method adding to the complexity of the process. The initial user focused work of the project has explored these issues in depth. From this two key requirements that do not currently exist have been identified:

- Timely tactical data to support individual crime prevention, detection and reduction
- Strategic statistical or management information available to aid policymaking and decision support.

Currently Member States cannot access accurate, meaningful assessments and statistical information about the incidence of gun crime. Neither EUROPOL nor Interpol is able to provide this important information to aid policymaking and decision support. Policy development is therefore piecemeal with no clear methods available to check that the right policy is in place and the right level of resource is being applied.

The current forensic approach across the EU is also fragmented. Many Member States use comparison microscopes to collect information from recovered bullets, cartridge cases and test-fired guns. Data about these 'traces' is stored in a local database connected to the microscope for later comparison and cross correlation with other data about bullets, cartridge cases and test fired guns but comparisons are limited to the local database concerned. The project is therefore actively working with users to link key crime standards, ballistic characteristics database standards, and data standards within key ballistic examination systems. The results of this work are not the focus of this paper. This paper explores the challenge of addressing the tactical and strategic needs of users through the deployment of both semantic and data mining methods.

2.2. Use Cases

Two major uses cases have come from the initial work of the Odyssey project. These derive from the above description of tactical (specific crime detection/prevention) and strategic (trends and policy) activities by Member States police forces. In most cases the Odyssey platform enables users to input data for further analysis and the use of the platform does not require any technical or data mining knowledge. Moreover, the users are informed when the previously performed searches return new information. Finally, the platforms subsystem generates Red Flag alerts in events of e.g. high risk.

In the tactical use case (Figure 1), the officer inputs either new data on a gun crime incident to Odyssey or very specific query. The system reports back similar incidents or matches on ballistic data. These returns may be immediate, others may occur much later after the system has received data from other users and developed new models. For example another user may input data at a later date on a matching cartridge from a crime in another member state – not only will this provide a match to the inputting officer but raise a red flag for the original officer. The officers can then interact to explore actual links between crimes and explore evidential (rather than tactical) data on the two incidents.

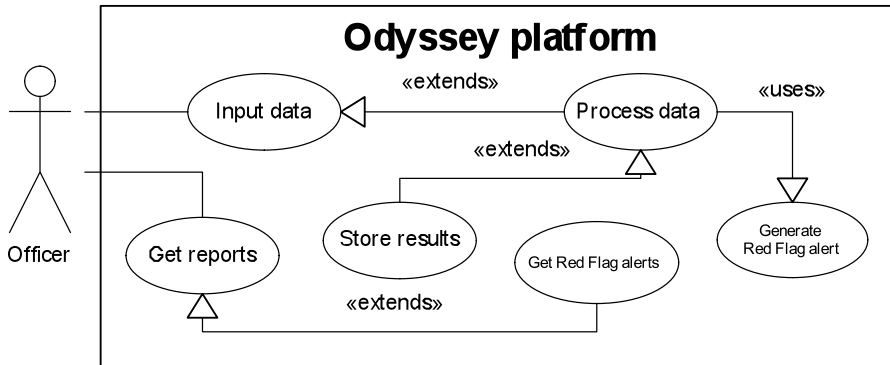


Figure 2. Odyssey platform semantic search and learning

The strategic case draws upon data mining and semantic methods. Data mining process uses common steps to retrieve information, but also associate the results with the semantic structure that is used for further knowledge retrieval, search and visualization. In this case an officer may have concerns about the use of a specific firearm or a specific type of crime (e.g. gang violence). By mining the Odyssey system the officer may be able to quickly see that the target firearm is use within a set of Member states, or that a specific firearm is becoming more commonly associated with gang violence in all Member States. This might allow the officer or Member States to develop policy or to address the source of the weapons – such as a specific manufacturer.

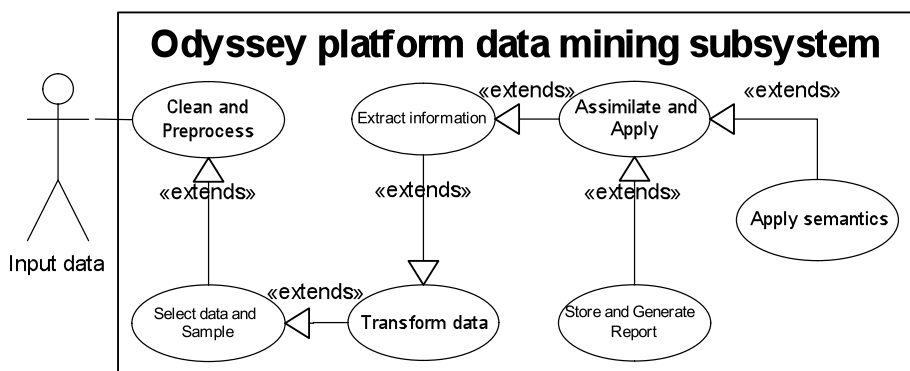


Figure 2. Odyssey platform data mining subsystem

One of the major achievements of the platform is the seamless integration of raw data processing and the use of semantics. It should be noted that the above 2 use cases were created based on collaborative requirements engineering process during Odyssey user group meetings. All

the information structures (input/output) are captured by direct input from user communities (e.g. Law enforcement agencies).

2.3. Semantic Technologies and Data Mining

Data mining technologies are a foundation for data analysis and lead to understanding of vast amounts of information. In order to analyse large bodies of data and extract relevant knowledge, the Platform requires use of methods, tools and algorithms that are efficient and can be provided at low cost. These include expert’s time and system resources.

The roots of data mining in theories of estimation, classification and clustering, and sampling, however other methods such as the construction of decision trees, neural networks will be also considered within the Odyssey Project. Generally, data mining (sometimes called data or knowledge discovery) is a process of analyzing data from different perspectives and summarising it into information that can be used to increase revenue, cut costs, or both. Data mining software allows users to analyze data from many different dimensions. It allows users to categorize, and identify relationships within the data. Existing data mining applications supporting variety of systems for mainframe, client/server, and PC platforms are limited by the size of the database as well as query complexity in terms of number of queries being processed imposes burden on the ability of the system.

Semantic technologies and data mining techniques are aimed at retrieval of required information. Semantic modelling techniques focus on representing data using formal structure that enables logic based reasoning and inference of knowledge. Moreover, data mining techniques rely on the use of algorithms to retrieve knowledge from the data as shown in the Figure 3.

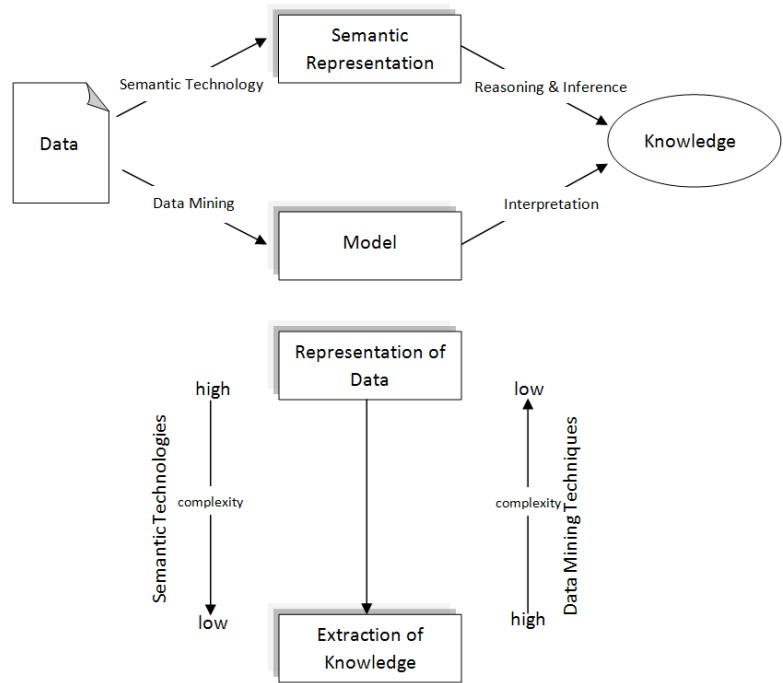


Figure 3: Semantic Technology vs. Data Mining

As a result, semantic technology pushes the level of complexity high on the efficient representation of data. Conversely data mining techniques impose high complexity on the efficiency of the extraction algorithms regarding huge volumes of the unstructured data. Finally, a balance between the two approaches is reached in order to achieve the most promising results.

2.4. Research Issues in Criminal Data Mining

Large-scale data mining projects in the law enforcement sector are increasing within and outside of academia (de Bruin *et al.*, 2006). For example the COPLINK system is a US police & university (Tuscon) collaboration using entity extraction and social network analysis from narrative reports. Within the UK FLINTS and FINCEN aim to find links between crimes and criminals in money laundering cases. Clustering techniques and self-organizing maps and multidimensional clustering algorithms have been widely used for behavioural modelling as well as the analysis of criminals' careers.

The biggest challenge in data mining is how to convert crime information into a data-mining problem. Nath (2006) foresees one-to-one correspondence between crime patterns defined in terms of crime terminology clusters (as a group of crimes in a geographical region) and data mining terminology cluster as a group of similar data points. The next challenge is therefore to find the variables providing the best clustering. Considering the fact that the crime analysts create knowledge from information daily by analyzing and generalizing current criminal records, the COPLINK system creates an underlying structure called "concept space". This is an automatic thesaurus as well as a statistics-based, algorithmic technique to identify relationships between objects of interest. These relationships consist of a network of terms and weighted associations. Co-occurrence analysis is done by similarity and clustering functions and thus the network-like concept space holds all possible associations between objects (Hauck *et al.*, 2002).

A general framework for crime data mining should therefore enable traditional data mining techniques (association analysis, classification and prediction, cluster analysis, and outlier analysis identify patterns in structured data) as well as advanced techniques to identify patterns from both structured and unstructured data for local law enforcement, national and international security applications (Chen *et al.*, 2006).

2.5. Research on (Ballistic) Semantic Intelligence Systems

The Odyssey project builds on the experience of prior developments – especially those that have drawn upon semantic methods. A ballistics intelligence system will primarily support crime detection through a creation of semantic knowledge-bases modelled on the data coming from distributed sources. A similar project is GRASP (Global Retrieval, Access and information System for Property items). It addresses the problem of sharing information by demonstrating how descriptions of objects can be captured, stored in a heterogeneous database, and widely distributed across a network environment. The project is specifically dedicated to museums, police forces, insurance companies, and art trading institutions, which are faced with the problem of the identification of stolen and recovered objects of art and have difficulties in sharing relevant information. The Odyssey platform develops from the semantic and data processing solutions introduced in systems such as GRASP in at least four areas:

1. It will define European standard for Semantic based Ballistic investigation. This will be later formalized as an ontology (Smith, Welty & McGuinness, 2004). The GRASP system only contained an already developed Art and Architecture Thesaurus with one root and 3 sub-concepts and almost no relations. The ontology was used to describe the artefacts in the terms of their appearance. Moreover, the ballistic ontology within

Odyssey will not only include rich structural domain knowledge model based on the newly developed standards, but also the additional meta-information guiding the knowledge mining;

2. The Ballistic system will apply knowledge mining techniques to discover potential links and correlations between various crime-related parameters;
3. Multilingualism will be handled in an easier, automated way. In the GRASP the languages are expressed not intuitively, but by a complex transformation into integer values followed by latter mapping back into actual words depending on the local language settings. In the Odyssey platform this transformation will be resolved using Protégé Ontology Editor that will allow an easy specification of the translations of all concepts used in the user interface, dynamically adjusting the presence of the defined entities to the selected language (Stanford University, 2009);
4. The mining of the correlations and associations in the data will be significantly faster as it will use the Odyssey semantic model. The technological challenges similar to Odyssey have been also present in the eJustice project. This project deals with European identification and authentication issues, with an emphasis on face and fingerprint biometry. The investigations made during the eJustice project have provided useful information about the security policies used in sharing government databases and protecting citizens' privacy.

3. Data Mining Module

As noted in Section 2.2 data mining is core to the strategic use case. Within Odyssey we are developing a range of data mining algorithms based on specific methods and tools. This section describes the prior work underpinning this development and the key tools (SAS Enterprise MinerTM) selected for the task.

3.1. Algorithms for the data-mining module

Data mining algorithms have been used in the past to support information needs to detect criminal networks in eight areas (Chen *et al.*, 2004):

1. **Entity extraction** techniques provide basic information such as personal identification data, addresses, vehicles, and personal characteristics from police narrative reports comprising multimedia documents (text, image, audio, video etc.) for further crime analysis, but its performance depends greatly on the availability of extensive amounts of clean input data.
2. **Clustering techniques** may be used to identify suspects who conduct crimes in similar ways or distinguish between groups belonging to different gangs. But, crime analysis using clustering is limited by the high computational intensity typically required.
3. **Association rule mining** discovers frequently occurring item sets in a database and presents the patterns as rules. This technique may be applied to network intruders' profiles to help detect potential future network attacks.
4. **Sequential pattern mining** finds frequently occurring sequences of items over a set of transactions that occurred at different times (time-sampled data). It must work on rich and highly structured data to obtain meaningful results.
5. **Deviation detection techniques** may be applied to fraud detection, network intrusion detection, and other crime analyses. However, such activities can sometimes appear to be normal, making it difficult to identify unusual/criminal activities.

6. **Classification techniques** find common properties among different crime entities and organize them into predefined classes. This technique has been used to identify and predict crime trends, reduce the time required to identify crime entities. But it requires training and the testing of data to maintain prediction accuracy.
7. **String comparator approach** can be used to analyze textual data but at the expense of intensive computation.
8. **Social network analysis** may be used to predict a criminal network illustrating criminals' roles, the flow of tangible and intangible goods and information, and associations among crime related entities.

The Odyssey project is currently researching and testing the applicability of above-mentioned algorithms. This work is focused on how these methods best support use cases scenarios and provide further innovation on performance improvement of data mining algorithms in the processing of ballistic and crime information.

3.2. Data Mining Tools

The core data mining tools being used by project Odyssey are provided by SAS. Over the years, SAS has built a strong track record on data and text mining methodologies and systems and is now classified among the best-performing analytic software developers worldwide (Gartner, 2008). The core of the SAS data mining product portfolio is represented by SAS Enterprise MinerTM. This SAS solution allows for the streamlining of the data mining process to create highly accurate predictive and descriptive models. With the ability to process large amounts of data for business decision purposes, SAS Enterprise MinerTM can perform a series of operations which fit with the Odyssey project purposes. The software can be customised to fully meet the project requirements, including, information extraction and elaboration; enhancing accuracy of predictions and easily surfacing reliable information. Better performing models with new innovative algorithms enhance the stability and accuracy of predictions, which can be verified easily by visual model assessment and validation metrics. Predictive results and assessment statistics from models built with different approaches can be displayed side by side for easy comparison. The creation of diagrams serve as self-documenting templates that can be updated easily or applied to new contexts without starting over from scratch.

The data can also be transformed with the capability to prepare and analyse time series data, binning interactive variables, creating ad-hoc data driven rules/policies and replacing data. Structuring advanced descriptive models will help Odyssey users to contextualise the information gathered (clustering and self-organizing maps, basket analysis, sequence and web path analysis, variable clustering and selection, linear and logistic regression, decision trees, gradient boosting, neural networks, partial least squares regression, support vector machines, two-stage modelling, memory-based reasoning, model ensembles).

Ensuring the scalability of the system, SAS Enterprise MinerTM fully complies with the Odyssey layer architecture that is underdevelopment and allows for scaling it up so to process a major amount of data in the future. The Odyssey knowledge extraction system will deal also with textual information: this will be accessed, extracted and transformed through specific SAS software, i.e. SAS Text MinerTM. The software automatically combines structured data and unstructured information and will allow the Odyssey objectives of information combining, comparing and correlating by clustering and categorising unstructured information. Any type of textual information will be grouped in "virtual dossiers" based on their content. A series of clustering techniques is made available, including spatial clustering, downstream clustering and hierarchical clustering.

3.3. Odyssey Semantic Module

The role of the semantic module is to support the Data Mining undertaken in Odyssey and to underpin the matching of crime and ballistics data. The semantic module is in the early stages of development and draws upon considerable data collated from key users – especially forensic firearms experts. Member States across the EU have been responsible for the collection of a vast number of items of information in the form of bullets, cartridge cases and test fires. The purpose of the semantic component for the project is several fold. First, in combination with the data-mining module it will allow for:

- matching the data from the ballistic analysis to the situation by using additional data sources
- matching two or more bullets as having been fired from the same weapon
- matching two or more cartridge cases and
- matching test fired bullets and cartridge cases with recovered samples.

Second, it will allow for knowledge extraction of similar events, crimes, crime patterns and “red-flags” for potential “high-risk” activities. The semantic module in Odyssey is key to the developing new knowledge and new insights from the database. Two initial goals of the project are to develop a conceptual model of the semantic structure of ballistic crime data and to better support the process of knowledge extraction.

Conceptual model of Ballistic Semantic Structure

In this work only the semantics and the conceptual framework for the proposed ballistics standard are being handled, as a precondition for defining the standard itself. The proposed ballistic standard combines two critical aspects

- Technological specifications; and
- Effective search and retrieval, comparison and knowledge mining requirements.

Regarding the technological specifications, the standard must satisfy two critical requirements:

1. to be generic enough to cater for various technologies used in the ballistic analysis, including technologies used overseas (in order to enable a broader international cooperation), and
2. the standard must be extensible, in order to cater for the future technological innovations in the field of ballistic analysis.

The project is currently focused on the development of a system designed to cross-reference ballistic and crime data in multiple sources, in order to discover potential links and correlations between various parameters, as they will be defined in the Project. The data mining system must integrate a knowledgebase in such manner that this knowledge can be applied during data mining. It must be capable of utilizing advanced knowledge representation and generating many different types of knowledge from a given data source. Emphasis is being put on the development of a generic methodology and a system that implements it for utilizing prior knowledge in data mining in order to produce new knowledge that is understandable to the user, interpretable within the domain of application, useful in the light of a user’s expectations and intentions, and reusable in further knowledge discovery. There is a need for automated data-mining and knowledge extraction using semantic capability to allow complex conclusions to be generated for fast and responsible decision making.

Knowledge Extraction

The main goal of the module is hypothesis generation through the knowledge extraction. It is intended that the system will focus on gaps in the crime scenarios and the presentation of possible semantically enriched propositions. This is to be done on three levels:

1. Stage Mining;
2. Knowledge Extraction;
3. Metadatabase.

During the stage mining, the system is taking into consideration ballistic and crime scene databases provided by a particular organisation. Then the results of the data mining algorithms are applied separately to different data sources. These are merged in the second stage-knowledge extraction. New mining techniques are applied to create more solid view for the hypothetical scenario. Results of filling the gaps in the network of crime linkage enable the creation of a metadatabase. Such analyses will be based on the output of the data-mining techniques, semantic enrichment and a knowledge base of logically inferred hypothetical crime scenario's. The module will provide the statistically processed qualitative and quantitative information not only about the data-mining derived bullet, cartridges, firearms and crime scene matches but it would also, using indirect association, generate hypothetical crime scenarios.

3.4. Semantic Engineering and Data Mining

We have argued above that combining the application of Semantic and advanced Data Mining technologies will allow us to address the two main use cases – tactical use and strategic use. This follows previous work that has argued such a combination allows the setting of new, simple, but effective standards for data management and knowledge discovery (Bonino, Corno, Farinetti & Bosca, 2004; Bonino, Corno, Farinetti, & Inf, 2004; Colucci *et al.*, 2009). In the context of project Odyssey and ballistic crime data it also provides the possibility for strong collaboration inside EU police community. The main developments in the project will be focused upon advanced data mining and semantic knowledge extraction based on the notion of knowledge as described by Akhgar & Siddiqi (2001). The beneficial research of combined semantic and data mining provide a platform for capturing the information hidden in the data and produce applied knowledge. It should be noted that the requirements arising from large-scale data mining scenarios like those in Ballistics are extremely challenging and topics of interest include:

- Architectures for data mining in large scale environments;
- Semantics in the data mining process, identification of resources for data mining, such as data sources, data mining programs, storage and computing capacity to run large-scale mining jobs, provenance tracking mechanisms;
- Data privacy and security issues;
- Data types, formats, and standards for mining data;
- Approaches to mining inherently distributed data, i.e. data that for one reason or another cannot be physically integrated on a single computer;
- Data mining of truly large and high-dimensional data sets, e.g. data sets that do not fully fit into local memory;
- Adaptation of existing and development of new data mining algorithms.

The feasibility of data mining techniques applied to the investigation of ballistic crime data is part of a developing wider research agenda within the EU, USA and elsewhere. In the UK work undertaken by the Jill Dando Institute of Crime Science at UCL is of relevance (see: Adderley & Musgrove, 2001, 2003; Adderley, 2004a, 2004b). As with project Odyssey this work assesses the feasibility of combining theoretical knowledge discovery applications to serious crime informed by the relevant academic literature.

As noted in the use cases in Section 2.2 it is intended that the Odyssey knowledge extraction module used by the law enforcement agencies could warn the authorities that the weapon type and or bullet(s) were involved in similar situations. Odyssey would have quantified the risk and the possible outcomes. The system would have based its information on the mining performed by the Data Mining module on the data. The mining would have been supported by the application - Process Models to data (the Odyssey knowledge extraction module).

4. Conclusions

The Odyssey platform incorporates the use of advanced data mining techniques enriched with semantic technologies. It extracts information from various data sources and indicates how the information will be used next. Moreover, it creates an ontology-driven knowledge repository that enables the analysis of information in a more abstract way. This also provides an advantage of being able to illustrate global tendencies or crime patterns (strategic use case). Also, the repository is used to operate and investigate real cases using logic reasoning and knowledge interference (tactical use case). Additionally, the platform is able to generate unified graphical results and clearly demonstrate the outcomes of complex analysis. Finally, the platform operates on a very specific domain, which enables the concentration of explicit problems, constantly evaluating outcomes, and suggesting the most promising solution.

The platform is set to fill a major gap in the cross-national investigation and security systems. National police forces will be able, once the platform will be running, to increase their investigation potential by accessing the refined data and graphically represented data patterns. Moreover, the Odyssey platform is structured as a framework which could be easily replicated for other forensic data sets as well as applied to different domains, thus re-defining the standards of information exploitation for large data sets.

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The needed adaptability for ERP systems

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Abstract: The new market trends are forcing companies for constantly business process' reorganizations in order to react quickly to the new economical challenges. Not always, enterprise information systems provide an appropriate response to these situations by several reasons, like technology failure, lack of adaptable configuration tools or even by the financial investment required, making it unaffordable to companies. This article presents a functional model for ERP systems (called FME) that would guarantee a baseline structure to build solutions which would provide a complete configuration, and therefore, a timely reaction for market fluctuations. This model has been developed also resuming some of the most used functionalities of the ERP systems available.

Keywords: ERP, adaptability, customize, functional, model.

1. Introduction

The last decades have been characterized by constantly market fluctuations in the global economy stability, leading companies to be faced with an applicant need for amending their strategic business processes. These changes demand, usually, tactical decisions for quick and accurate responses over companies working processes, heading for short-term adaptation actions to face the new market needs. However, this constant (and ill) adaptation, it is often considered a veritable Babel Tower, since its maintenance is performed without a completely "thought and organized" process. A simple change in a process may lead to organizational restructuring and, therefore, demand for changes and new configurations on the existing information systems.

This new trend requires the enterprise information systems to be provided with tools for rapid customization (and management) to enable an effective and timely response to these needs. In this context, there are several Enterprise Resource Planning (ERP) systems in the market capable of answering to these requirements, such as SAP, Microsoft Dynamics, JD Edwards, Priority, PHC Software, Manufactor, Primavera Software, etc. However, they present different solutions and framework concepts for the same functions, and none of them presents a complete solution.

It is in this work, it is presented an "adaptive" functional model that could be assumed as the "baseline" for ERPs systems. This model has, as its primary aim, to provide the necessary conceptual architecture to build software solutions which provide a complete parameterization and configuration, that guarantee an effective response to organization's needs.

2. Major problems founded

Implementing and managing ERP systems might become a complex process due to several causes, like human inadaptability, for instance. According to Lin (2002), about half of ERP implementations fail to meet expectations. Most of them suffered from over-budget, over-time, user dissatisfaction, threatened lawsuit, failed to introduce all planned modules, or the big and horizontal ERP systems pulling back into beta testing.

The following topics resume some of the most common in this business, according to the experience of the author.

2.1. Awareness from market

Software companies develop ERP systems regarding roadmap's interests due to time and cost restrictions, somewhat "forgetting" to study the actual needs of the market. According to Davenport (1998), software houses try to structure the systems to reflect best practices (series of assumptions about the way companies operate in general), but it is the vendor, not the customer, that is defining what "best" means. In many cases, the system will enable a company to operate more efficiently than it did before. In some cases, though, the system's assumptions will run counter to a company's best interests.

Most of the time, software companies are aware of the companies' major difficulties when regarding their policies of distributing software (leaving the responsibility of consulting and analyzing the market to smaller companies, named partners; which, sometimes, aren't prepared for such a difficult task). According to Bingi (1999), because the ERP market has grown so big so fast, there has been a shortage of competent consultants. Finding the right people and keeping them through the implementation is a major challenge, since ERP implementation demands multiple skills -- functional, technical, and interpersonal skills. Although this strategy (high number of partners) might increase software house's sales it, indeed, positioning them away from the companies' "real need" analysis.

(Mandal, 2003) has defended that software vendors should apply for an "iterative evolutionary method" for developing enterprise-wide information systems, since would enable system developers and their customers to communicate effectively with each other to evolve the system towards some defined objective. Such a strategy would help them to analyze the impact of the software implementation on the organization. Unfortunately, such kind of strategies (although, sometimes promised) were never take "really" in consideration.

2.2. Factors preventing decision-making

According to Holland (1999), a new ERP platform forms a critical infrastructure in any company for, at least, the next decade. This sentence enhances the importance of a consistent choosing decision of an ERP system for an organization.

But, an ERP system's implementation is often a complex process, requiring the internal restructuring, both in terms of work procedures and human resources. The growth of Project Management, such as science, proves the importance and complexity of these processes, in order to guarantee a complete control of tasks, resources and associated costs. Even at a stage of "cruising speed" (in which, finally, the company begins to truly enjoy the usage of an integrated system), any change is considered (by companies' managers) as a cost for the organization; even when ranked as essential to answer to new market adversity. According to Oliveira (2004), the impact that Information Systems and Technologies have in organizations lifecycle is such, that a

simple study on her information systems approach is enough to classify her (as innovative) in the market.

These “pessimistic” thoughts have been growing since managers felt that invest continuously (and highly) on technical and human factors for an ERP system that responds, only partially, to the expectations that have been set. According to Davenport (1998), the growing number of horror stories about failed or out-of-control projects certainly gives managers pause. Nowadays, any change becomes subject of a “deeply” financial analysis and hardly consideration by managers.

The following topics resume some of the factors influencing the decision of managers, concerning the changing or customization of an ERP system in their organization:

- **Organizational changes (Human)**

As already mentioned, an ERP system can obly to organization’s structure, and therefore, user’s adaption to new functions and work procedures According to Davenport (1998), an enterprise system imposes its own logic on a company's strategy, culture and organization. (Umble, 2003) described that even the most flexible ERP system imposes its own logic on a company's strategy, organization, and culture. Thus, implementing an ERP system may force the reengineering of key business processes and/or developing new business processes to support the organization's goal. Such an approach might result on some workers’ refuse to change to the new system!

Another author enhances the human factor (Courtois, 2006), defending that the success of a system depends of peoples’ motivation for the implementation project, needing to know exactly their expectations and follow organization’s interests.

Besides that, it also should be considered the period which two applications run “in parallel”, to ensure a continuous and “untailored” process. Although this scenario seems to be the most secure, in fact, promote fatigue on users. (Yusuf, 2004) has identified some risks related to human concerns when implementing ERP systems, like: resistance of change to new process methods by management and supervision; possible failure to cut over to the new system through an inability to load data; possible failure to cut over to the new system through the inappropriate systems testing of volume, stress and data conversion.

- **Implementation costs (Finance)**

According to Bingi (1999), the total cost of implementation could be three to five times the purchase price of the ERP system. The implementation costs increase as the degree of customization increases. The cost of hiring consultants and all that goes with it can consume up to 30 percent of the overall budget for the implementation, making this stage as one of the most expensive. Besides that, it’s one of the stages most “affected” when a reengineering decision is applied or when a wrong analysis is made, since it gathered the business rules definition and customization procedures.

- **Supplier dependency**

When an organization buy an ERP system become, in a certain way, dependent of their software supplier/partner, to configure and parameterize the system. After the implementation stage, it might be required high-cost maintenance contracts to ensure the ERP system evolution to organization’s needs. These types of scenarios are, normally, predicted by managers and might become a constraint when deciding for an ERP system. This “dependency” can be reduced if internal teams follow, constantly, all stages of the implementation stage and ask for a high degree of participation. This will give some autonomy to companies manage their maintenance costs.

2.3. Implementation times

According to Bingi (1999), the problem with ERP packages is that they are very general and need to be configured to a specific type of business which takes a long time, depending on the specific requirements of the business. For example, SAP is so complex and general that there are nearly 8000 switches that need to be set properly to make it handle the business processes in a way a company needs. The extent of customization determines the length of the implementation. The more customization needed, the longer it will take to roll the software out and the more it will cost to keep it up-to-date.

(Tchokohué, 2003) referred a study made by the Standish Group, which found that 90% of ERP implementations end up late or over budget. And, in some cases, the implementation time is extended indefinitely, which has negative consequences for both the companies and the morale of their employees.

An additional factor can be added if the implementation process is carried out by less competent partners/implementers, which will increase implementation times, risks and costs.

2.4. Upgrade process (new versions)

Other handicap detected on these kinds of systems (even the “most advanced” ERP systems which include many configuration features) is that they become a “nightmare” when an upgrade is needed; since it became very hard to maintain the same performance, when a new release is available to market. Besides these problems, it also can be pointed a technological restriction: some of the ERPs systems are developed based on two layers (Presentation and Data layers), which turn the upgrade operations a difficult task. This type of architecture does not provide the desired scalability for such a complex and multi-department system.

These scenarios also “spread” the feeling of not buying the first ERP versions to avoid the first errors; so called the Beta versions. It became a usual procedure, on software markets, customers prefer to wait for “mature” versions to reduce implementation’s problems.

As a first conclusion, it can be assumed that all these indicators are considered by companies’ managers, to analyze the impact on their organization. Companies’ deal, daily, with alternative scenarios evaluation to support the decision process, comparing all the benefits and weaknesses of each option (internally, regarding processes’ modification; externally, the market’s reaction that can be provided).

3. “State-of-art” of ERP systems

The actual ERP systems already include solutions for quick customizations. However, all of them, present some advantages and disadvantages among each other, becoming difficult to find a “standard meaning”. This chapter presents the traditional functional structure of these kinds of systems.

Figure 1 presents a scheme, which represents the existent functional structure for ERP systems, divided in 3 parameterization levels. It can be defined a first level for ERP internal business development, which includes all the business rules developed by the software house as standard operation routines. The second level is defined as the Business Process customization level, which concerns the entire advanced configuration promoted by consultants and implementers, in order to guarantee system’s adaptation to companies’ requirements. Finally, the third level is dedicated to Low level customization, which includes the entire parameterization available for ERP’s users.

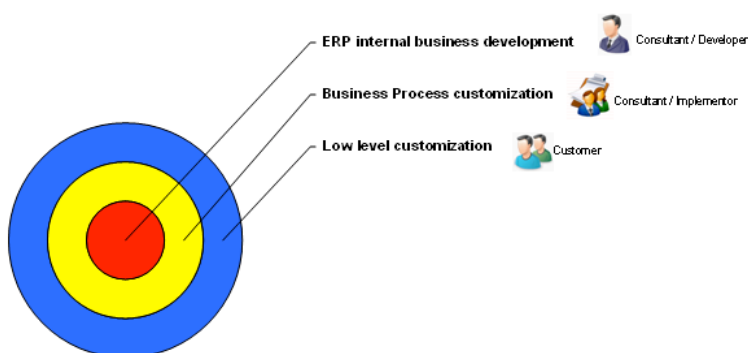


Figure 1 – Parameterization' levels of ERP systems

1st Level: ERP internal business development

This level includes all the standard routines developed by the software house for the ERP system. On an implementation process, this level is never applied, unless a "software bug" is detected or the customer argue for a specific need, that even the "Business Process implementation" level cannot handle.

This level is assumed as the "heart" of an ERP! Built in a complex structure (data and programming code); it's the responsible for guaranteeing the perfect integration between processes and data, for a complete coherent information kept. Changes to this level are always avoided by the software houses, to prevent major problems. Normally, it's only changed when mandatory developments are required, for instance, like changing of financial/government legislations.

2nd Level: Business Process Customizations

This level includes all the available configuration tools to be used by consultants. Since the major ERP systems work on a three-tier development application scheme, it might include several changes to ERP's business rules, regarding advanced customizations requested by customers. Since the most part of the processes is already standardized (like financial and commercial, for instance), this level assumes a high importance since it reveals the major differences between the ERP systems. This means that the major difference on buying/choosing an ERP is the ability of customization/parameterization of this second level.

3rd Level: Low level customizations

This level includes the entire "local" customizations available for users, to allow single tasks like choosing colours, configuring columns orders, sending e-mails by a condition, etc. Although not assuming a major importance like the previous level, in fact, it promotes some flexibility on internal processes, giving some ability to users (easily) enhance their daily procedures.

The ERP systems existing on the market have different approaches to answer to these three levels. Some of them present better solutions for the 3rd level, forgetting that (to answer effectively to companies' requirements) need to dedicate a high attention for the 2nd level. The ideal scenario would be an ERP system that could promote a user-friendly configuration tool (but highly advanced concerning the parameterization ability) to "explore" conveniently all capacities of the 2nd level.

4. (desired) Functional model for ERP systems

It is extremely important that ERP systems provide an internal reactive model, regarding the availability of configuration and parameterization tools, to promote user's interaction with the software. The next image (Figure 2) presents a functional model (called FME) that could be applied for designing a complete innovative and integrated system, with a high level of adaptability and interactivity.

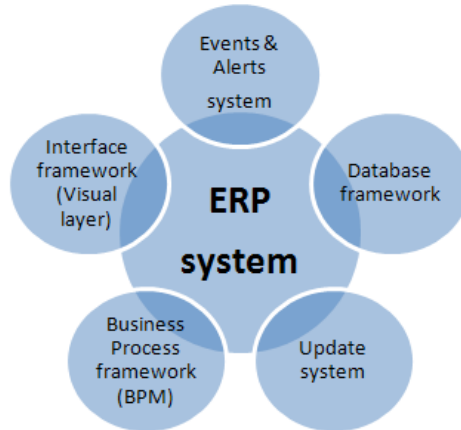


Figure 2 – FME – Functional model for ERP systems

The presented model includes an internal **Event and alert sub-system**, user-friendly, to be used by the “common” user (without the need of technical knowledge). Some examples of this kind of sub-system is the parameterization to include validations and alerts messages to ensure the fill up of mandatory fields presented on screen; another example is configuring the system to send e-mails after a certain action or condition detected. This sub-system enhances the “local” flexibility to customers, betting on user’s motivation by solving simple needs; also promotes highly attention of consultants/implementers on the second level (presented on the previous topic).

Regarding the principle that “ERP systems must be adapted to companies and not the opposite”; surely systems’ interfaces must be changed to add or hide data required by users. For this concern, the FME model presents a sub-system called **Interface framework**, which allows the complete design of interfaces (forms) of the ERP system to answer customers’ needs. This sub-system allows functionalities like add new or hide existing fields, and even control their appearance by user’s privileges. A typical example is hiding monetary fields for users, which do not belong to the financial user’s group.

Looking to an ERP system as a living creature, certainly, his blood would be data! ERP systems need to “grow” to follow organizations lifecycle, keeping safely information and providing the desired scalability. This sub-system is named **Database framework**, and includes the advanced management of information systems database. For instance, adding user fields to standard tables, creating new tables, creating triggers and indexes, procedures, etc. These type of functionalities should only be performed by specialized teams (consulting/implementers) since the wrong use may affect the global performance of all application. On the other hand, a “well know use” can provide a higher performance on the global system.

As already mentioned, an ERP system must ensure scalability to the company. It must guarantee that its updates or new versions do not affect negatively the existent data, reducing impacts to the system. Usually, software houses apply these kinds of operations updating single DLLs or Web-Services, to ensure the global appliance on the system and reducing the need of client's software update. The sub-system responsible for these procedures is named the **Update system**.

The business rules parameterization approach completes the FME model! At this sub-system (called **Business Process framework**), it is included all the configuration tools which allow processes adaptation to ensure a continuous and accurate information flow in all company. Although dedicated to consultant/implementers, this sub-system should provide a graphical tool for business process representation, for a better visualization and configuration.

The next image (Figure 3) presents an example of an advanced BPM application for process' parameterization, available on ERP Priority. This tool provides an easy interface to create document's status, manage their approval and provide e-mail messages for a complete knowledge and control. This example (Purchasing Process) presents a user-friendly configuration tool, with a high impact on system's usage.

At a high complex stage, FME model would also recommend allowing the editing of the programming code on processes' rules for a complete customization (but always controlling the correct execution and their dependencies with other sub-systems).

The FME model would support any ERP system to achieve integrated functionalities, totally dedicated to organizations' needs. However, like any model, asks for an additional requirement: documentation! When an ERP system's implementation presents highly levels of customization, it demands that his stages to be reported, to share information for future projects. Although not represented on Figure 2, it is assumed as an essential topic at any of the sub-systems presented.

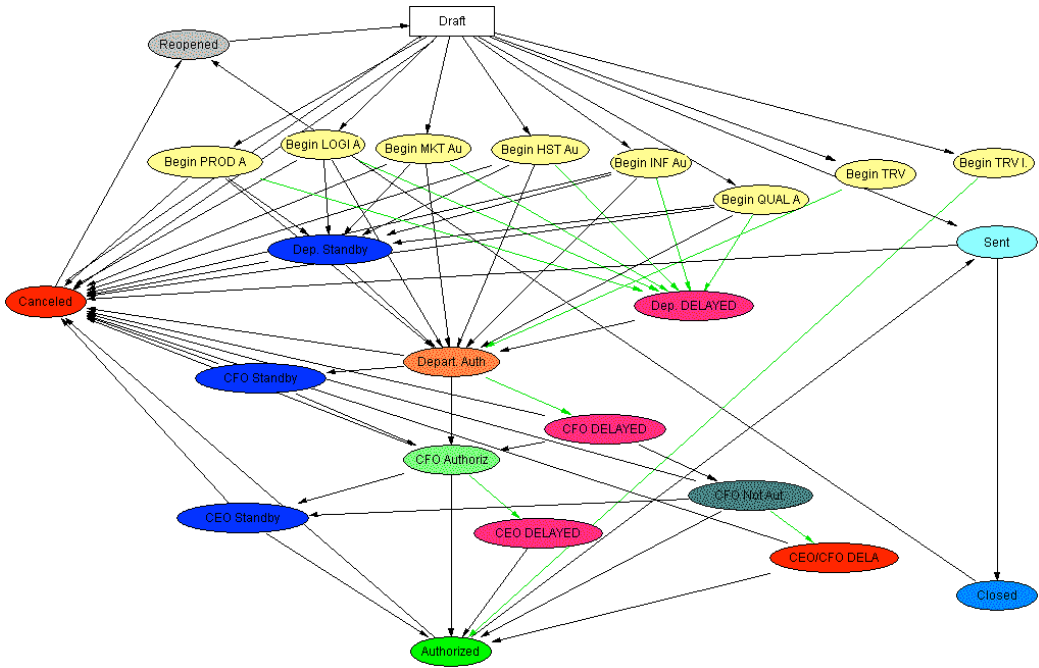


Figure 3 – Example of BPM configuration on ERP Priority

The FME model is, easily, “inserted” on the actual parameterization levels of ERP systems, which enhances the idea of a practice appliance, for a future work. The next image (Figure 4) presents the relation of the FME model’s sub-systems with the parameterization levels mentioned on the last topic. The sub-system Event and alert has been, basically, classified on the “Low level customization”, ensuring an easily use for the common users; but, it also has been included on the “Business Process” level, to considerer the needed advanced parameterizations made by implementers.

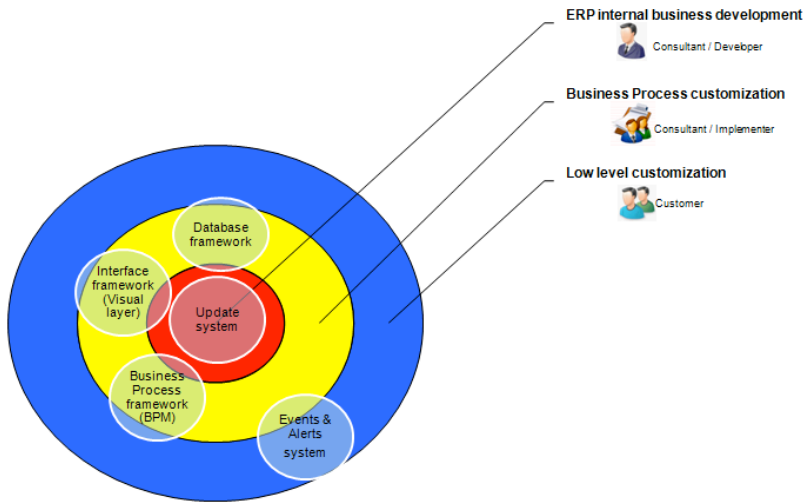


Figure 4 – FME model and their parameterization levels

5. Conclusions

According to Davenport (1999), if a company doesn’t take careful, it might face the dream of information integration run into a nightmare. This enhances the importance of an ERP system on a company and, therefore, the responsibility a manager has when choosing a system.

This paper resumed some of the main restrictions founded by companies when configuring ERP systems, guaranteeing constantly adaptations, for an accurate answer for their market. For several times, financial and time restrictions block the decision for changing an ERP system; on other occasions, the systems do not provide the needed "reaction capacity" to face this reality.

To achieve a complete solution, a new functional model (called FME) has been designed to be applied to any ERP system. Using brief descriptions and simple diagrams, this complex model has been resumed in five sub-systems that would ensure a dynamic lifecycle for these kinds of enterprise systems. It promotes and searches for a highly process’ integration, flexibility on the local user and reducing errors when updating versions. The major aim is customer’s satisfaction by using an ERP system that follows (and answers) his needs, for longer periods.

For future works, the major challenge is to design an architectural model (developing issues and restrictions) to support such a model on an ERP system.

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e-Business and Enterprise Portals

Designing an information management web system for the commercialization of agricultural products of family farms

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Abstract: Graxafamiliar.com is a project for developing the Galician rural milieu both socio-economically and culturally in order to appreciate quality of life and rural culture, to create communication links between the rural and the urban world, to emphasize the importance of the traditional self-supply production market of Galician family farms, and to promote the spread of New Technologies as a social intervention tool against the phenomenon of social and territorial exclusion known as "Digital Divide".

Keywords: farm; family; rural development; traditional production; new technologies; digital divide; social networks; electronic commerce.

1. Introduction

Galicia is an area which is cut off and switched off as an information society, occupying the last places in the use of new technologies according to the information provided in the eEspaña 2007 report (pp. 232-235). Bearing in mind that Spain is in penultimate place at a European level, Galicia's marginal position as an information society is emphasized still further. A research team from the University of Santiago is developing a pilot scheme in several rural municipalities spread over Galicia with the objective of prompting social, economic and cultural development in the Galician rural environment and spreading the use of new communication and information technologies. The Granxafamiliar pilot scheme is part of a research module called E-Inclusion within the organic structure of the project SINDUR (Information Society and Urban-Regional Development) (SEC2002-01874, SEG2006/08889). In this paper we present the technical and scientific characteristics of SINDUR, the methodology and development of granxafamiliar.com, an interactive multimedia digital tool designed to face the phenomenon of social exclusion known as the "Digital Divide" of the peripheral areas cut off from the information society and of the use of new information and communication technologies (ICTs).

1.1. The SINDUR Project

SINDUR started in 2002 as part of the national R & D plan of the now defunct Ministry for Science and Technology, today part of the Ministry for Education, and among its objectives was a plan to create and give continuity to a scientific debate forum centred around the analysis of the impact of new technologies on peripheral areas. This is currently in its second phase. The purpose of the SINDUR project is to study the effects and impacts of the information society on urban development in peripheral regions, in order to assess quality of life and promote the spread of information and communication technologies as tools of social assistance in facing the phenomena of socio-territorial exclusion known as the "Digital Divide". It involves researching, from a social point of view, the communities and territories which are cut off -switched off- from the information society.

The overall objective of the SINDUR project is to make a theoretical and empirical study of the territorial and social effects linked to the development of the information society and to the implementation of information and communication technologies. We intend to assist the progress of public decisions and administrative efficiency when the time comes to invest in the services and suitable activities of the information society, defining the needs of the cities and peripheral regions to develop their competitiveness and to address the new social demands generated. In turn, the specific objectives are the following:

- To provide a technical territorial audit tool for regional and urban managers to evaluate civil satisfaction with the investments and promotional policies of the information society and implementation of information and communication technologies.
- To propose a methodology of assistance to managers of social policies against the exclusion caused by the information society, having as its starting point the need to spread the use of information and communication technologies efficiently.
- To drive a network of universities and researchers interested in the study of the information society and its socio-territorial effects in European peripheral regions, with the critical mass and sufficient synergy to be admitted to European Union research calls.
- To develop and establish a line of comparative international research of an interdisciplinary nature relating to the impacts of the information society, which facilitates and channels the educational excellence of young researchers who direct their doctoral thesis towards this subject matter.

2. Presentation of the project

Granxafamiliar.com is an information management system for the commercialization of agricultural products of family farms. The purpose is to boost socio-economic development and spread the use of new information and communication technologies in several Galician rural municipalities, with the aim of assessing their quality of life, appreciating rural culture, establishing channels of communication between the urban and rural world, integrating the traditional self-supply production of Galician family farms into the market, and promoting the spread of new technologies as social assistance tools to face the phenomenon of socio-territorial exclusion known as the "Digital Divide". To promote the study of the impacts this scheme generates at territorial and social levels.

2.1. Precedents

We do not know of any schemes regarding rural development and new technologies in Spain which are comparable to what we are trying to develop in Galicia. The closest precedent is Granjafamiliar.com in the Basque Country, an individual initiative in the town of Elorrio in Biscay, which commercialised the family production of pork and calves with notable success on the Internet, as well as marketing informational and other products (www.granjafamiliar.com). Worthy of mention as well is the digital platform www.infobrion.com, which was developed in the municipality of Brión and which nowadays is being implemented in 33 municipalities across the province of Salamanca through an agreement made between the University of Santiago de Compostela and the Germán Sánchez Ruipérez Foundation which focuses on socio-economic development from the digitalization of culture and local education. Also of strategic interest is www.lonxanet.com, which acts as a direct marketing system of products from the sea between fishermen's associations from different Galician regions and the buyers; as well as www.agroalimentariadoeume.org, which is an innovative initiative for commercializing farm produce in the Eume-Ace Pontes (Galicia) region.

Specialized studies on the territorial and social impact of the information society in Spain and in Galicia are really very scarce. The pilot opinion experiments that sense changes and deep transformations in all aspects of life stand out, but there is no in depth academic research on the subject. The reports on the information society published by telecommunications companies are also of note, especially the I Report on the Development of the Information Society in Spain "España 2001" and the same following reports, as well as those by the Retevisión Foundation, which are a pioneer but also very general.

The experiment that we are going to develop in Galicia is original in itself. As we have already said, there are precedents in a similar initiative which is being carried out on an individual basis in the Basque Country with notable success (www.granjafamiliar.com), in a research team from University College Cork in Ireland (Northside Folk Project) which has good relations with the University of Santiago, and with the InfoBrion.com project, as well as with the Centro Internacional de Tecnologías Avanzadas para el medio rural (International Centre of Advanced Technologies for the rural environment, CITA) of the Germán Sánchez Ruipérez Foundation from Salamanca. Therefore, there are possibilities open for establishing contacts and exchanging information and experiences with a view toward establishing some type of collaborative network.

We are checking the existence of electronic commerce websites dedicated to agricultural products, sausages, wines and spirits, etc., as well as fish and shellfish, but they are always associated to business and industrial brand name commerce. There are noteworthy cases in Spain and internationally: interjamon.com, lamejornaranja.com, fanbar.eres, mariskito.com, etc.

2.2. Objectives

Our objective is to boost social, economic and cultural development in the Galician rural environment. It is our aim to bring about the recovery of historical records and the reassessment of local rural culture in the context of the information society. To this end, we are planning the architecture of www.granxafamiliar.com, which is developing the creation of a virtual community based on boosting commercial transactions and the possibilities of being able to buy and sell traditional produce for family self-supply that exists in the rural environment. We intend to promote it globally across the internet by promoting the use and spread of ICTs (information and communication technologies) as tools and commercial channels for agricultural products, mutual knowledge between rural and urban communities, as well as information and learning channels.

We also intend, from the university's point of view, to make an empirical and theoretical in-depth study on the territorial and social effects linked to the development of the information and

communication society in rural communities. We are trying to assist in the progress of public decisions and administrative efficiency when the time comes to invest in the services and suitable activities of the information society in the rural environment, defining the needs of people resident in peripheral regions-spaces with the purpose of developing their competitiveness and addressing the new social demands generated. The specific objectives can be summarized as follows:

- To increase rural family income in Galicia.
- To introduce traditional produce for family self-supply on to the market.
- To spread the use of the new technologies at a local level to counter the digital marginalization known as digital divide.
- To push to recover historical records in rural environments and spread them towards urban environments.
- To reassess rural culture after using new technologies.
- To promote relations, communication, and direct contact between rural and urban Galician families.
- To promote the expansion of innovation and development capacities in the Galician rural environment.
- To motivate young people to face rural development and the development of agricultural activities.

2.3. Methodology and work plan

Granxafamiliar.com is structured and organized from working in cooperation with researchers, technicians, designers and computer programmers. The project involved the development of the computer system with regard to information and communication, the production and management of multimedia content for the website, a marketing plan, system management and coordination work, and locating local producers. The responsibilities and tasks are detailed below.

Management and coordination

The work of managing and coordinating the Granxafamiliar project was taken on by the Research Group on Society, Technology and Territory (GIS-T IDEGA) of University of Santiago de Compostela. In addition to this, the work of producing the multimedia content and its administration also falls to GIS-T IDEGA.

Putting the Granxafamiliar project into operation involved signing a collaboration agreement between the Vice-Chancellor of the University of Santiago de Compostela, the town hall of Brión, the town hall of Antas de Ulla, the town hall of Lalín, the Feiraco Foundation, Obra Social Caixa Galicia and Caritas Diocesana of Santiago.

Computer development

The granxafamiliar.com project involved the design, architecture and putting in operation of an information system, communication through a public website and another private one for managing contents. The website was conceived using advanced free PHP programming with a strong multimedia content. It allows video, sound and digital image about the family farms to be shown and the products which they are offering for sale.

The architecture, editorial management and general broadcasting of the granxafamiliar interactive multimedia portal was carried out with the collaboration of two computer teams responsible for the design and programming of the website.

GranxaFamiliar is an information system for promoting and selling quality farm produce from family farms without intermediaries. To give it an outlet of quality and elegance without losing its natural Galician roots are the premises used to build the graphic framework which promotes it.

The graphic design started with the creation of the brand. The distinguishing values of the project are reflected graphically in various components of the brand.

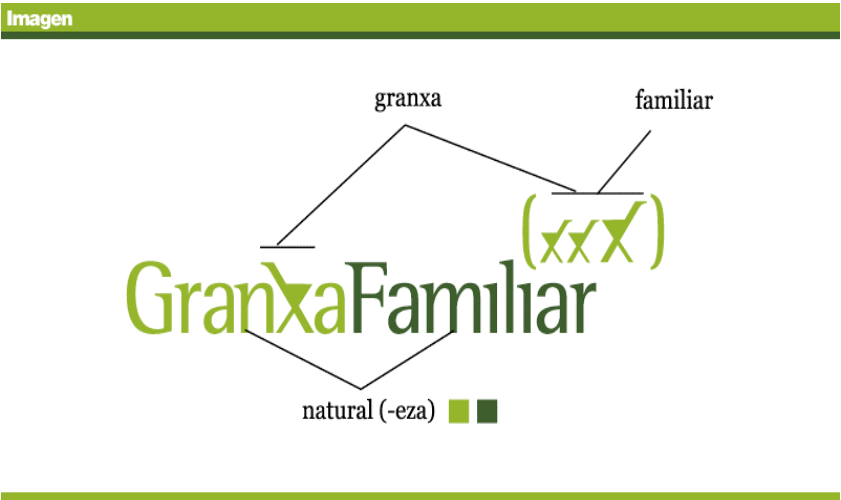


Figure 1 – Brand image of GranxaFamiliar



Figure 2 – Design of the www.granxafamiliar.com website

The idea was to create an attractive portal for users and consumers. The difference with other portals of this type is in giving a serious, organized appearance which reflects the quality and the natural content of the products and the family farms promoted on the website. The colour, dynamism and variety of sections, as well as the graphic design according to standards on

corporate design used like guidelines, try to make this portal a market reference point for this type of product.



Figure 3 – Design of the www.granxafamiliar.com website

Granxa Familiar is aimed at any buyer who feels attracted by the quality of the products offered on the website. For this reason, the programming of the website was planned to make it easier for users to carry out all the actions on the system in an attractive and simple way. Our intention is that possible buyers can appreciate the quality of traditional produce from Galician family farms, as well as the tracking process of the products through diverse multimedia material.

Marketing plan and diffusion

To make the purpose and usefulness of the project known to producers and potential buyers and users of the information system that has been set up, several informative days were held in the rural municipalities of Galicia involved, the Feiraco Foundation and the Diocesan Caritas of Galicia. Granxafamiliar keeps a media presence from the press offices of the University of Santiago de Compostela and related institutions. It runs a news publication system from the granxafamiliar.com website. Furthermore, it has designed and published various printed leaflets in three-page and multi-page format for general distribution in the towns involved and in Galician and Spanish town markets.

Locating local producers

The Granxafamiliar pilot scheme started by locating and selecting 12 farms, which have grown progressively as the project has advanced, until reaching a maximum number of 30. Currently, the system has 24 production families to its credit. The decision to begin with an average number of

farms was based on the need to carry out a first assessment of results and fulfillment of the proposed objective.

For the location of production families, each one of the collaborating institutions engaged in providing a list of candidate farms to participate in the research project. From the list of farms, the research team GIS-T IDEGA selected those that fitted the following requirements better:

- Small and medium family agricultural and cattle farms.
- Production for family self-supply.
- Farms which practice traditional agricultural and cattle farming.
- Products made using natural methods -no remains of chemical products- to preserve and protect the environment.
- Commitment from the farmers to the recovery of the Galician rural environment using new technologies.

Field work and information processing in the laboratory

The GIS-T IDEGA research team, organized into two-researchers groups, went to the farms in order to compile a wide range of multimedia material in the form of image, audio and interview regarding the traditional contents and products for self-consumption aimed at the market and produced in local family farms.

From the resources obtained in the local community itself, the research team proceeded, in the laboratory, to treat and process the information for its subsequent digitalization on the web page. The Granxafamiliar portal manages various contents in digital format of interest to the producers and potential buyers and users of the information system which has been set up.

Protocol for identifying the farms

For the management and administration of the contents obtained in the local communities, files have been set up to identify and classify the producers, the products on offer and the daily activities carried out at family farms.

2.4. Architecture and content of the site

The Granxafamiliar website is structured in three large interrelated blocks:

- Local producers. Granxafamiliar offers informational services of interest to local producers and users of the system in general. Information about the geographical location of the farm, life history, the composition of the family, the main activity on the farm and the products for self-consumption produced on the farm.
- Immersion in the information society. Promotion and spread of new technologies at a local level as a tool for the commercialization of farm produce, for mutual knowledge between urban and rural communities, and for information and learning. It promotes the practice of electronic commerce through a "Virtual Market" for purchases, sales, product exchanges and general goods or services in the local community. It promotes and offers e-mail services associated to www.granxafamiliar.com for users of the information system. Also, it promotes the development of a local space for opinion and debate through forums, <http://www.granxafamiliar.com/foros/index.php>.
- Creation of virtual museums in order to promote and recover historical records in the Galician rural environment. Granxafamiliar intends to become a cultural benchmark for the Galician rural environment through a series of didactic museums, www.granxafamiliar.com/nososmuseos/index.php, which collect the present and future traditions of Galician farming in small texts and digital multimedia material.

4. Evolution of the www.granxafamiliar.com portal

Granxafamiliar appeared on the Net in February 2008. In figure 1, information can be seen showing the growing development of the number of users, which finished stronger in the last four months of 2008. According to the constant monitoring carried out by the Multimedia Global application, in the month of November more than 50,000 pages were visited and 7,746 visits by 2,971 different visitors were registered, which proves the interest caused by the web page.

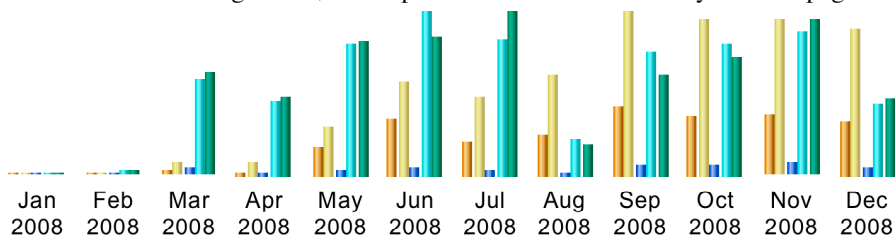


Figure 4 – Visits to www.granxafamiliar.com in the period January–December 2008. Source: GIS–T IDEGA, University of Santiago de Compostela.

Chart 1 – Visits to www.granxafamiliar.com in the period January–December 2008. Source: GIS–T IDEGA, University of Santiago de Compostela.

Month	Different visitors	Number of visits	Pages	Requests	Traffic
Jan-08	0	0	0	0	0
Feb-08	5	6	668	10724	333.85 MB
Mar-08	215	588	28591	429043	14.82 GB
Abr-08	270	669	17962	331416	11.17 GB
May-08	1471	2420	33894	600924	19.43 GB
Jun-08	2960	4765	35789	763446	20.29 GB
Jul-08	1692	3933	28117	618046	24.46 GB
Aug-08	2101	5135	21040	162123	4.36 GB
Sep-08	3502	8600	44517	552200	14.76 GB
Oct-08	3031	7989	46445	601490	17.31 GB
Nov-08	2971	7746	51786	638339	22.39 GB
Dec-08	2680	7368	40776	328071	10.99 GB
Total	20898	49219	349585	5035822	160.31GB

In Chart 3 the URL can be seen with more access, highlighting above all the forums service, our farms and the home page. The most visited page by default for being the most common entry point to the website is the forum section. The distribution of access and visits to the website

reveals that this page is awaking sufficient interest among visitors to select some another section besides the access point and to navigate more deeply in the website.

Chart 2 – Pages–URLs (Top 10). Source: GIS–T IDEGA, University of Santiago de Compostela.

566 different pages	Access points	Average size	Home page	Exit
/foros/index.php	108104	23.95 KB	31218	30519
/nosasgranxas/granxa.php	35366	21.37 KB	1138	2319
/principal/index.php	31387	16.05 KB	11476	4627
/nosasgranxas/granxaproducto.php	27757	17.62 KB	642	1392
/nosasgranxas/index.php	16427	23.00 KB	625	911
/nosomercado/nosafeira.php	11672	18.91 KB	870	1603
/nosoproductos/producto.php	11426	18.16 KB	230	644
/nosasgranxas/noti cia.php	11326	19.98 KB	358	621
/sistema/a recursos.php	11253	17.35 KB	9	34
/nosoproductos/index.php	10557	12.89 KB	266	439
Otros	74310	207.21 KB	2387	6110

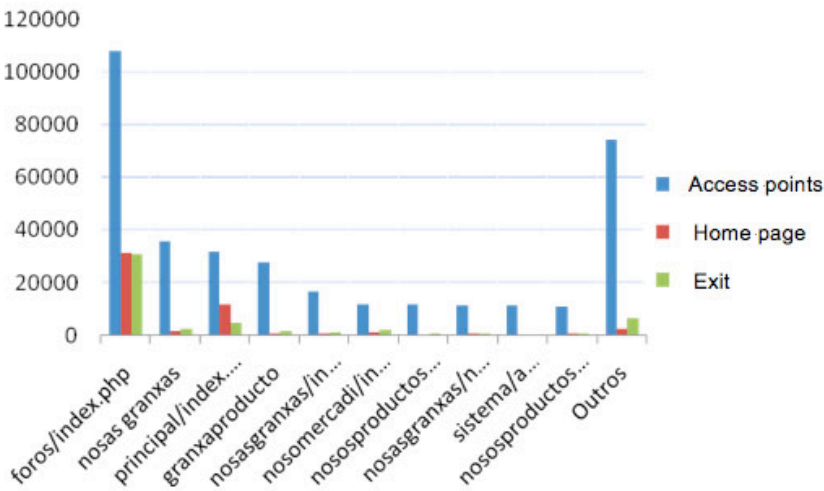


Figure 6 – URLs (Top 10) most visited in the period January–December 2008. Source: GIS–T IDEGA, University of Santiago de Compostela.

5. Benefits of the project

Generally, Granxafamiliar is making a noteworthy contribution to scientific-technical knowledge about the social, economic and territorial effects of the information society and information and communication technologies on the rural environment. In particular, the direction of this project toward rural towns is benefiting the development of territories that are switched off or cut off from the information society. Moreover, it is making several rural Galician town halls visible as

models in the development and use of new technologies in the commercialization of family farm produce.

The potential beneficiaries of Granxafamiliar.com through the transfer of results will be:

- Local administration and civil society. There will be an advanced system of information management specialized in rural economic development, as well as the equipment and technical and human resources needed to be able to efficiently manage the telematic tool designed and presented as www.granxafamiliar.com. There will be a benefit from the social assistance methodologies set against the exclusion caused by new technologies. There will be personnel qualified in the management of digital editorial systems to maintain the www.granxafamiliar.com portal, with all the technological tools for the communication and electronic commercialization of farm produce.
- The cooperative business. It will be possible to obtain an advanced agricultural commercialization system from Granxafamiliar.com that pushes up the family incomes of farms. Besides, they will have preferential access to a very detailed source of information about the impacts that the new information services generate in the rural environment, and they will be able to get to know possible market niches for the application of information and communication technologies. Granxafamiliar.com will assume a clear role in the pilot scheme centred on the spread of social utilisation and universalisation of the use of new information technologies on a local and rural agricultural scale. It will be a comparable experience with possibilities of being reproduced in other Galician municipalities and outside Galicia.
- The University. Through the excellent education of the researchers and postgraduate students specialized in the study of the socio-territorial impacts on the information society and its dinamization on a local, rural and urban scale. And with the strengthening of a strong interdisciplinary research team with sufficient critical mass and synergy to establish international contacts and to be admitted competitively to European Union research calls.

In short, Granxafamiliar.com has been conceived as a public digital communication service to promote the appreciation of traditional products for family consumption and an increase in value of local and rural culture as an educational resource and of local economic promotion available universally through the Internet.

Likewise, the Granxafamiliar.com project is promoting relations and direct contact between rural and urban Galician families, contributing to the recovery of historical records in the rural environment and spreading it towards the urban environment.

Finally, a very positive perception can be seen from the farmers themselves about the recovery and preservation of the rural environment in general and farming activities in particular. All of the farms selected for the project practice traditional and environmentally friendly farming. The farmers interviewed see the Granxafamiliar.com project as one which promotes small family farms and publicises the quality of their products.

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LBES: Location Based E-commerce System

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Abstract: Mobile devices as they are found in today's market contain advanced technical capabilities, enabling, therefore, the sustainability of complex software applications. Such capabilities are responsible for conveying several fair opportunities when it comes to the creation of value added services to users, among which location-based mobile services (LBMS) are greatly focused. Therefore, this paper puts forward an architecture designed for location-based e-commerce system, that is, a system thought of to enable a given user, depending on his/her present location, to search, book and still purchase products in his/her surroundings.

Keywords: Ubiquitous, E-commerce, LBMS, E-business, Mobile-Devices.

1. Introduction

Currently, it is rather common to find in the mobile devices a rich set of technical features and functionalities. In fact, it has become quite ordinary to bump into devices equipped with a wide range of technologies, adding up to a significant processing capacity, distinct communication technologies like GPRS (General Packet Radio Service), UMTS (Universal Mobile Telecommunications System), 802.11x, Bluetooth, Infrared and NFC (Near Field Communication), location abilities such as GPS (Global Position System) or through one's service provider, detection of movement using accelerometers, among others.

Such assembly of technical abilities allows the equipments to support complex software applications as well as the execution of several services, including LBMS.

Bringing environment-contextualized information and services to users through their mobile-devices seems yet to be roughly explored as an electronic business, regardless of the fact this is quickly changing, considering the set of applications that appear to be boosting within the mobile market in the last months, for instance, those designed for the iPhone platform (Communications, 2009; Earthcomber, 2009; LightPole, 2009).

It is, therefore, within this context that we set forth an architecture for a system and location-based e-commerce system. More precisely, such system is thought of to provide a given user, who may intend to identify potential suppliers of products/services in a given geographical proximity, the possibility of searching these same products/services, making reservations to buy and even concluding the purchase, by the way of the very convenient use of a mobile device.

This paper is structured as follows: the next section presents the literature review, followed by the presentation and discussion of the system architecture and, then, the analysis of the system prototype. The final section is completed with some relevant conclusions obtained from this paper.

2. Background

The ever growing and wide spread of mobile devices with increasing technological capacity playing the role of mobile computing platform together with a particular feature that stays permanently close to the personal life of individuals (Raento, Oulasvirta, Petit, & Toivonen, 2005; Srivastava, 2005), explains its status as privileged tools for the development and implementation of the "context-aware" concept, while referring to applications and services (Raento et al., 2005; Rao & Minakakis, 2003). Currently, it is, in fact, the real-time obtained geographical location the preferred basis upon which the services with context related information, in which the individual is also included, are provided (Toye, Sharp, Madhavapeddy, & Scott, 2005). Obtaining this information has been facilitated and has become more efficient, besides fast, mainly due to the widespread introduction of technologies such as GPS in mobile devices or the use of networks of service providers (Rao & Minakakis, 2003).

The concept of LBMS opens in a new direction to the development of content and applications for mobile platforms (Helal, 2008; Vaughan-Nichols, 2009), as well as ways to integrate the latter - concerning its hardware particularities and communications - into the already existent and working digital services networks, presenting, however, the opportunity to innovate because an ubiquitous and personal vehicle associated with growing multimedia facilities, are capable of leading to real-time relevant, personalized and contextualized services and contents, which can be presented transparently to the user and in the very palm of his/her hand (Toye et al., 2005).

Regarding to the economic potential that may be well acquired by service providers, their profits range from traditional operators to virtually any entity with a web platform ready to be accessed by mobile devices or to provide their services using web services (Farley & Capp, 2005; Oriana, Veli-Matti, Sebastian, & Lasse, 2008). This stands for a whole new market that combines together the mobility and contextual domain, a role very much played by the ever present element of day-to-day: the mobile phone. There are already some examples of location-based services for individuals and public institutions, namely services of virtual waiting lines, issuing tickets for transport, social networks, urban planning, pedestrian navigation and others, being then briefly described as an example.

A service of virtual waiting lines is described in (Toye et al., 2005), allowing that a restaurant customer does not have to hold for a table in the lobby. Using a mechanism of local context - a visual tag (QR Code) the client uses his/her mobile device to photograph the element of context and an application previously installed to decode the content, which in this case contains a series of addresses providing Bluetooth connections between the client's mobile device and restaurant's server. The customer is, therefore, informed about the average time of waiting, the number of people standing ahead of an individual and then asked whether if one desires or not to be placed in the virtual queue. If yes, the customer is then asked to indicate how many people will be served when available. Finally, the client may now wait for his/her turn lightly, taking time to go shopping or doing any other kind of service that he/she is required to accomplish. The user will then be notified by the system of the restaurant, through SMS, letting the client know when to get back and be served in the shortest time possible.

Additionally, the SitOrSquat.com (SitOrSquat.com, 2009) site puts forward the possibility to find, for example, a bathroom near your present setting. In detail, as soon as we insert a given

location within the map presented, it moves towards the selected location where we may find all the bathrooms registered in the systems which are thus shown. Furthermore, when we click on the bathroom icon, a small window containing basic information about that bathroom appears and if we click on the icon corresponding to the name of the bathroom, more and detailed information on another window is also made available. It is again possible to use this service on mobile phone by downloading it to your Blackberry or iPhone, and, in addition, to find precisely how to get to the nearest bathroom by again sending a SMS and following the instructions as provided.

The WhosHere (Honan, 2009) consists of an application set for digital social networks and is also able to show other users that are geographically close, through the basis of provided information about the current location of the individual, and likewise facilitate the interaction between them by means of short written messages. Similarly, it also allows performing searching activities among available users, based on criteria such as whether the person is available or not for friendship relationships, casual encounters, among others. Furthermore, accessing users' profiles and further exchange of their respective multimedia information, like photographs, turned out to be possible as well.

The Mobile Cab Finder, CAB4Me (cab4me.com, 2009), consists of an application whose main feature relies on making easier for us to find a taxi and is available for the T-Mobile G1 Android phone. All we have to do is to choose our location/setting on a map and we are then shown where the nearest taxi is, if available. By clicking on the call tab, the local cab companies are likewise illustrated. If registered on the database, the companies and its related information, such as payment methods and car types, are also on hand. If there are no registered cabs for one area, a local web search is performed.

Selling public transports tickets based on the user location (Bohm, Murtz, Sommer, & Wermuth, 2005) is a relatively new reality coming with a really simple concept: the user dials a check-in number when one is about to start using public transports and is located using their mobile services provider and multimedia activities, such as photographs. Next, and once one takes the public transport and selects the journey, within the area covered by the service, it goes all the way through and as long as one desires. It only takes the user a quick contact to the check-out number when the journey is finished. Thus, based on the initial position, final position and the public transports network, the service is able to calculate the value to charge and follows by automatically deducting it from the account belonging to client's mobile operator. Tickets selling for sport events and music concerts, as well as related promotions is also described in (Farley & Capp, 2005).

LBMS can also help to change urban planning and strongly influence public administration policies (Ahas, 2005). Mobile devices can precisely pinpoint their geographic location and also supply a saved user profile. Together, they provide the basis to study – through certified entities, due to privacy issues and only with the user consent - time and space social flows in a given geographic area. By creating flow charts and models, public entities can know what are the most travelled streets, roads, routes, visited locations, among others, but also by using a statistical approach, the expected people on a given geographic location, at a given day and time. This information will greatly help to plan public services, urban development and transportation routes/timetables.

Finally, a pedestrian navigation aid system is described in (Arikawa, 2007). In this, a user is shown as capable of selecting a destination within a city along with some preferences/conditions to make the journey. The mobile application will, based on the user's initial geographic position and through a web-service, obtain the optimized route from source on the way to destination, respecting the most the user's conditions. Meanwhile, as soon as the journey starts, it will also provides a detailed step-to-step guide and visual representation of the urban scenario in the user's mobile device detecting, for that purpose, the direction to where the user is heading for. Some

services, like the location of restaurants, shopping malls and transport platforms in the vicinities are also made available, providing a complement to the main navigation aid service.

3. System Architecture

The system that we propose relies on the availability of information and services, based on the location of those who request them. Consequently, it is intended that a given user by means of a mobile device with a previously installed application, may be allowed to search products/services using his/her mobile phone. The research is prepared by indicating an expression of research (identifying the product/service required) together with the action range (maximum distance) in which the user wishes to collect the product or acquire the service. The running of the research enables the establishment of a link between the mobile device to a location based search engine, which in return will provide a list of suppliers of products/services in the surrounding area as selected, based on the information from previous index of products/services and made available by the suppliers who are afforded access in the system.

Once in the possession of information about potential suppliers, it is up to the user to decide which supplier he/she requests and make an immediate booking or purchase, if it is something the user looks for.

As can be seen in Figure 1, the system LBES is made of several components that are described below: Mobile Device (MD), Location Based Search Engine (LBSE); Stores (S).

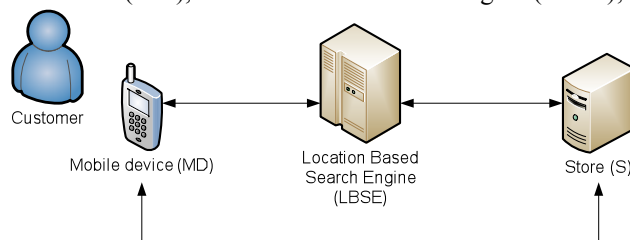


Figure 1 – LBES Global Architecture

MD: It stands for devices such as a PDA or mobile phone which enable the user to search, reserve and/or buy products/services in a selected geographical area.

LBSE: Consists of a search engine whose function relies on indexing products/services from several stores, in a primary and initial stage of the process, and in a second phase, replying the requests on products/services search by MD.

S: Represents the suppliers systems of products/services, in which it is registered the information about products/services available in stores belonging to these suppliers.

In the overall operation of the system, it is possible to identify several of its moments, whose messages exchanged among the various components are represented in Figure 2, as follows:

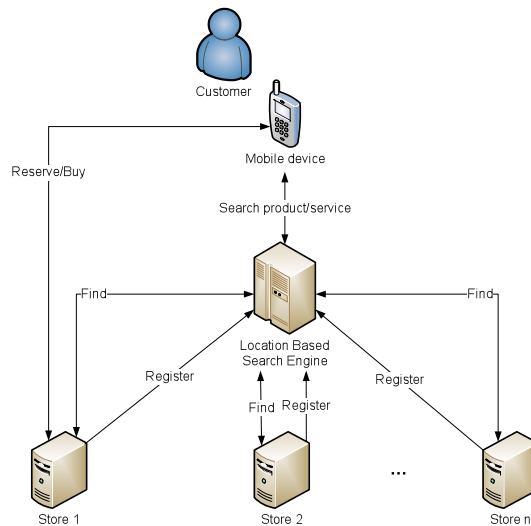


Figure 2 – LBES architecture detail (general exchanged messages)

First moment:

- Each S system is registered in LBSE system (message “Register”).

Second moment (cyclic):

- ← Each product/service is indexed by LBSE (message “Index”).

At the final stage of the second moment the products/services will become available in the LBES system for further search.

Third moment:

- ← The user, by means of a MD, configures the search that he/she wants to carry out, defining some parameters, such as the maximum distance from his/her specific location and a search string of the desired product/service;
- ← At that moment, it is sent the "Search product/service" message from the MD system to the LBES one, indicating what search is effectively selected by the user. Through the latter, it is accordingly sent a response by the ELBSE to the MD system containing the list of products/services as found in the surroundings, and resulting from the search as previously conducted;
- ← If the user desires, he/she may as well book or purchase either a certain product or service directly in one of each stores shown up as the result of the search he/she has completed. For such purpose, it will be sent a “Reserve/Buy” message from the MD system to one of the S systems. As a feedback, in case the purchase is indeed possible, the user will be delivered an electronic sort of confirmation of the referred reservation/purchase action through his/her MD.

4. Prototype

The LBES system was put into practice by making use of the Android operating system for mobile devices exclusive application purposes, whereas Linux proved to be relevant in the system repository of events. Such performance did implicate the use of a range of technologies, such as Java, Web services (PHP), Apache and MySQL. In general, these technologies were used because

they are open source, which reduces the implementing costs and are furthermore supported by a broad community of users, enhancing its development with the addition of new features.

Regarding the recent operating system named Android, enabling, nonetheless, a direct interaction with the Google Apps (e.g. Google Maps), it has got significant advantages when developing applications in a well established language (JAVA), not to mention the remarkably ever growing applications market developed by its supporting community.

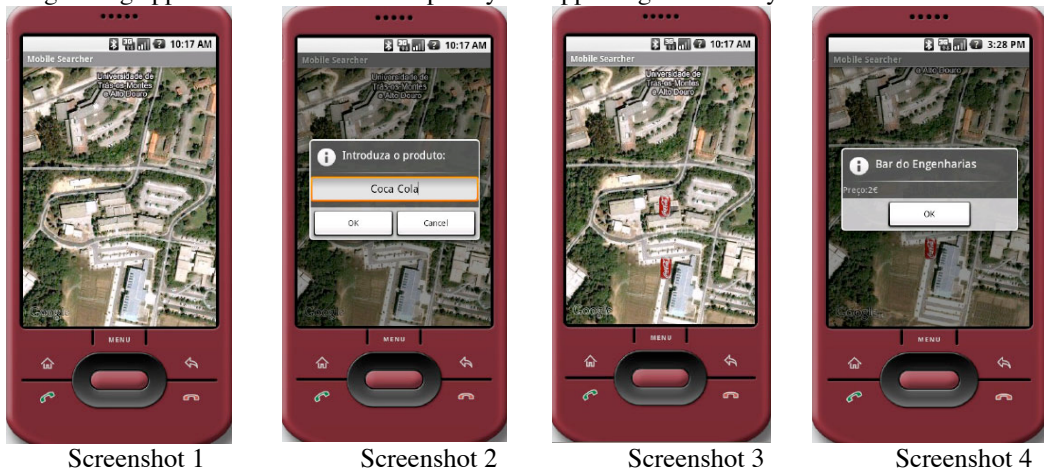


Figure 3 - LBES prototype screenshots

In **Figure 3** there are several screenshots of the application especially designed for mobile devices.

When started, the application automatically loads a global terrestrial map indicating the user's present location and providing him/her the possibility to start a given search (screenshot 1, by touching on the map). Once the map is loaded, the user is able to navigate freely on it, as well as zoom in, zoom out and change the way the map is showed. Then, by simply laying an hand on the map, the "Search" option shows up, allowing the user to insert the search keywords related to with the product/service he/she wants to look for (screenshot 2) in its corresponding small window in the middle of the screen. The confirmation of the undergoing search (screenshot 2, button "ok") will activate an HTTP request to be sent to a web service. The HTTP request will therefore contain a *Simple Object Access Protocol* (SOAP) message with several parameters: the product/service introduced, the user location, the server IP address and the function that will be called. Subsequently, the web service returns all the stores containing products/services connected to the search keywords introduced and the results are shown on a new window (screenshot 3). To verify the product/service price, the user must select one store from the search result list by clicking on it.

Once the product/service as retrieved is selected, it is shown the price regarding the product (screenshot 4). As future work and consequent developments, the prototype features are expected to put into action the reservation/purchase facilities.

5. Conclusions

LBMS are promptly arising and on the way to become part of everyday routines, and this is mainly due to the fact that they offer contextualized real-time services, meaning an unquestionably help and a promising future assistance in the context of both professional and personal lives, through one's own ever-present mobile device.

The system as proposed in this article comprises a whole new way through which users may indeed search and obtain information about products/services sold in their geographical proximity, providing an effective interface skilled at obtaining structured, focused and timely information, which, so far up to present, is not possible to achieve by any other means with similar efficiency. Therefore, we strongly believe and support that the system we have been studying and describing absolutely represents a new and ultimate step in the context of LBMS systems.

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Virtual Center for Entrepreneurial Competencies Assessment and Development – Preliminary Architecture Design

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Abstract: The paper debates the following items: (1) the university entrepreneurial education as a process of knowledge transfer based on the knowledge map competencies for the engineer graduate student profile (engineering and management specialization); (2) the training needs for business creation - based on a preliminary market research developed with subjects with technical and economical background and that allow the identification of the entrepreneurial knowledge; (3) preliminary design and architecture of the virtual center for competencies/expertise evaluation CE@ANPART (based on a web platform concept) that will highlight the role of the information technology in the proposed activities and the propose specific steps and arrangements for the entrepreneurship education innovation. Finally, some relevant conclusions and the directions of future researches are presented for the entrepreneurship education development in the case of human resources with engineering background.

Keywords: Entrepreneurship, education, competencies, training/education, assessment procedure, Web platform, architecture.

1. Introduction

Even in this crisis period, Europe needs to foster the entrepreneurial drive more effectively. It needs more new and thriving firms willing to embark on creative or innovative ventures. Encouraging the enterprise spirit is a key to achieving these objectives. Education can contribute to encouraging entrepreneurship, by fostering the right mindset, by raising awareness of career opportunities as an entrepreneur or a self-employed person, and by providing the relevant business skills (European Commission reports, 2008). Entrepreneurial skills and attitudes provide benefits to society, even beyond their application to business activity. In fact, personal qualities that are relevant to entrepreneurship, such as creativity and a spirit of initiative, can be useful to everyone, in their working activity and in their daily life. “The European Commission found that there is today in most EU Member States — although in varying degrees — a policy commitment at governmental/ministerial level to promote the teaching of entrepreneurship in the education system” (European Commission reports, 2008).

In the context of this paper, human resources training regarding their entrepreneurship competencies development have to be amplifying in the high education period and it has to continue with training during all professional life with the support of the dedicated long life

learning programs. Encouraging the enterprise spirit is a key to creating jobs and improving competitiveness and economic growth (Draghici & Draghici, 2006), (European Commission reports, 2008).

If it is to make a success of the Lisbon strategy for growth and employment, universities need to stimulate the entrepreneurial mindsets of young people, encourage innovative business start-ups, and foster a culture that is friendlier to entrepreneurship and to the growth of small and medium-sized enterprises (SMEs). However, the benefits of entrepreneurship education are not limited to start-ups, innovative ventures and new jobs. The Bologna process can have a positive effect on the way entrepreneurial knowledge is spread. So, in the knowledge based society universities have to play an enhanced role in innovation as entrepreneurs. This paper presents some important aspects of knowledge transfer processes developed by universities to become entrepreneurial and to increase their implication and contributions to human resources development at the local/regional economic level. These mechanisms are expected to contribute to economic development through universities roles: education, research and knowledge transfer to society (Izvercianu & Draghici, 2008).

Entrepreneurship refers to an individual's ability to turn ideas into action and is therefore a key competence for all, helping young people to be more creative and self-confident in whatever they undertake (Tornatzky et al., 2002). At higher education level, the primary purpose of entrepreneurship education should be to develop entrepreneurial capacities and mindsets. In this context, entrepreneurship education programs can have different objectives, such as: a) developing entrepreneurial drive among students (raising awareness and motivation); b) training students in the skills they need to set-up a business and manage its growth; c) developing the entrepreneurial ability to identify and exploit opportunities (Draghici & Draghici, 2006), (Tornatzky et al., 2002).

The paper debates the following items: (1) the university entrepreneurial education as a process of knowledge transfer based on the knowledge map competencies for the engineer graduate student profile (engineering and management specialization); (2) the training needs for business creation - based on a preliminary market research developed with subjects with technical and economical background and that allow the identification of the entrepreneurial knowledge; (3) preliminary design and architecture of the virtual center for competencies/expertise evaluation CE@ANPART (based on a web platform concept) that will highlight the role of the information technology in the proposed activities and the propose specific steps and arrangements for the entrepreneurship education innovation. Finally, some relevant conclusions and future researches will be presented.

2. Entrepreneurship Competencies Development through the University Study

2.1. The entrepreneurship education as part of the knowledge transfer process in university

The first research aim was to have an overview of the activities type that are carried out by a university in the field of knowledge transfer and that can be considered for entrepreneurship education in universities (Ropke, 1998), (Tornatzky et al., 2002). In accord with the references, the ten most mentioned activities are: (1) Patents and licensing; (2) Spin-off and enterprise creation; (3) University-industry networks; (4) International cooperation; (5) European affairs; (6) Continuous professional development - Comprises the post-initial education programs aiming at improving the capability and realizing the full potential of professionals at work; (7) Alumni

affairs; (8) National subsidies; (9) Regional subsidies; (10) Grants - Are provided by the government or other non-profit organizations to encourage (individual) development or growth in a particular area. These knowledge transfer activities were analyzed in the case of the Politehnica University of Timisoara. The identification of the knowledge transfer activities allowed their characterization by translating into a scale of increasing mutual obligations or increasing cooperation and integration (Figure 1) of the “actors” on the market. The mechanisms of knowledge transfer evolve linked with the stages of cooperation from the traditional knowledge transfer organization (the first stage) and the virtual knowledge transfer organization (the last stage).

The researches regarding the knowledge transfer mechanism, together with the state-of-art study of the specific methods and tools (developed under the UNIKM project) have been the premise of the CE@ANPART virtual center for entrepreneurial competencies assessment.

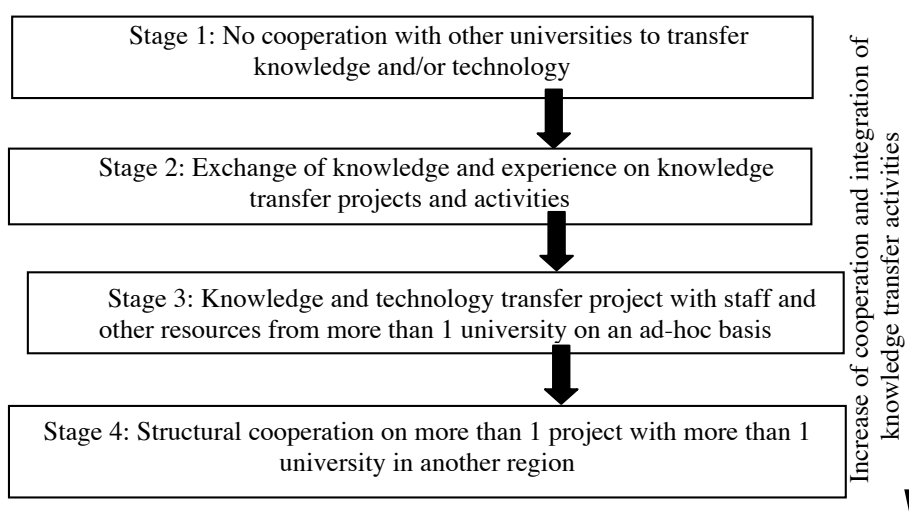


Figure 1 – Extend of integration and cooperation of knowledge transfer activities

2.2. Market survey for the training needs identification

In the following we shall present the most relevant research results started since 2007 because our involvement in the FORCREST project (Izvercianu, 2007), in the framework of Leonardo da Vinci Program where 9 European countries were partners in this collaboration: Spain, Germany, France, Ireland, United Kingdom, Italy, Czech Republic, Hungary and Romania. The research motivation and objectives were to detect the knowledge gaps of the undergraduate students from technical and economics universities, in the area of business creation, during their involvement in the high education programs. The research methodologies were: phenomenological group analysis and investigation based on questionnaires (non-directly centered group interview technique). The questionnaire structure consist the following items (the subjects were faced with real or imaginary situation and were encouraged to give their comments – answers on those particular items): drawing-up a business plan, technical study, financial-economic study, innovation management, project management, environment impact study, managerial skills and communication skills. The research scenario that was design and test in the context of the Leonardo da Vinci project was re-

apply with new subjects to identify the dynamics of the entrepreneurial behavior and interests in different skills education.

The presented survey allows us to outline the student profile in business creation field. The comparative results for target groups as well as their different needs are briefly presented in the following. Final analysis affects the curricula improvement mainly in the MBA program at the Politehnica University of Timisoara, Romania. The market survey has referred to the training needs of human resources with technical and economical background, in order to acquire the knowledge regarding the process of business opportunities creation and development and also, to train them for the trials they will confront with for business creation, to aware them on sustainable development implications, and to offer them the necessary competencies. 155 subjects were involved in the survey and they belong to two target groups: 80 subjects are graduates, undergraduates or undertaking master of science courses with technical background – this is the technical group; 75 subjects are graduates, undergraduates, undertaking master of science courses or from SMEs with economical background – this in the economical group (Izvercianu, 2007), (Izvercianu & Draghici, 2007).

Some relevant conclusions were elaborated regarding the needs for entrepreneurial training development (synchronous with the competencies development in the field). For our present and future research, the conclusions regarding the technical group (with engineering background) are briefly presented in Table 1. The research has underlined the lack of minimal entrepreneurial skills in the structure of university curricula and the need for specific tools development for the entrepreneurship competencies / expertise development and/or evaluation.

Table 1 – Entrepreneurial competencies that have to be developed – for the technical group (with engineering background)

Research or questionnaire items that were analyze:	Entrepreneurial competencies required to be developed (training lines):
Drawing-up a business plan	Marketing and competition; Distribution
Technical study	Know-how transfer
Financial-economic study	Business viability (efficiency and efficacy) indicators; Project scheduling
Innovation management	Tools for implementing innovation
Project management	Information technologies tools for project management; Human resources management
Environment impact study	Profit and sustainable development
Managerial skills and communication skills	Team working (including management, motivation and leadership); Communication in the company

3. The CE@ANPART Virtual Center for Entrepreneurship Competencies Assessment – Preliminary Architecture Design

3.1. The CE@ANPART project – short description

The project (www.ceanpart.lx.ro/index.htm) proposes to contribute to the accession of competitiveness by developing a partnership for excellence research in the field of entrepreneurial abilities and competitive human capital on knowledge and innovation-based economy and society. The results of this project will be materialized into innovative services for the educational and economical environment, as well as through assessment and development services for the entrepreneurial abilities and for the competences of entrepreneurial management on the basis of the tools developed inside this project. Another materialization of this project will be the establishment of implementation mechanisms of the research results which must ensure their sustainability through the CE@ANPART portal.

The results of the project will contribute to the improving of competitiveness and to the promotion of the entrepreneurial behavior, to the development of organizational culture based on innovation and entrepreneurial spirit within the systems of economy, education and research. All there are addressed to the target groups of beneficiaries as well as to the involvement of young highly qualified researchers.

At the same time, the project ranges with the latest researches and concerns at an European level, taking into account that one of the suggestions of the “Oslo Agenda for Entrepreneurship Education” claims that “it should develop a common framework of the desirable results of entrepreneurial education – the development of capabilities, abilities, individual mentalities and it should encourage the use of these capabilities, contributing this way to the development of both economy and society “. The project aims at promoting the reinforcement of education in the development of one the Lisbon Key Competences: KC7 Entrepreneurship at a national level and especially among young people.

The project's results will contribute to the increase of the competitiveness and the promotion of the entrepreneurial behavior, the development of organizational culture based on innovation and entrepreneurial spirit in the economy's systems, of education and research.

3.2. The context of the IT tool development – the approach motivation

Beside the aspect of “capacity building” effects of the network, the question of sustainability has to be considered to reach a long term partnership among all participants. To do so the broad expertise, the technical infrastructure and the distributed locations of the partners can be used to reach a high number of “clients” - students all over the country. The research network (developed under the CE@ANPART project and linked with the UNIKM network's project) will develop training modules on different levels of education and offer its services to interested target groups (Adelsberger et al., 2002).

The demand for entrepreneurial education is permanently rising and not limited to a certain age, degree or job position. Even among retired people there is a demand for continuous education to extend their personal knowledge and skills in the field of new practices of their own business administration (intrapreneurial skills development are also consider to be developed). The

detected target groups for educational services are shown in Figure 2. In general, one can identify four major groups for scientific education (Niemann et al. 2004), (Niemann et al. 2003).

The “qualifying education” is meant as a education for students who are enrolled at a university or any other educational institution to get a scientific degree. This also includes people who already have a degree and study on to reach a higher or an additional degree. The group of “Post graduates and Scientist” requires activities to reach a higher level of personal knowledge and skills in specific and selected fields. This additional knowledge are necessary to master daily job requirements. The education is offered on a continuous or continual basis. The third group includes students of any age and any social level. These courses are open to everybody. Such courses offer a platform to learn and discuss about the latest research results and allow people to join lectures which are not related to their core subjects. The objective of such courses is to extend one’s individual general knowledge base and create expert forums. The fourth group consists mainly of retired persons who are still interested in learning and extending their personal knowledge and skills. The main objective of this group is not to hunt for certificates, but to keep contact with current questions and results of research. These types of students are, frequently integrated into the schedule of undergraduate courses.

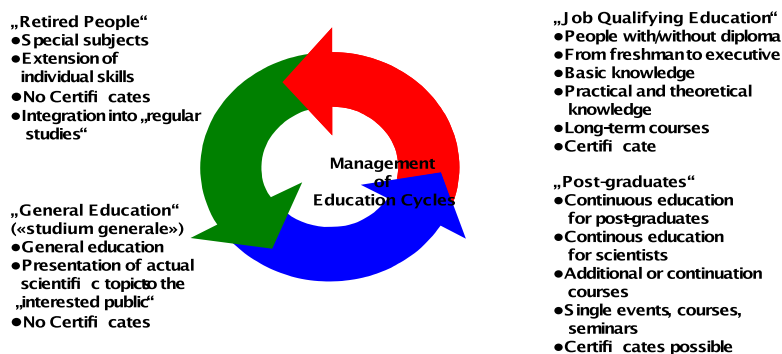


Figure 2 – Potential target groups for the CE@ANPART virtual center

As can be seen in Figure 2, the different target groups for scientific education call for a holistic approach to master the entire range of students. On the other hand the management of education cycles requires individual programs to meet the various demands of all groups. Delivering adequate education modules to such different target groups calls for adequate organizational structures and resources of the educational institution.

The key conditions for a network with virtual structures are courses which are offered in modules. A modular structure provides flexibility and faster reaction to turbulent market conditions. The modules can be delivered “on demand”, in different languages and from the partner of the network that is most competent.

The network activities are managed by a *broker* who keeps contact with network partners and configures the course portfolio (Figure 3). She/He determines the form of education course and the necessary support activities (materials, communication channels, etc.) delivered and provided on the web platform (Niemann et al. 2003), (Niegemann et al. 2004).

The construction of such a web-based model ensures the system’s flexibility, because new courses can be established “on demand” and –if necessary- at short notice. The broker establishes – based on the specific field of demand – a course offer to meet this demand. He chooses the adequate form of teaching (seminar, workshop...) and decides about the channel of knowledge transfer (internet, face-to-face...). In a third and fourth step, the location and the course tutors are

established. The course tutors determine the contents of the courses and are responsible for the delivery of adequate materials. So, the approach to generating a course is a mixture of a bottom-up and a top-down strategy.

This open broker organization supports the demand for fast reaction to market requirements and allows integrating many partners and experts (Figure 3). Especially for international research co-operations or education networks the system offers a high degree of flexibility (Westkämper, 2006). In this modular organization each partner teaches courses in their specific fields of core competence. The system provides a high level of independence concerning location and content of courses. The synchronizations of different courses and co-ordination are subject to the broker.

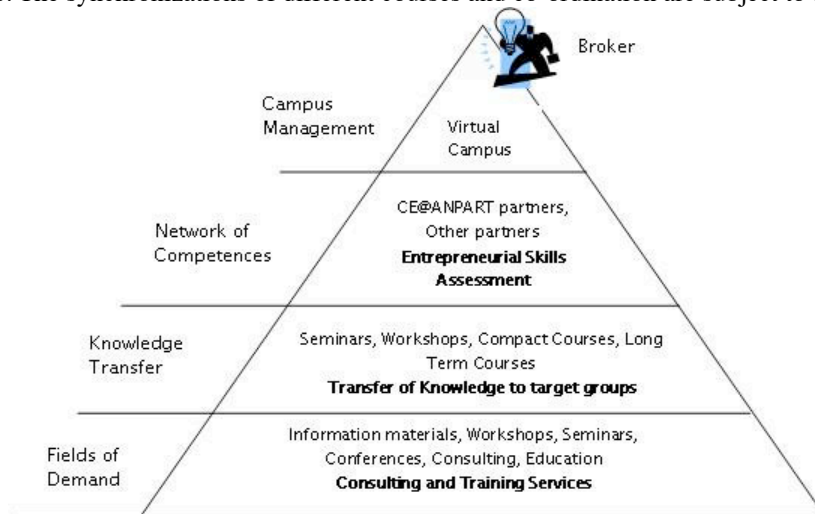


Figure 3 – The concept of the virtual center for entrepreneurship competencies assessment and development

The existing technical infrastructure also enables the CE@ANPART partners in the network to offer tele-based courses via videoconference, so that the courses can be offered at many physical locations at the same time (“any time-any place potential”). It is also an option charge a fee from participants for some selected courses or trainings will help to make the system independent from public funding.

The CE@ANPART virtual center will therefore ensure the permanent spreading of current research results and will open a gate to offer further educational or training services to different target groups. The efforts will also foster the deep integration of the network into the society and to open further links between researchers if we consider the Entrepreneurial Centers that will be developed in the location of each partner involved in the project.

3.3. Preliminary Architecture Design of the CE@ANPART virtual center

There is tremendous value in seamlessly connecting people, systems, and business processes across your organization. Operational efficiency goes up, operational costs go down. Better aligned, the company can stay agile and competitive. An *integration competency center* is an efficient information technology application that is design to share services function consisting of: people, technology, policies, best practice and processes (Lenzerini, 2002). So, our approach is

based on the preliminary study of the existing solutions of integration competencies centers, their structure and users facilities.

The main objective of building the CE@ANPART virtual center was to offer on the market unique products/services through information and communication technologies (in particular with semantic Web facilities) that support the entrepreneurial initiatives. The preliminary researches showed that there is still an acute need for training and consulting services in this field. The virtual center development process started from two ideas:

1. The design of a special section dedicated to entrepreneurial training (e-learning system for competencies development and evaluation, WWW based courses support system) and consulting (portal of entrepreneurship resources, business services, library) on the existing web page of the CE@ANPART project, and
2. The development of the virtual conference system that will be a powerful tool for the collaborative learning and research between the partners involved in the project (the universities of Iasi – the coordinator, Cluj-Napoca, Timisoara and Sibiu) and for the entrepreneurs - clients.

Figures 4, 5 show the client – server architecture of the proposed web platform. It is build around a central server, hosting the e-learning application (AeL Enterprise e-learning platform (www.advancedelearning.com)) that allow asynchronous, synchronous in class and at distance learning), database system and the file system (documents and research project's management).

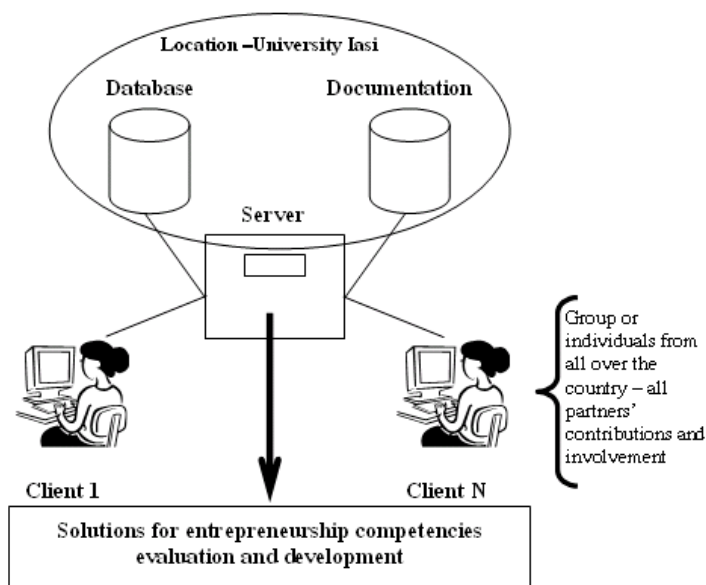


Figure 4 – The CE@ANPART virtual center preliminary architecture

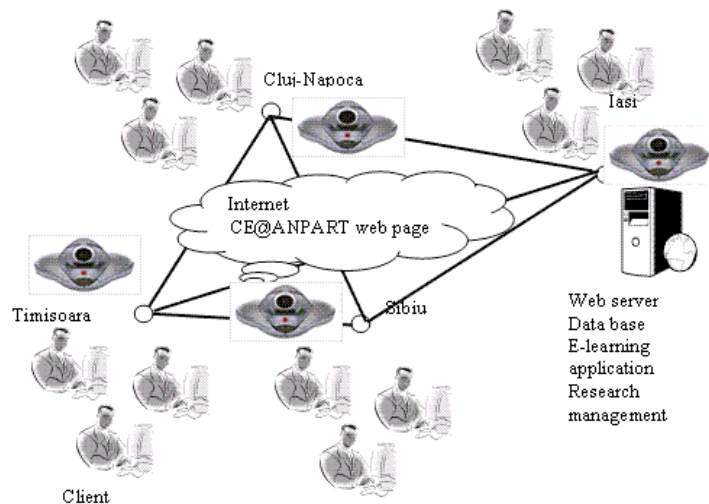


Figure 5 – The CE@ANPART virtual center – representation of the network IT tool

The main facilities of the AeL Enterprise software that are developed for entrepreneurship training and evaluation are: asynchronous study, virtual class and library, training record (including the evaluation tests of gain competencies), reports (regarding the training process evolution), administration, and discussion forum. The business consulting session is a server-oriented architecture approach that integrates three entities: the services need – client (user friendly interface), the information technology (IT) system (server) and the services data base (integration at the service level with the flexible and quick response to add/change actions).

4. Conclusions and Future Researches

The paper has debated the new role of the university in the knowledge based society for increasing the knowledge transfer process for the entrepreneurship education. The knowledge transfer activities and mechanism is the core of an efficient university-industry-government relationship for entrepreneurial outcomes increasing. Based on a marketing research, there have been described the training needs for business creation and development or for complete the actual competencies (base on existing abilities) of young people (with technical and economical background) to become successful entrepreneurs. The research consequences were focused on: (a) Adjustments of the university curricula; (b) Identification and description of those activities that can be carried out by universities in the field of knowledge transfer and that can be considered for entrepreneurship education, too (especially for the technical education); (c) The CE@ANPART virtual center design as an answer to the market demand and with the support of a university partnership for research.

Future researches will be developed for building the virtual center for competencies - expertise evaluation CE@ANPART and test all the functionalities with real clients – entrepreneurs. Also, comparative researches will identify the correlations and differences of knowledge management in engineering education institutions (under the UNIKM project).

5. Acknowledgement

The presented researches have been developed under the National Center of Programs Management (CNMP) financial support in the projects: “Partnership for excellence in research for the entrepreneurial skills and competitive human capital development in the knowledge and innovation base society” (contract no. 91069/2007) and “Comparative researches concerning knowledge management in Romanian engineering education - UNIKM” (contract no. 92074/2008).

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The Clickthrough and buyer behaviour model in the Web

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Abstract: As a result of permanent and unpredictable market changes, managers see their companies operating in an unpredictable and changing environment, which put them under uncontrollable variables. The Internet changed the traditional marketing communication model, and led to a radical change of making publicity and communication. In this context, this study aims at understanding the influence on buyer behaviour when he/she is exposed to publicity in the Internet. Thus, fourteen variables were identified from the bibliography research undertaken on this subject and a new one added: the clickthrough. This variable represents the decision power of the user to access (or not) information when he/she is stimulated by publicity in the Internet. In this way, this study establishes the variables that motivate and determine managers behaviour by measuring the degree of linear association amongst them. The result was the development of an Internet buyer behaviour model of B2B.

Keywords: Web Marketing B2B, e-Marketing, e-advertisement, Marketing Business to Business, Digital Marketing.

1. Purpose

As a result of the constant alterations on the market, managers find their companies involved in an unpredictable and inconstant environment, subject to uncontrollable variables, where it becomes difficult to take decisions with minimum risk (estimated). For some years now, a revolution in information systems has increasingly gained shape, profoundly altering the traditional communication model, leading to a change in the way advertising and communication is made through the media. The underlying reason of this revolution is the Internet, in other words, the mass intercommunication (global) between computers which, as a new means of marketing, has the potential to radically change the way companies carry out business with their customers (Yuill, Verónica, 2000). However, in spite of the vast investments made by marketing managers, little is still known on this new means of interactive communication. Consequently, there is a need for research which can be made, namely on the efficiency and effectiveness of advertising in interactive environments, particularly, when compared with the traditional means of communication (Hoffman, Donna. L., Thomas. P. Novak e Yiu-Fay Yung, 1999, Yiu-Fay Yung, 1998). Hence, this work seeks to lead to an understanding of the implications on the behaviour of the buyer. For the effect, a model was constructed (of online buyer behaviour) which, formally, allows for a better understanding of this new means of communication, so as to enhance the effectiveness of advertising when undertaking commercial activities (trading) on Hypermedia Computer-Mediated Environments (CMEs). These are the important issues which marketing

managers and other researchers seek to understand and use to predict consumer reactions to advertising stimulus exposed on the Web sites, in view of the unpredictable and uncertain characteristics of the online environment (Forrest, Edward e Richard Mizerski, 1996). Therefore, the purpose of this research is to determine the way the buyer reacts to advertising pressure in interactive environments, business to business in Hypermedia CME. A conceptual structure will be developed (online B2B buyer behavioural model) which will formally allow researching which variables motivate and/or limit the behaviour of company managers, as well as measuring the degree of the linear relationship between these variables. The importance of Clickthrough resides in the fact that this variable represents a new information resource and provides detailed data on the behaviour of the buyers (final buyer or companies of the resource market) to the stimulus from the contents of the advertising Banners present in the Informercials. In this way, the data obtained from a simple “click” permits researching the way potential buyers react to advertising over time and at the level of each person (unit of analysis). The objective of this study is, therefore, the construction of a structural model of the Behaviour of the Buyer in Hypermedia CME (network navigation on the Web) introducing the Clickthrough conceptual structure into this model; including the evaluation and testing of the propositions resulting from the research made on this model, for the purpose of enhancing the effectiveness of e-marketing.

2. Methodology

This chapter presents a description of the collection of data (Hill, Manuela e Andrew Hill, 2000), which were obtained through a questionnaire distributed to the media and large companies, representing above than 95% of the universe, of the most representative of Portuguese industry, involving the mechanical engineering, electronics, wood, footwear, textile and related product sectors. An analysis was carried out of the main components through the Statistical Model of Analysis of the Main Components of the Category Variables (Meulman, Jacqueline J. e Willem J. Heiser, 1999 e Pestana, Maria Helena e João Nunes Gageiro, 1999). Subsequently, through the Factorial Analysis model, it is observed whether the existing underlying patterns permit the reorganisation of the data in order to reduce them into fewer sets of factor data, with these factors respecting the inter-relationships observed in the original data. Using the Multiple Linear Regression Model (MLRM), the behaviour of the quantitative variables is predicted from the relevant variables constituting the buyer behaviour model, with information presented on the margin of error on these predictions. The analysis is then carried out through the MLRM on the fifteen variables of the proposed model, rotating them as either dependent variables or independent variables and estimating the respective liner inter-relationships between them. Finally, this section constructs the model through the structural equations (analysis of the structure of the covariance).

Table 1 – Total Distribution of the Samples

Activity sectors	Questionnaires sent	Questionnaires received	Questionnaires returned (no filled up)
Textile/Related products	588	46	12
Mechanical engineering	374	53	-
Footwear	236	17	9
Wood	142	18	-
Electronics	104	13	-
Other (sector not identified)	-	6	-
Total	1444	153	21

In order to produce a quantitative variable to make the Clickthrough concept operative, an analysis was made of the nine variables describing the Clickthrough phenomenon using the main component factor analysis model. The result consists in the extraction of the two main components with their own values (Eigenvalues) greater than one (4.361 for the first component and 1.110 for the second), and therefore, with significant explanatory and interpretative values. However, of these two components the one of interest for the analytical purposes of the pursuit of the study will only be the first component with the name Clickthrough. The percentage of the total variance in the correlation matrix (between the above analysed variables) explained by the first component, as presented in the table below, is 48.459%. For the second component, as a curiosity, the homologous percentage is 12.331%. The two components, cumulatively, account for 60.790% of the explained total variance, which, taking into account that an initial set of nine variables was transformed into another set of two variables, obtained strategically and supposedly equivalent to the first, this can be considered a criterion met satisfactorily. It should be noted that the values indicated above (percentage values of the explained variances) are practically the same under a situation of rotation of factors as under the non-rotation of factors. In this study the varimax method was used (maximisation of the variance) for the rotation of the factors. Hence, this procedure leaves both the actual values and the total accumulated explained variance unaltered. It should also be noted, in particular, that it can be concluded that this component is by far the most valuable, being clearly differentiated from the rest of the components.

Table 2 – Total Variance Explained

Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
4.361	48.459	48.459	4.360	48.440	48.440
1.110	12.331	60.790	1.112	12.350	60.790

Table 3– Results Rotated Component Matrix

	Component	
	1	2
Ad Banner first time		.237
More Passive Ad Banner	-.757	.331
Passive ad Banner strong Competition	.825	
More Active Ad Banner	.	.896
Active Ad Banner Strong competition	.379	-.218
Same Ad Banner in different visits	.846	
Present same Active Ad Banner	.851	
Future same Active ad Banner	.895	
Same act.ive Ad Banner different pages	.829	

Table 4 presents the “betas” and their respective significance. This table also presents the correlation coefficients for each of the regressions. It should be noted that the significance of the p-value of the regression model for the models under analysis is null.

The p-value represents the estimated probability of obtaining the results of the sample (or most favourable results) for the null hypothesis, if the sample has been collected randomly from a population where the null hypothesis is true. A low p-value means that it is unlikely that the sample has been collected from a population where the null hypothesis is true.

Through the analysis of the estimated coefficients and t tests, it can be observed that none present statistically significant values (test values <0.05), which means that the model may be written without containing these variables. However, we decided to introduce the constant in the model given that its influence on the dependent variable is insignificant, due to be one. A set of statistical indicators which evaluate the quality of the model was also obtained through AMOS 4.1., namely the χ^2 (*Chi-Square*), *RMSEA* (*Root Mean Square Error of Approximation*), *ECVI* (*Expected Cross Validation Index*) and *CFI* (*Comparative fit Index*).

The χ^2 (*Chi-Square*) relates to the statistical probability test traditionally used as a robust test of the covariance matrix of the non-restricted sample and restricted covariance matrix, in other words, interpreted literally, this statistical test indicates the probabilities that the hypothesis of the relationships summarised in the model actually occurred (Bollen 1989 b).

Table 4 – Analysis of the Multiple Linear Regression (Stepwise method)

Dependent Variable	Independent Variable	Beta1 and Significance	Beta2 and Significance	Beta3 and Significance	B4 e Sig	B4 e Sig	B5 e Sig	r ²	F
Clickthrough	Exploratory behaviour; Challenge; StartWeb	-0.221 (0.05)	-0.884 (0.020)	0.144 (0.049)	—	—	—	0.141	0.00
Arousal	Focus attention; Challenge; Control	0.172 (0.07)	0.156 (0.014)	0.103 (0.040)	—	—	—	0.112	0.01
Challenge	Palyfulness	-0.026 (0.024)	—	—	—	—	—	0.034	0.024
Control	Time distortion; Positive effect; Clickhthrough	0.00289 (0.00)	0.006709 (0.00)	0.003.6 (0.012)	--	---	--	0.301	0.00
Exploratory Behaviour	Envolvement; playfulness; Clickhthrough	-0.338 (0.00)	-0.205 (0.007)	-0.205 (0.018)	—	—	—	0.260	0.00
Flow	Time distortion; Envolvement	0.481 (0.00)	-0.191 (0.006)	—	—	—	—	0.303	0.00
Foccus Attention	Time distortion; Telepresence; Skills	0.0035 (0.00)	0.0036 (0.016)	0.0019 (0.021)	—	—	—	0.278	0.00
Interactivity	Exploratory behaviour; Focus attention; Telepresence	0.218 (0.00)	-0.472 (0.00)	-0.148 (0.001)	--	---	--	0.246	0.00
Playfulness	Exploratory behaviour; Challenge; Envolvement	-0.247 (0.003)	-0.449 (0.031)	-0.179 (0.34)	-	-	-	0.166	0.00
Involvement	Exp. Beha.; Skills; Pos. eff.; Staweb; playfulness, Clickthrough	-0.025 (0.001)	-0.025 (0.00)	0.142 (0.040)	-0.183 (0.09)	0.162 (0.022)	0.138 (0.027)	0.368	0.00
Positive Effect	Focus attention; Envolvement; Arousal; Time distortion	0.773 (0.00)	0.212 (0.00)	0.159 (0.017)	-0.128 (0.019)	—	—	0.315	0.00
Skills	Envolvement Clickthrough	0.370 (0.00)	0.210 (0.08)	—	—	—	—	0.143	0.00
Telepresence	Flow; Telepresence	0.122 (0.00)	0.0092 (0.001)	—	—	—	—	0.337	0.00
Time Distortion	Telepresença; Flow; Positive effect	0.387 (0.00)	0.262 (0.00)	-0.196 (0.002)	—	—	—	0.431	0.00
StartWeb	Skills, Envolvement; Clickthrough	-0.107 (0.001)	0.0093 (0.003)	0.0033 (0.051)	--	---	--	0.222	0.00

Statistical significance of the estimated Coefficients

H0: $\beta = 0$, the Hypothesis is rejectedH1: $\beta \neq 0$, the Hypothesis is not rejected

Table 5 – Statistical Indicators of the Structural Equations Model

	Model
CFI (Comparative Fit Index)	0.961
RMSEA (Root Means Square Error of Approximation)	0,028
90% confidence interval	(0,00, 0.058)
Chi-Square	72.7
d.f.	65
Sample size	153
Number of Observed variables	15
Number of latent variables	0
Number of restrictions	0
Number of estimated parameters	70
Minimisation of Interactions	12
ECVI (Expected Cross Validation Index)	1.202

3. Findings

The constant alterations on the market place companies in situations where it becomes difficult to take low risk decisions. Hence, with a view to responding to these new unpredictable and competitive scenarios, researchers have developed new concepts of organisational structures. One of the determinant factors of success for companies is precisely the capacity of adaptability and/or reconfiguration, which implies structures with greater flexibility and agility. Added to this fact, technological developments have enabled a revolution in the architecture of organisational structures resulting from the development of information systems, namely the *Web*.

The Challenge conceptual structure is solely dependent on the diversion behaviour of its users, in other words, the managers of companies perceive the use of the *Web* as a Challenge but for the sole motive of diversion. However, the perspective of the use of the *Web* by managers is actually the objective gaining of information for professional purposes. Therefore, self-challenging activities are interpreted as leisure or diversion activities. The greater the use of the *Web* the higher will be the level of Expertise.

According to the results of this study, there is a dependent linear relationship between Expertise, Involvement and *Clickthroughs*. Indeed, a high degree of Expertise is required for *Goal-Directed* activities. Navigation activities, where the experiences of the buyer/user have become familiar with the *Web*, will be followed by an increase of Expertise leading to the Challenge presented by the environment. In other words, learning occurs when buyers begin to seek greater challenges. As a result, an instrumentalised orientation will probably dominate the interactions of the buyer on the *Web* at a later date, although both orientations may be present at different times depending on the characteristics of the buyer, namely his/her Exploratory Behaviour. Exploratory Behaviour conceptual construction is linearly related to the Involvement, Diversion and Clickthrough conceptual structures. Exploratory Behaviour is a conceptual structure strongly dependent on the *Flow* conceptual structure. Hence, the *Flow* is strongly related to perceptions on flexibility, the capacity to alter and experiment.

Therefore, for Exploratory Behaviour to occur it is necessary that the *Flow* take place first. The results of this study support the need for a flexible *Web* environment which encourages Exploratory Behaviour by managers.

High diversion levels on the computer are linearly dependent on high levels of experimentation. Involvement conceptual construction has been observed to be strongly related to the conceptual structures of Exploratory Behaviour, Expertise and Positive Effect, *StartWeb* and *Clickthrough*.

The Involvement conceptual structure is related to different research motives (*Goal-Directed* or *Experiential Flow*), and, may determine the Involvement leading to an increase of Clicks. This variable is associated to the Flow conceptual construction and is related to objective search activities or situational involvement with the product, namely, completing tasks, purchase intentions.

It has also been observed that managers show minor Involvement and are only driven by objectives related to the conclusion of tasks. Diversion conceptual structure is linearly related to Exploratory Behaviour, Challenge and Involvement. And, the greater the Exploratory Behaviour the greater the Involvement will be and, consequently, also the greater the number of *Clickthroughs*.

It has also been observed that there is a linear relationship between Focused Attention and the Time Distortion, Awareness and Expertise conceptual structures. On the other hand, the presence of Focused Attention is necessary for Incitement and *Clickthrough* to take place.

Interactivity conceptual structure is associated to the Exploratory Behaviour, Focused Attention and Awareness conceptual structures. As noted above, this conceptual structure is strongly linked to the characteristics of the site. It has been observed in the present buyer behaviour model that the Awareness conceptual structure is associated with the Time Distortion and Flow conceptual structures. Hence, high levels of Awareness promote Clicks. Furthermore, the greater the Awareness, the greater the Focused Attention and Interactivity will be.

On the other hand, it has been observed in the present buyer behaviour model that the Time Distortion conceptual structure is linearly dependent on Awareness, *Flow* and Positive Effect. It has also been observed that the Time Distortion conceptual construction directly influences the Control, *Flow*, Focused Attention, Positive Effect and Awareness conceptual structures. Finally, it has been observed in the present study that the *StartWeb* conceptual structure is linearly dependent on the Expertise, Involvement and *Clickthrough* conceptual constructions.

As user time progresses, Expertise becomes increasingly greater, thus increasing Involvement and *Clickthrough*. All these linear relationships explain the model of *business to business* buyer behaviour in *Hypermedia CME* for Portuguese companies of the sectors referred to above and which result from this study.

In accordance with the results obtained in this study, it is important to summarise some of the conclusions which are absolutely essential to enhancing the strategic effectiveness of Marketing on the *Web*: Managers neither perceive the *Web* as a form of Challenge to their capacities, nor as a form of Diversion, because their navigation on the network is carried out for the purpose of the search and obtaining of information specifically linked to their professional activity. In fact, when navigation on the network is carried out for reasons of experimentation and/or diversion, the navigation becomes inconstant and haphazard, with all the time available for "surfing". However, this study shows that this is not necessarily the type of use of the *Web* made by managers. Therefore, given that the type of use of the *Web* by managers is objectively determined by the reasons noted above, it is essential to enhance the flexibility and agility of the *Web*, so as to make its use more simple, easy and practical.

Since only in this way will it be possible to ensure that learning to use the *Web* will be faster, thus increasing Expertise, Exploratory Behaviour, Control and Diversion and, consequently, Involvement and *Clickthrough*. Since navigation on the *Web* by managers is of an objective

character (*Goal-Directed*), it is important to ensure that at any given moment when managers need information, it will be possible to obtain it using the least time possible for the effect.

The *Web* should be made more Interactive through the improved architecture and design of the sites, more attractive pages, faster and more appealing downloads and, finally, through more user friendly language. In this way, increasing interactivity also increases the Involvement and *Clickthroughs*. Increasing exposure to *Ad Banners* inevitably leads to a decrease of *Clickthroughs*. As a consequence, according to this study, advertising strategies on the *Web* should be designed taking into account that managers do not want to see the same *Ad Banner* many times during the same visit, apart from which the sites should figure in *Advertiser's Web sites* and/or *Publisher's Web sites* which are specific (or related) to certain areas of interest, since in this way the manager will not be unnecessarily exposed to the *Ad Banners*. - However, it is important to ensure that at any given moment when the manager needs the information, it should be possible to find it quickly. Another conclusion which can be drawn from the results is the fact that managers feel more receptive at an initial stage to *Active Ad Banners* due to their dynamic character. Marketing managers should also develop dynamic management actions, aimed at maintaining user attention at high levels, namely: constantly altering the advertising exposed on the *Ad Banners*; reaching specific target market segments by ensuring that the messages and language presented on the *Ad Banners* are more appropriate to these targets; and, lastly, visible promotions on the *Ad Banners*, which should be changed over short spaces of time.

Table 6 – on the rejection and non-rejection of the hypotheses

Hyp.	Original Hypotheses of the Model	R. C. Matrix	Observations
Hyp.1	When I see a Passive Ad Banner for the first time I feel like Clicking.	----	rejected
Hyp.2	The greater the number of times an advertising Passive Ad Banner appears during the same visit, the more I feel like Clicking.	-.757	Not rejected
Hyp.3	The greater the number of times an Active Banner appears, the more I feel like Clicking on the following visits.	0.825	Not rejected
Hyp.3	The greater the exposure to advertising Passive Banners resulting from the strong competition between the different advertising agents the less I feel like Clicking	--	rejected
Hyp.5	The greater the number of exposures to the advertising Active Banners resulting from the strong competition between the different advertising agents the less I feel like Clicking.	0.379	Not rejected
Hyp.6	The greater the number of exposures to the advertising Active Banners resulting from different visits the more I feel like Clicking.	0.846	Not rejected
Hyp.7	The greater the number of exposures to the advertising Active Banners resulting from the current visit the more I feel like Clicking.	0.851	Not rejected
Hyp.8	The longer I am on the Web and the more I am exposed to advertising Active Banners the more I feel like Clicking.	0.895	Not rejected
Hyp.9	The greater the number of pages I visit on the Web and the more I am exposed to advertising Active Banners the more I feel like Clicking.	0.829	Not rejected

4. Originality/value

In accordance with the results obtained in this study, it is important to summarise some of the conclusions which are absolutely essential to enhancing the strategic effectiveness of Marketing on the *Web*:

- Managers neither perceive the *Web* as a form of Challenge to their capacities, nor as a form of Diversion, because their navigation on the network is carried out for the purpose of the search and obtaining of information specifically linked to their professional activity. In fact, when navigation on the network is carried out for reasons of experimentation and/or diversion, the navigation becomes inconstant and haphazard, with all the time available for “surfing”. However, this study shows that this is not necessarily the type of use of the *Web* made by managers. Therefore, given that the type of use of the *Web* by managers is objectively determined by the reasons noted above, it is essential to enhance the flexibility and agility of the *Web*, so as to make its use more simple, easy and practical. Because, only in this way will it be possible to ensure that learning to use the *Web* will be faster, thus increasing Expertise, Exploratory Behaviour, Control and Diversion and, consequently, Involvement and *Clickthrough*.
- Since navigation on the *Web* by managers is of an objective character (*Goal-Directed*), it is important to ensure that at any given moment when managers need information, it will be possible to obtain it using the least time possible for the effect.
- The *Web* should be made more Interactive through the improved architecture and design of the sites, more attractive pages, faster and more appealing downloads and, finally, through more user friendly language. In this way, increasing interactivity also increases the Involvement and *Clickthroughs*.
- Increasing exposure to *Ad Banners* inevitably leads to a decrease of *Clickthroughs*. As a consequence, according to this study, advertising strategies on the *Web* should be designed taking into account that managers do not want to see the same *Ad Banner* many times during the same visit, apart from which the *sites* should figure in *Advertiser's Web sites* and/or *Publisher's Web sites* which are specific (or related) to certain areas of interest, since in this way the manager will not be unnecessarily exposed to the *Ad Banners*.
- However, it is important to ensure that at any given moment when the manager needs the information, it should be possible to find it quickly. Another conclusion which can be drawn from the results is the fact that managers feel more receptive at an initial stage to *Active Ad Banners* due to their dynamic character.
- Marketing managers should also develop dynamic management actions, aimed at maintaining user attention at high levels, namely: constantly altering the advertising exposed on the *Ad Banners*; reaching specific target market segments by ensuring that the messages and language presented on the *Ad Banners* are more appropriate to these targets; and, lastly, visible promotions on the *Ad Banners*, which should be changed over short spaces of time.

5. Research limitations/implications

This dissertation naturally presents some limitations with respect to the extrapolation of the empirical results. However, these limitations present alternative fields for research, namely: enlargement of the study to small companies; coverage of other activity sectors and other geographical areas; testing of the model on virtual companies; comparison of the model in terms

of the segmentation of activity sectors (e.g. Services versus Industry, Footwear versus Textiles, etc.), carrying out this comparison in a rotational manner between the other sectors; introduction, in the model, of new conceptual structures considered determinant for comparisons of the evolution of the model in different periods of time, observing their evolution.

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Business Process Modelling

Deriving goals for a Software Process Modelling Language to support controlled flexibility

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Abstract: Software processes are dynamic entities that are often changed and evolved by skilful knowledge workers such as software development team members. Consequently, flexibility is one of the most important features within software processes and related tools. However, in the everyday practice, team members do not wish for total flexibility. They rather prefer to learn about and follow controlled flexibility advices, i.e., previously defined information on which, where and how they can change/adapt software process models and instances to match real-world situations. In this paper we define a set of high level goals to develop a Process Modelling Language (PML) to support the modelling of controlled flexibility in software process models. Goals are useful to delimit the domain of the language. Their definitions will also be useful as input to further phases of the language development process.

Keywords: goals, process modelling language, controlled flexibility, software development process

1. Introduction

Software process modelling involves eliciting and capturing informal software process descriptions, and converting them into a software process model. A model is expressed by using a suitable Process Modelling Language (PML), and is best developed in conjunction with the people who are participants in, or are affected by, the software process. Most common PML concepts include activities, work products, roles, control flow elements (*e.g.*, sequencing, fork, join, decision and merge nodes) and object flow elements (*e.g.*, inputs and outputs to activities). These process elements are generally expressed in the PML's metamodel, wherein a process engineer can specify the vocabulary, concepts and possible elements that can be used for process modelling.

The modelling, enactment, monitoring and management of software processes can be supported by a type of Process-Aware Information Systems (PAIS) called Process-centred Software Engineering Environments (PSEE). The need for this specialisation is mainly due to the changeability nature of software and associated process models. As opposed to many manufacturing and operational serial production-based stable ones, software process models are

commonly held as dynamic entities that must evolve in order to cope with changes occurred in: the enacting process (due to changing requirements or unforeseen circumstances); the software development organization; the market; and in the methodologies used to produce software (Cugola, 1998; Fuggetta, 2000; Heller et al., 2003; Cass & Osterweil, 2005).

In fact, experiences conducted regarding software development organisations (see, e.g., (Grinter, 1997)) revealed that allowing flexibility in the software process (e.g., in the allocation of people to tasks), or even using flexible coordination software tools, contributed to process improvement and, consequently, to software product quality. However, software organisations often strive for finding an in-between solution to total process rigidity *versus* total flexibility. They know the changeability essence of software, and often promote flexibility in software development processes through the use of agile methods such as eXtreme Programming (XP) (Beck, 1999) and Scrum (Schwaber & Beedle, 2001). Nevertheless, they often need to impose constraints to the software development process and derived software projects, due essentially to resource limitations, time to market pressures and changes in the operational environment.

More recent research advocate that, in the everyday business practice, most people do not want to have much flexibility, but would like to follow very simple rules to complete their tasks, making as little decisions as possible (Bider, 2005). In fact, latest case studies on flexibility in software processes (see, e.g., (Cass & Osterweil, 2005)) make evidence on the need of having (senior) process participants expressing and controlling the amount of changes that other process participants are allowed to make in the software process. All these aspects constitute a reasonable basis for controlling flexibility in software processes. This *controlled flexibility* can be defined as *the ability to express which, where and how certain parts of a software process can be changed, while keeping other parts stable* (Soffer, 2005).

In this paper we present a set of high level goals for a PML to support the modelling of controlled flexibility in software processes. This requires an in-depth understanding of software development social organisations, their work, and the ways cooperation and learning are enforced. Therefore, each derived goal is supported by a set of needs and assumptions identified by important works from empirical software and knowledge engineering research areas. We also adopt an iterative engineering process to construct the language, in which goal definition constitutes the main start-up activity. The resulting PML implementation will provide process engineers and software development teams members with the ability to design and learn about software processes with controlled flexibility information. Considering a two-step modelling approach (see (Martinho et al., 2008)), process engineers will be able to define, in a first step, which, where and how the elements of a software process model can be latter changed by the software development team members (second modelling step).

This paper is organised as follows: section 2 presents an overall engineering process for developing the controlled flexibility-aware PML. Section 3 contains the paper's main contribution: the goals for the language, as well as thorough reviews and justifications for the viewpoints expressed by each goal. Section 4 presents most prominent related work and section 5 concludes the paper and presents future work.

2. Engineering Process

Goals are a familiar concept in the area of requirements engineering. They are well-suited to be applied in combination with scenarios or viewpoints in order to elicit and define requirements, and to drive a requirements engineering process.

Figure 1 illustrates a high-level Unified Modelling Language (UML) activity diagram of the engineering process proposed for the design of the flexibility-aware PML. This process is iterative

and it is definitely influenced by most prominent research works on goal-oriented requirements engineering, such as the ones by Alspaugh & Antón, (2008) and van Lamsweerde, (2008).

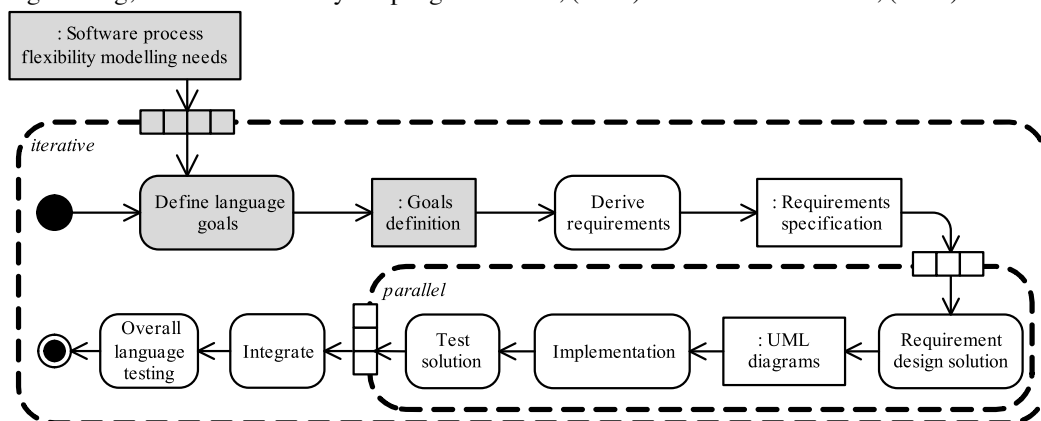


Figure 1 – Focus of this paper within the process of defining the controlled flexibility-aware PML.

The grey-shaded process elements of Figure 1 delimit the scope of this paper. When developing a language, the first task is to define its goals. Goals justify language development, and points out its intended scope. Additionally, goals specify the domain of the language. Goal definitions are useful as input to language functional and non-functional requirements. For more complex problems, the main goal is divided into subgoals. More specific requirements are then associated to these subgoals.

After specifying requirements, we turn to a solution-oriented model. This is achieved by using UML diagrams that capture requirements' entities and relationships, and can be used as input to the following implementation and testing phases. For each requirement implementation, unit and acceptance testing is carried out until a satisfactory solution is agreed. Overall acceptance testing is performed after integrating all requirement implementations into a complete flexibility-aware PML and supporting PSEE.

3. Language goals

The general goal that determines the high level scope associated to this work is defined as follows:

G. Provide process engineers and software development team members a way to express and learn about which, where and how software processes can be changed, i.e., a way to express and learn controlled flexibility within software processes.

This goal rests on well supported assumptions, namely: 1) software processes are dynamic entities that often evolve to cope with changes in real world situations (Cugola, 1998; Fuggetta, 2000; Heller et al., 2003; Cass & Osterweil, 2005); 2) for this kind of dynamic and changeable processes, it should be possible to quickly implement new ones, to enable on-the-fly adaptations of those already running, to defer decisions regarding the exact process logic to runtime, and to evolve implemented processes over time (van der Aalst & Jablonski, 2000; Adams et al., 2005; Schonenberg et al., 2008; Reichert et al., 2009).

However, in the everyday business practice, process participants do not wish for totally flexible processes, i.e., processes where every composing element is 100% changeable from start, without any restrictions or guidance to the amount or type of changes allowed. Instead,

participants would like to follow very simple rules to complete their tasks, making as little decisions as possible, even when changing parts of a process to reflect real-world situations (Bider, 2005; Borch & Stefansen, 2006). In the software process context, case studies on flexibility and related languages and tools evidence the need of having means to express and control the amount of changes that process participants are allowed to make in process definitions (Cass & Osterweil, 2005; Regev et al., 2007; Reichert et al., 2009).

The next goals assume software process models and PMLs as the preferred choices for supporting our main goal:

G1. *Focus on software process models as a medium for learning, knowledge transferring and enactment on controlled flexibility;*

G2. *Define a process modelling language to support controlled flexibility in software development processes;*

G3. *Provide a method supporting the language specified by G2.*

The first two goals follow long time recognised assumptions about software process models and the activity of process modelling, starting with the one that states “*to model is to understand*” (McGowan & Bohner, 1993). Indeed, process models facilitate human understanding, support process management and change, and provide foundations for process guidance and execution automation (Curtis et al., 1992; Fuggetta, 2000; Sommerville, 2006). Process models are built using PMLs, which can enhance several process perspectives, such as the functional, behavioural, organisational and the informational ones (Curtis et al., 1992). We advocate that controlled flexibility can easily become one of these process perspectives, and take similar advantages of its representation within software process models. Goal **G3** emphasises the need for language method support. This refers essentially to guidance on technical issues of the language, modelling construct examples and adequacy to the use of the language in real-world situations. A language without a supporting method is like a program without documentation, i.e. barely useful.

We unroll goal **G1** into the next subgoals to specify how process models should enable learning and enactment of controlled flexibility:

G1.1 *Use a modelling approach that enhances the reflection of changes occurred in real-world situations into process model and instance definitions;*

G1.2 *Provide interactive and distributed models to enable controlled flexibility modelling and enactment by end-users.*

These two subgoals reflect some specific characteristics of software, software processes and software developers. Lehman & Ramil (2002) observed that software is, in its essence, constantly subjected to pressures of change, with similar impacts on the associated processes and models. This justifies the use of modelling approaches that promote evolving, incomplete and semi-formal models that are needed to control and reflect the changes made in real-world situations. This opposes to rigid and pure formal approaches that do not allow for process deviation, inconsistency tolerance, exception handling and late modelling aspects that often occur when developing software (Fuggetta, 2000).

Also, the unusually strong modelling skills of software developers are related to the nature of software development (Cass & Osterweil, 2005). Here, models are frequently used, often several models for each piece of software, as also programming languages, which have similarities to the languages used to develop software process models (Osterweil, 1987). Additionally, those who perform the work should be involved in modelling it. In our context, we consider process engineers as being responsible for modelling which, where and how other software team members can or cannot create, change/evolve or delete software process elements in models and associated instances. This means that a process engineer can, for example, delegate to more skilful team members the modelling of an underspecified part of a process model.

The use of interactive and distributed models plays a main role in quickly updating process models upon changes. They also provide software team members not only enhanced (concurrent)

modelling capabilities but also immediate knowledge transference about changes occurred (Turetken & Demirors, 2008). In the context of controlled flexibility, this means that these models enable process engineers to reflect alterations to the way they want to control changes in process models and instances. Then, the models will also reflect effective changes made by software team members.

The following subgoals unroll goal **G2** on choices made to develop a controlled flexibility-aware PML:

G2.1 *Extend an existing core PML with controlled flexibility-related language constructs;*

G2.2 *Support customisation on the way controlled flexibility is defined, both in modelling and defining the language concepts and derived constructs.*

The focus assumed on this work is to provide means for modelling controlled flexibility in software processes. This implies one of two language design choices: 1) to develop a whole new PML or; 2) adopt an existing and sufficiently prominent one and, upon availability, extend it with the controlled flexibility-aware semantics. We dropped the first choice for considering it way too ambitious and rather unnecessary. For the time we started worrying about the language design on controlled flexibility, we had to have the whole basis of a PML implementation plus tool support for experimentation. This would require effort and resources beyond the purpose of this work. Moreover, much like other non-functional aspects of software process models (such as usability), the modelling of controlled flexibility only makes sense if applied to existing process modelling elements (such as activities). Therefore, controlled flexibility can be assumed as an additional aspect of a core PML which process engineers and software team members use on a daily basis to create and customise software process models.

Goal **G2.2** refers the support for user customisation on the way controlled flexibility is achieved, both in defining and applying the language concepts and related constructs. In spite of many efforts (Heinl et al., 1999; Regev et al., 2006; Weber et al., 2008; Schonenberg et al., 2008), there is not a sufficiently widely adopted taxonomy on process flexibility. Therefore, the PML architecture should provide easy incorporation of new concepts, or changing existing ones, in order to enable software organisations in defining their own perspectives on controlled flexibility.

On the modelling side, process engineers should be able to apply the language constructs interchangeably to fulfil specific controlled flexibility needs on a process model. Other software development team members should then be able to enjoy some controlled freedom in changing/adapting those models to be used as work plan guidance for a specific software project. This certainly puts software organisations on the right track to increase process fidelity, i.e., to reduce the gap between software process models and the reality of their instances (software projects).

Goal **G3** refers to a method for supporting the flexibility-aware PML. This method can be decomposed into the following subgoals:

G3.1 *Provide guidance for the controlled flexibility technical aspects of the language, and guidelines for constructing a process model with controlled flexibility;*

G3.2 *Provide user adaptability.*

These goals are fairly standard for method support. The first **G3.1** goal emphasizes the need for both technical and process guidance. The second goal expresses our view that different users have different needs, and the meaning of a model element should not always be fixed. It should be able to evolve as the negotiation of meaning unfolds. Participants should be invited to reflect upon their language and their process of negotiating meaning (Wenger, 1998).

The overall structure of these goals is illustrated in Figure 2. This hierarchy constitutes the input to the *Derive requirements* activity in the adopted engineering process, and all resulting requirements must relate to some goal(s).

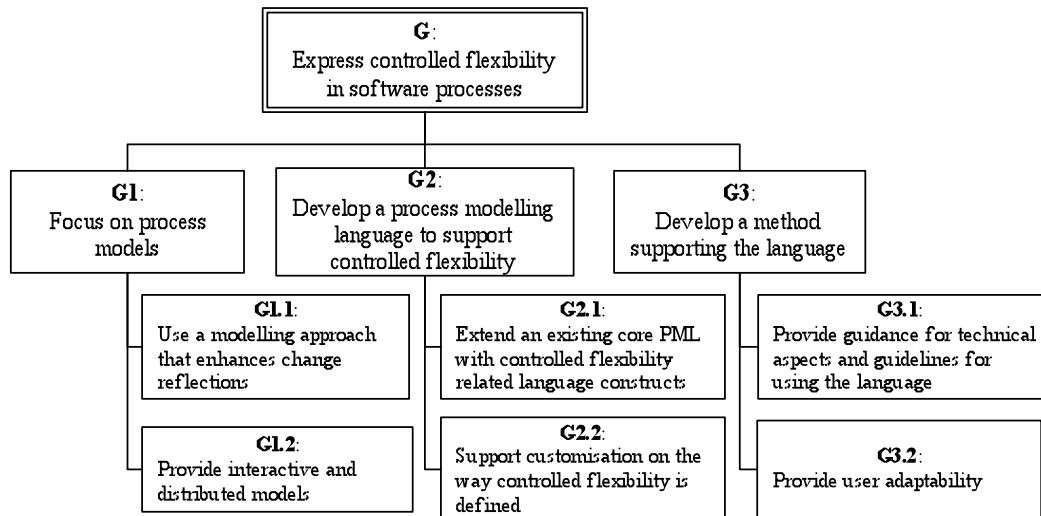


Figure 2 – Goal hierarchy for the development of the controlled flexibility-aware PML

4. Related Work

There is a plethora of PMLs that can be generally used for business process modelling, and which implement several modelling approaches. These include formal, rigid, descriptive/imperative and enacting workflow definition languages to more informal, declarative and evolving ones. As related work, we briefly focus here on flexibility features of SLANG, Little JIL, ADEPT2 and UML-based languages, chosen according to the degree of achievement and presence in literature.

SLANG is the software process modelling language used in the SPADE PSEE (Bandinelli et al., 1994). The language is reflexive, and supports changes to activity definitions during execution. Different change strategies are supported (e.g. lazy and eager), and as the meta-process is modelled, new strategies can be developed. The information hiding provided by activities makes it possible to isolate changes. However, software developers cannot express how and why processes should change, i.e., controlled flexibility is not supported.

In (Cass & Osterweil, 2005), the authors advocate that, in spite of software design requiring a lot of creativity and insight, some process rigidity seems necessary when tailored to help and guide the novice with a particular design pattern or architectural style. They propose the use of a PML called Little JIL (Cass et al., 2000). It is a visual PML based on the notion of step. A process model in Little JIL can be viewed as a tree of steps whose leaves represent the smallest specified units of work and whose structure represents the way in which this work will be coordinated. Although it supports process changes through exception handling, we could not find ways to incorporate information about which, where and how changes can be made.

The ADEPT2 (Reichert et al., 2009) flexible PAIS is able to adapt process instances to (concurrent) changes occurred in real-world processes, on a quest to support most of the workflow patterns, including the exception ones. It focuses mainly on process enactment support, as well as the establishment of balanced criteria on what to do when correctness, compliance and consistency constraint violations happen upon changes made to a process instance. Interaction (via PML or not) with end-users is done upon development of ADEPT2 client software that fits a certain domain of application (non software development-specific also, such as healthcare or

construction engineering). Although change enactment support is a great force of this work, we also could not find specific flexibility PML constructs to be used by process participants in order to control the way changes can or cannot be made.

Finally, UML (OMG, 2005) has been used also as a PML specifically for software process modelling. The Software & Systems Process Modelling Metamodel (SPEM) (OMG, 2007) initiative proves this, as it constitutes a UML profile for a PML to model agile and flexibility-aware software processes, such as OpenUP (Eclipse Foundation, 2008), XP (Beck, 1999) and Scrum (Schwaber & Beedle, 2001). UML has thirteen types of diagrams that can provide modelling support for the main process perspectives. Although there is no specific support for modelling controlled flexibility, UML specifies extension mechanisms (such as stereotypes) that can be used to extend the core language.

5. Conclusions and future work

In this paper we derived a set of goals for a PML to support the modelling of controlled flexibility within software processes. Main ideas expressed by these goals include the use of process models as a medium for learning and knowledge transferring about controlled flexibility, and also the need for developing a PML and method to back up the modelling of this kind of flexibility in software processes. Each goal and related subgoals are justified by thorough analyses on most prominent works from empirical software and knowledge engineering research areas.

Goal definition is part of an overall engineering process that we adopted to develop the flexibility-aware PML. It includes subsequent language requirements specification, implementation and testing activities. In this context, we are developing a proof-of-concept prototype which we call WebFlexEPFC (see Figure 3). It is based on already fully specified requirements derived from the goals presented in this paper (see (Martinho et al., 2008) for further details).

WebFlexEPFC is a web process editor that uses UML as the extended core PML for modelling software processes with controlled flexibility. Software developers already use UML as a standard *de facto* language for designing software. Thus, using it as a PML reduces the learning curve on its language constructs and enhances end-user participation in changing/adapting software process models. Moreover, UML is defined under an object-oriented metamodel which foresees extension mechanisms such as stereotypes. We developed a set of these and formed a UML profile (Martinho et al., 2007), using activity diagrams as the main type of diagrams where controlled flexibility can be modelled, consulted and enforced within a software process model.

Figure 3 illustrates the workflow perspective of a customised OpenUP *Elaboration* phase process model. It contains four controlled flexibility stereotype applications on the *Use Case Model* work product, the *Analyse a use case* task, the horizontal *Join node* and the *Test Solution* activity. These profile applications are shown as textual representations of the stereotypes' names between «guillemets» and corresponding tagged values in notes, placed above and nearby the graphical representation of the process elements. These stereotypes and associated values state which, where and how software team members can change the process model.

For example, the *Analyse a use case* task has two stereotype applications: 1) «SwiftinessP» (tag *strategy* with the value *immediate*) and; 2) «TBAdvice» (tag *text* with the value *recommended*). This means that the process engineer wants to inform software team members that, if changes occur in that task modelling element, it is *recommended* that they *immediately* propagate to all related instances of that task. This can be achieved by a PSEE that supports this kind of propagation mechanism, when managing instances of that particular task model definition.

When enforcing these controlled changes, team members are provided with proper guidance on the flexibility properties of the process element they want to change, as exemplified with the horizontal *Join node* editing action in Figure 3's prototype.

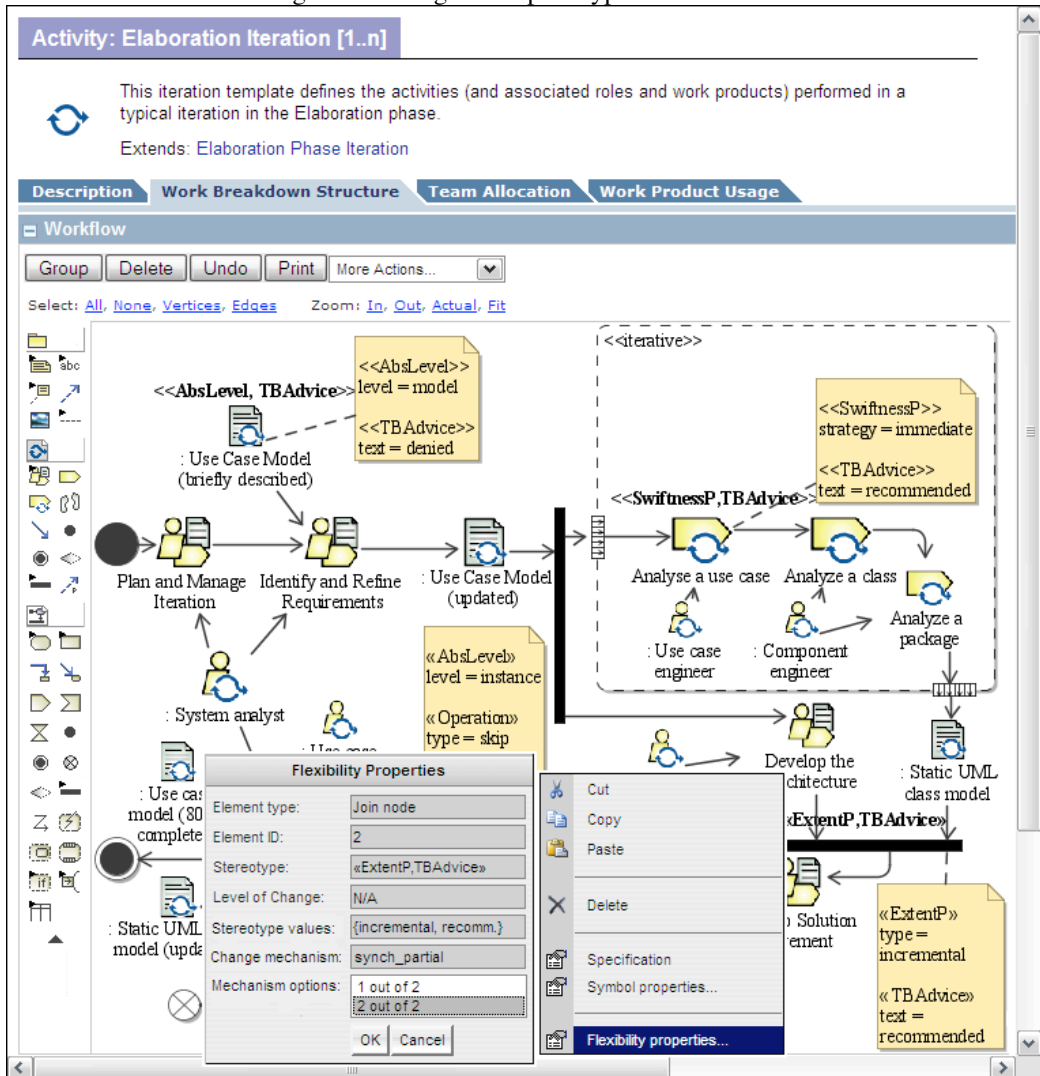


Figure 3 – WebFlexEPFC prototype for modelling controlled flexibility in software processes

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Ontology construction: representing Dietz “Process” and “State” models using BPMN diagrams

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Abstract: Capturing knowledge has always been an objective although known to be costly and time consuming. ontologies, being “an explicit specification of a conceptualization”, have tried to capture knowledge within the aspects of concepts (used to represent a domain entity), relations (representing a interaction between the domain concepts), functions (a special case of relations), axioms (which represent true statements) and instances (used to represent domain elements). The enterprise ontology, which represents the work on ontologies applied to the enterprise, as proposed initially by Gruber, can be seen as a collection of terms and definitions relevant to business enterprises that can be used as a basis for decision making. A new concept of enterprise ontology proposed by Dietz is defined as the realization and implementation essence of an enterprise proposing a distinction world ontology and system ontology. The sequence of actions, according to Dietz can be classified as datalogical, infological and ontological and all become under a Transaction Pattern which consists of four basic states: request, promise, state and accept. Further more the author defines four models that can be used to verify the consistency of the actions: Process, Action, State and Construction models. The traditional way to model processes, like the BPMN, draw events, activities and data in a sequence of symbols that may not represent completely all the actions in presence and, above all, does not detect and identify consistency between actors and actions. However, BPMN diagrams can also be used to represent various actions and models proposed by Dietz as the transaction, process and state diagrams. Both ways of representing have advantages and disadvantages and can be used, either isolated or together to give a deep representation of reality.

Keywords: Ontology; DEMO; BPMN; Center for Organizational and Design Engineering; Organizational Design & Engineering; Enterprise Architecture.

1. Introduction

Ontologies have been used to capture knowledge and representing domains of interest. Since the first works, around 1990, ontologies have evolved significantly and they are used, in the present time, within a broader scope.

As the first ontologies consisted of practical examples defining syntax and semantics about a domain, today they have many formal definitions, each having advantages and disadvantages, and can define concepts, relations, functions, axioms or instances of the domain elements.

The Enterprise Ontology is a collection of terms and definitions relevant to business enterprises modeling and provides a formal way to define a particular domain: the enterprise trying to scope together some of the key organizational elements like goals, work processes, authority, positions and communication. More recently, some authors proposed a framework for modeling organizations.

Thus, the Enterprise Ontology presents several sections: Meta Ontology and Time, Activity, Plan, Capability, and Resource, Organization, Strategy and Marketing and associated concepts and relations between them. The TOVE model considers an organization to be a set of constraints on the activities performed by agents and has the objectives to produce and develop the organizational object taxonomy.

Although ontologies serve several purposes they do not identify lack of coherence between actions of a domain. Dietz Enterprise Ontology, objectively proposes a methodology and a set of models to represent and analyze consistency of actions in a given process, while identifying three types of human abilities: “performa” (performer acts), “informa” (expressing acts) and “forma” (datalogical acts).

Dietz transaction pattern defines four states: request, promise, state and accept. The existence of the four states should be considered as a universal need for every transaction. Further more, to detail exhaustively the several actions a set of four models, with their exclusive way of representation, Process, Action, State and Construction are defined by the author, who then demonstrates using the Volley example.

Although it seems that the transaction pattern is a convenient and universal method to state identifying the four models could be represented in an existing language, like the BPMN.

Using the Portuguese Air Force Mission Request process, more complex than the Volley, the authors intend to assert that Dietz’s transaction pattern also applies and demonstrate that two models, Process and State, can be represented using BPMN.

Speaking of the enterprise ontology implies revisiting the concept of ontologies, in chapter two, and the particular case of the enterprise ontology (chapter three). Chapter four introduces Dietz enterprise ontology and presents the concepts behind: the transaction pattern and the Process, Action, State and Construction models applied to the Volley case study. Chapter five discusses the mission request process and the application of the transaction pattern in its analysis and its Process and State representation using BPMN. Chapter six concludes.

2. Ontologies

Capturing knowledge has always been an objective although known to be costly and time consuming (Neches et al 1991). Additionally successfully acquiring and representing the knowledge for a particular domain does not mean that the knowledge can be reused in a new system (Swartout et al 1994).

The work on the ontologies field goes back to the beginning of 1990. From those early years, ontology-building methodologies have evolved, and several have been proposed in order to achieve the current state of the art in ontology design (Baptista et al 2004).

The first ontologies consisted in practical examples, built from scratch and made available in order to demonstrate the usefulness of such technology. By that time no methodologies or guidelines were available to lead or ease the building process. After some experience on the field, Gruber (1993), introduced some principles for the design of ontologies. Gruber’s work was the first to describe the role of ontologies in supporting knowledge sharing activities, and presented a set of guidelines for the development of ontologies. The ontology-building process became clearer, with the continuous development of several other ontologies. As a consequence, the first

methodologies for building ontologies appeared in 1995, leading to the emergence of the ontological engineering field (Baptista et al, 2004).

2.1. What is an Ontology

The term “Ontology”, dated circa 1721 (Merriam-Webster 2008), in its abstract philosophical notion can be defined as “a branch of metaphysics concerned with the nature and relations of being” (Merriam-Webster, 2008), “a particular theory about the nature of being or the kinds of things that have existence” (Merriam-Webster, 2008). As early as 1900, the notion of a formal ontology has been distinguished from formal logic by the philosopher Husserl (Smith 1998).

The formal term “Ontology” is used to refer to the shared understanding of some domain of interest which may be used as a unifying framework to identifying important underlying concepts, define them, assign terms to them and note their important relationships, improving shared understanding, communication (among organizations, people and software systems), systems specification, requirements identification, inter-operability and the potential for reuse and sharing [Usschold & Gruninger 1996]. Formal definitions include:

- “An Ontology is an explicit specification of a conceptualization.” (Gruber 1995);
- “An Ontology is a theory of what entities can exist in the mind of a knowledgeable agent.” (Wielinga and Schreiber, 1993);
- “An Ontology for a body of knowledge concerning a particular task or domain describes a taxonomy of concepts for that task or domain that define the semantic interpretation of the knowledge.” (Alberts, 1993);
- “An Ontology is a explicit knowledge level specification of a conceptualization, (...) which may be affected by the particular domain and task it is intended for.” (van Heijst, Schreiber and Wielinga 1996);
- “Ontologies are agreements about *shared* conceptualizations. Shared conceptualizations include conceptual frameworks for modeling domain knowledge; content-specific protocols for communication among inter-operating agents; and agreements about the representation of particular domain theories. In the knowledge-sharing context, ontologies are specified in the form of definitions of representational vocabulary. A very simple case would be a type hierarchy, specifying classes and their subsumption relationships. Relational database schemata also serve as ontologies by specifying the relations that can exist in some shared database and the integrity constraints that must hold for them”. (Gruber 1994);
- “An Ontology is an explicit, partial account of a conceptualization.” (Guarino & Giaretta 1995);
- “An Ontology is an explicit, partial specification of a conceptualization that is expressible as a meta-level viewpoint on a set of possible domain theories for the purpose of modular design, redesign and reuse of knowledge-intensive system components.” (Schreiber, Wielinga & Jansweijer 1995).

The several possibilities above prove that a definition is still a debated issue; each having advantages and disadvantages (Guarino 1996).

Ontologies should create a formal specification of a knowledge domain (Benjamins and Gómez-Pérez, 1999). Five components were defined in order to attain the desired formalization level (Gruber, 1993).

- *Concepts*, used to represent a domain entity (tasks, functions, strategy, etc.);
- *Relations*, representing a interaction between the domain concepts with cardinality n:n;
- *Functions*, a special case of relations with cardinality n:1;
- *Axioms*, which represent true statements;

- *Instances*, used to represent domain elements.

3. The Enterprise Ontology

The motto ontologies are built to be reused (Fernandez et al. 1997) conveys in an appropriate manner the ideas originally proposed by Gruber (1993). Therefore, one of the steps taken to achieve the proposed objective was to survey existing information sources of the organization (enterprise) domain and verify their adequacy. Of these sources, some fall in the spectrum of definitions, presented by (McGuinness 2003), that details the concept of ontology introduced by Gruber (1993).

Mintzberg (1983) provides an early (and informal) analysis of organization structure distinguishing among five basic parts of an organization and five distinct organization configurations that are encountered in practice. This “ontology” includes several mechanisms that together achieve coordination, like goals, work processes, authority, positions and communication. The various parts of an organization are distinguished by the specific roles they play in achieving coordination with the above means.

The “language/action perspective” (Winograd 1987) on cooperative work in organizations provides an ontology that emphasizes the social activity by which “agents” generate the space of cooperative actions in which they work, rather than the mental state of individuals. The basic idea is that social activity is carried out by language and communication.

In the same vein, (Auramaki et al. 1988) present a method for modeling offices as systems of communicative action through which people engage in actions by creating, modifying and deleting commitments that bind their current and future behaviors.

The work of Lee (1988) looks at language acts in the bureaucratic office, viewing language not as a mechanism for information transfer but as a mechanism for social interaction and control. He presents a logic-based representation of deontic notions - authorization, permission, prohibition and the like - and shows how this can be used to model cooperative work in the office.

Yu and Mylopoulos (1994) have proposed a framework for modeling organizations as being made of social actors that are intentional, having motivations, wants and beliefs and strategic, evaluating their opportunities and vulnerabilities with respect to each other. This formal model is used to explore alternative process designs in business reengineering.

The Enterprise Ontology is a collection of terms and definitions relevant to business enterprises modeling the enterprise in an organization wide-view manner that then can be used as a basis for decision making (Uschold and King 1995).

The major role of the Enterprise Ontology is to act as a communication medium; in particular, between: different people, including users and developers, across different enterprises and different computational systems (Uschold et al. 1995).

The Enterprise Ontology was developed as “*a collaborative effort to provide a method and a computer tool set for enterprise modeling*”, using strong facilities for integration², communication³, flexibility⁴ and support⁵, with the aim of providing and assuring a enterprise-wide view an a common understanding at all levels (Uschold et al 1995).

² “Integration must be achieved for relating information to obtain different views of the enterprise, for relating tasks to be performed to the tools that support them, and to establish connections between the tools themselves.”

³ “Communication must be achieved between people, ensuring that the enterprise models are shared within the organization, between tasks that are performed so that information can be used where it is relevant, and between the tools used to perform the tasks so that relevant data can be passed between them.”

The Enterprise Ontology presents several sections: Meta Ontology and Time, Activity, Plan, Capability, and Resource, Organization, Strategy and Marketing and associated concepts and relations between them.

In the same manner, ontology defined terms are presented as a core asset for term conformance within the ontology itself. Uschold et al 1995 defined the formal terms, addressing the Enterprise Ontology, for different areas of interest (activity, organization, strategy, marketing and time).

The TOVE Enterprise Modeling project (Mark S. Fox, Mihai Barbuceanu, Michael Gruninger, and Jinxin Lin 1999) intended to create the next generation Enterprise, a Common Sense Enterprise Model. The TOVE authors consider an organization to be a set of constraints on the activities performed by agents. This view follows that of Weber (1987) who views the process of bureaucratization as a shift from management based on self-interest and personalities to one based on rules and procedures.

The TOVE model considers an organization to be a set of constraints on the activities performed by agents. In particular, an organization consists of a set of divisions and subdivisions (recursive definition), a set of organization-agents (said to be members of a division of the organization), a set of roles that the members play in the organization, and an organization-goal tree that specifies the goals (and their decomposition into sub goals) the members try to achieve. An organization-agent (or in short agent) plays one or more roles. Each role is defined with a set of goals that the role is created to fulfill and is allocated with proper authority at the level that the role can achieve its goals. Agents perform activities in the organization, each of which may consume resource (e.g. materials, labors, tools, etc.) and there is a set of constraints that constrain the activities (Fox et al 1997). Figure 1 shows the organizational object taxonomy.

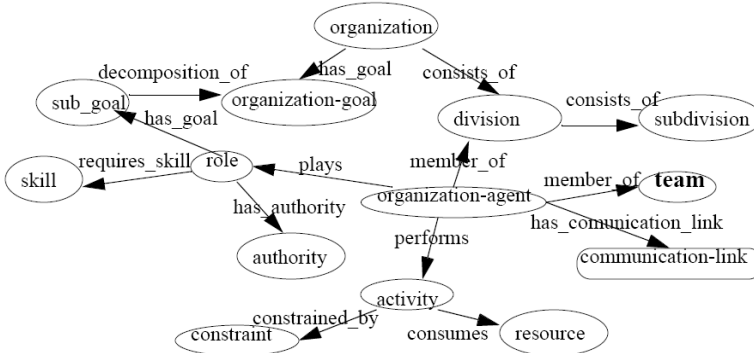


Figure 1 – Organizational object taxonomy (source: Fox et al, 1997)

⁴ “Flexibility is important to allow an organization to adapt its business processes to meet changing goals and changes in its environment; e.g. to take advantage of deregulation. It is also important to allow flexibility in the enactment of processes to ensure that people’s time is used as effectively as possible, giving people the choice of what to do and when to do it.”

⁵ “Support must be provided, assisting the user by making clear what is going on and why, stepping them through difficult situations as well as taking care of technical details. This ensures that processes are carried out effectively and efficiently reducing risk of confusion which could arise with too much flexibility.”

An approach to engineering ontologies begins with defining an ontology's requirements; this is in the form of questions that an ontology must be able to answer and can be referred as the competency of the ontology. The second step is to define the terminology of the ontology – its objects, attributes, and relations [Fox et al. 1997].

The diagram in Figure 1 can be used to represent organization actors, agents and actions and the relation between. However, it does not validate the processes in which they are involved.

Dietz proposes a “stronger” form of Enterprise Ontology. In fact, true semantic can only be achieved if action modeling is taken into consideration. Therefore, besides characterizing the elements that are involved in the action, Dietz also validates if the process activities are formally correct. It is the first step of a process towards implementation which, in the author's opinion, represents a complete new issue on organization design and engineering. The next chapter shows an example.

4. Dietz Enterprise Ontology

In chapter two of his book the Enterprise Ontology, Dietz defines enterprise ontology⁶ “as the realization and implementation independent essence of an enterprise, in short, as the deep structure behind its observable surface structure” (Dietz 2006).

In his analysis of the complexity of an apparent simple case – the “Volley” case, he uses a flow chart to show the sequence of actions that are performed stating that, under the axiom explained in his book (chapter 12 – see Figure 2), the actions can be classified as **datalogical**⁷, **infological** (both concepts as defined originally by Langefors (1977)) or **ontological**⁸.

According to Dietz “a **datalogical** production⁹ act is an act in which one manipulates the form of information, commonly referred to as data, so without being concerned about its content” that are translated in acts like “copying, storing, and transmitting data” (in the case volley the act of recording an application for membership in the letter book). **Datalogical** acts are associated with **datalogical** typical coordination acts like “speaking, listening, writing, and reading”

An **infological**¹⁰ act, like deciding and judging, always brings new original things and does not concern about the form but “about the content of information only” like inquiring, calculating

⁶ **Ontology**. Generally speaking, it is the metaphysical study of the nature of being and existence. Specifically (in this book), the ontology of something is a conceptual model that satisfies the next requirements: coherent, comprehensive, consistent, concise, and essential. We distinguish between world ontology and system ontology.

⁷ **Datalogical**. A notion related to *production acts*. Production acts that concern the storing, transmitting, copying, destroying etc, of *data* are called datalogical production acts.

⁸ **Ontological model**. The constructional model of a (homogeneous) system that is fully independent of its implementation.

⁹ Dietz defines the Operation Axiom with two acts: the Production act as the act in a transaction by which the executor establishes the production factum (or production result); the Coordination act as an act by which a coordination factum (or coordination result) is created.

¹⁰ **Infological**. A notion related to production acts. Production acts that concern reproducing, deducing, computing etc. of concepts are called infological production acts.

and reasoning (e.g. calculating the membership fee). **Infological** acts also include formulating thoughts) written or spoken sentences) and interpreting perceived sentences (through listening or reading).

Langefors distinguished between two work areas or problems in the development of information systems: the infological problem and the datalogical problem. The infological problem is how to define the information to be provided by the information system in order to satisfy user needs. The datalogical problem is how to organize the set of data and the hardware in order to implement the information system.

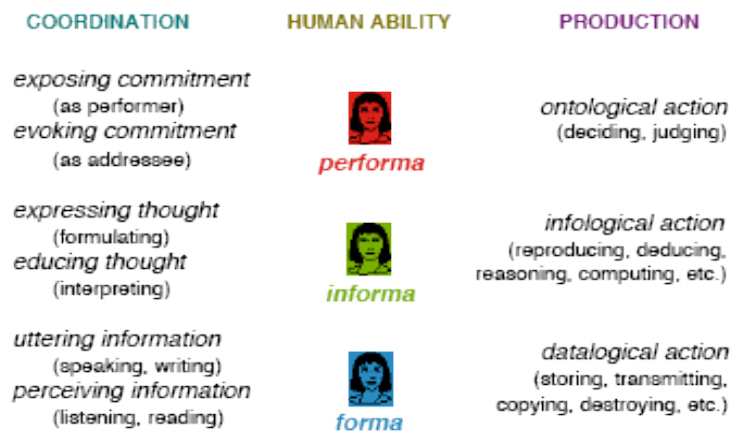


Figure 2 – The three Production Acts (source: Dietz 2006, Fig. 12–1)

Dietz defines a circular transaction pattern (where typical ontological acts are requesting and promising) and draws a flower request example (shown in Figure 3) where a bouquet is requested by the requestor with a tacit promise by the vendor. In this request there are some assumptions subjacent to the request showing that the requestor is aware of the type of bouquet that is sold by the vendor (natural flowers or plastic flowers or n flowers for each bouquet).

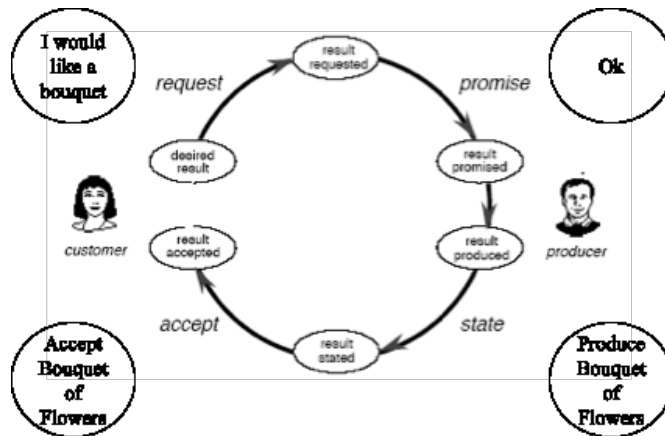


Figure 3 – Dietz Transaction Pattern (adapted) (source: Dietz 2006, Figure 3.5)

In the case Volley there appears to be two ontological transactions (becoming member of the tennis club and paying the membership fee – T2). The author delves into the analysis of the case Volley presenting several flow charts annotated with the several type of acts within the transaction pattern showing incoherencies (for example the inexistence of T01 promise and acceptance acts).

Focusing on the ontological production of the case Volley, the author defines four models: The Process, Action, State and Construction models.

The **Process Model** (shown in Figure 4) describes the basic steps of the two transactions linking the several steps within the transaction model. Dietz also specifies an action rule model that identifies what to be done when the producer has to deal with a request.

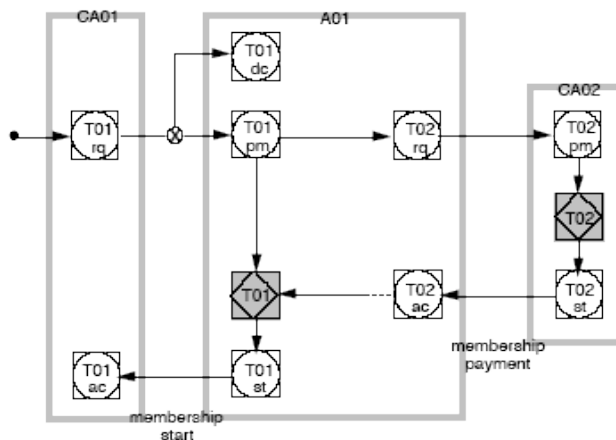


Figure 4 – Dietz Ontological Process Model of Volley (source: Dietz 2006, Fig. 3-9)

The **Action Model** (represents the collection of action rules for the enterprise. Figure 5 shows an example.

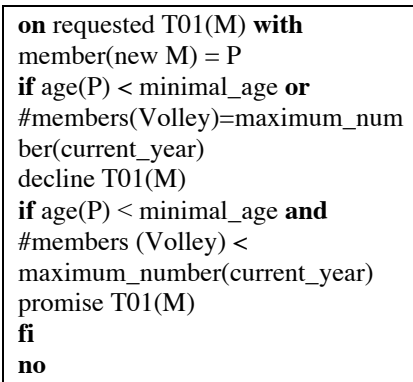


Figure 5 – Dietz Volley case Action (source: Dietz 2006, Chapter 3)

The **State Model** (shown in Figure 6) whose function is to show all the information items (object classes and fact types) that occur in the Action Model. Considering the same two ontological type transactions it means that the membership starts to exist and that the first membership has been paid.

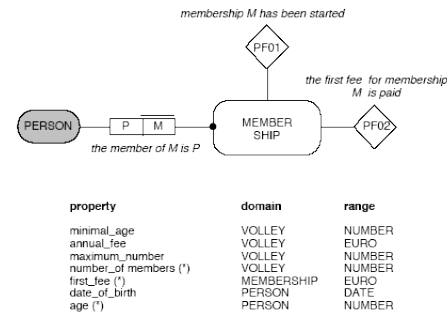


Figure 6 – Dietz Ontological State Model of Volley (source: Dietz 2006, Fig 3–10)

The **Construction Model** (Figure 7) demonstrates that the ontological models are independent of the way in which it is or might be implemented.

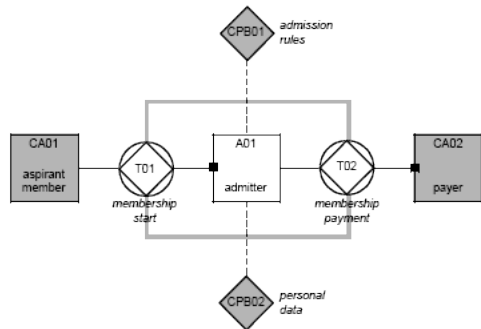


Figure 7 – Dietz Ontological Construction Model of Volley (source: Dietz 2006, Fig 3–11)

After presenting the several ontological aspect models, Dietz enforces the idea that the ontological fact (being very stable):

- Is fully abstracted from the current way in which it operates;
- It does not contain organization functions;
- it does not contain infological or datalogical things;
- is completely abstracts from the communication acts being totally independent from new organizational structure;
- Shown things that have no explicit implementation, like the promise and acceptance;
- Serves for proposing, analyzing and implementing organizational changes providing the right amount of (re)design and (re)engineering freedom;
- Is composed by a set of four aspect models that are coherent based on a theoretical foundation;

The independence of the ontological models from implementation and the usefulness of the ontological facts are valuable factors in analyzing business processes. The next chapter presents the Portuguese Air Force Mission Request Process and uses Dietz Transaction Process and the four ontological models to assert the existence of all the transaction components.

However Dietz, as opposed to using conventional and well established representation languages, like BPMN, choose to lay down a new form for representing some of his diagrams. In fact he could have used BPMN to draw the entire representations.

The following chapter describes the Air Force process in a textual manner and analyses the same process according to Dietz transaction and ontological models and, while verifying consistency, using BPMN to represent the Transaction, Process and the State models.

5. The Portuguese Air Force Mission Request Process

This chapter describes the Air Force mission request process and uses Dietz transaction, Process and the State models to concepts to characterize it. The representation is done using BPMN diagrams to show that existing representation languages can also be used to show new concepts.

5.1. Process Description

Every organization can issue a mission request for the Air Force. The mission request should be sent, by letter, fax or postal mail to the Chief Of Staff Cabinet. In that letter the requesting organization has to mention its name, telephone number, postal address, fiscal number (street, house number and zip code), the type of mission, estimated time of departure, estimated time of arrival, departure location, arrival location, number of passenger and/or cargo (number of packages, size and weight and information about the passengers (birth date and sex).

Upon receiving the request, one person inside the Chief of Staff Cabinet, the one that administrates mission requests, checks whether the information provided is complete. If not, he makes a telephone call to the sender in order to complete the data.

If the information is complete, the person adds an incoming mail number and the date, records the letter in the IT system, and archives a copy. He then checks for the existence of a memorandum of understanding (MOU) between the Air Force and the requesting that foresees the realization of such missions. If the MOU does not exist he checks the potential interest for the Air Force on accomplishing the mission. In both cases, existing MOU and Air Force interest, he checks with the Operational Command for availability of the type of aircraft and crew for the requested date and time.

Upon verification completeness, he prepares a Memo and proposes to the Chief of Air Staff whether this mission is to be performed.

If a mission request is denied (e.g., because lack of aircraft availability or because the maximum number of requested passengers or cargo exceeds the aircraft capacity), the mission administrator will send a letter in which he explains why the applicant cannot receive the requested mission.

If the decision is affirmative, the mission details are sent to the Operational Command that generates an Air Task order. This is an application with numbered missions and each new mission is entered on a new line. The line number is the mission number, by which the new mission is referenced in the Air Force.

Upon receiving the Air Task the operational unit performs the mission and reports it on the mission report format and sends it to the Operational Command that after due analysis, sends it back to the Chief of Air Force Chief of Staff Cabinet.

Next, the mission administrator calculates the mission fee that the requester has to pay. Based on existing Memorandum of Agreement or aircraft hour of flight cost, he finds the amount due. Then, he writes down the amount in the mission report and sends it the finance directorate.

Upon receiving mission report, the finance directorate issues a mission card on which are mentioned the mission number, the commencement date, the organization name, the mission date, the departure and arrival locations, and the postal address and prepares an invoice to the requester for payment. Payments have to be performed by bank transfer.

As soon as the payment is received the receipt is sent to the mission requester by postal mail or fax.

5.2. Transaction and Ontological models application

The Mission Request process is more complex than the Volley. Under the perspective of the transaction pattern the Volley has two main stages: membership request and acceptance (which then culminates with paying the first membership). The in processing of the request is depending only in one actor and all the actions are performed within the same office. Therefore, a “request” is followed by a “promise” (of processing the request) and then a “state” that is “accepted” by the person which wants to becoming a member and paying the first membership fee.

The Mission Request is rather more complex. The requestor issues the “Request” which, as opposed to the Volley case, does not have a tacit promise. Evaluating the request is done by several persons, within one cabinet, that produce a recommendation. The final decision is given to the chief of air staff. Only then there’s a “Promise” and only if the answer is “yes”. The subsequent stages include preparing the mission and its accomplishment and report which, all together represents the “State” phase of the transaction pattern. After the mission is finalized one can think that the requestor has accepted it and thus it can be considered as the “Accept” stage. However, this is not true and the “Accept” stage should only be considered when the requestor receives the invoice and pays the mission cost (for requestors that produce a memorandum of understanding with the Air Force it is considered that the mission is already under the terms agreed which include payment).

Actually, the ontological values are exactly the same in both cases. Becoming a member and pay the first membership fee as opposed to getting the mission and paying its cost can be seen as the ontological facts of the Volley and Mission Request Process.

In sequence of what was written before, and referring to the ontological models application which is represented in BPMN (see Figure 8) of the mission request process. As the mission request comes in (*CA01 Mission Request Starts*), the Air Force Cabinet has to verify that the necessary data is present. In Dietz transaction model this can be considered that the mission request (*T/01 Request* is done but it does not have a tacit promise).

Upon element completeness verification, several actions have to be made internally in order to assure if the mission can be accomplished. *A01 square* shows all the actions that need to be done including verifying if there is an existing memorandum of understanding between the Air Force and the requesting entity, checking mission interest, and verifying aircraft availability.

Upon verifications finalization a proposal is submitted to the Chief of Staff decision. This stage represents a ***T01 Execute/Dcline*** state in the transaction model. If the decision is affirmative, a letter is sent to the requesting entity (***T01 Promise***) and an order to execute is sent to the operational command.

Mission acceptance (***T01 State***) and accomplishment are performed in the CA02 square. Upon mission accomplishment a mission report is sent to the chief of staff cabinet that verifies the execution elements and sends (in the lack of a memorandum of understanding existence) to the finance department which produces the invoice and sends it to the requesting entity (CA03 square). The acceptance (***T/01 Accept***) stage of the transaction model is then performed by the requesting entity.

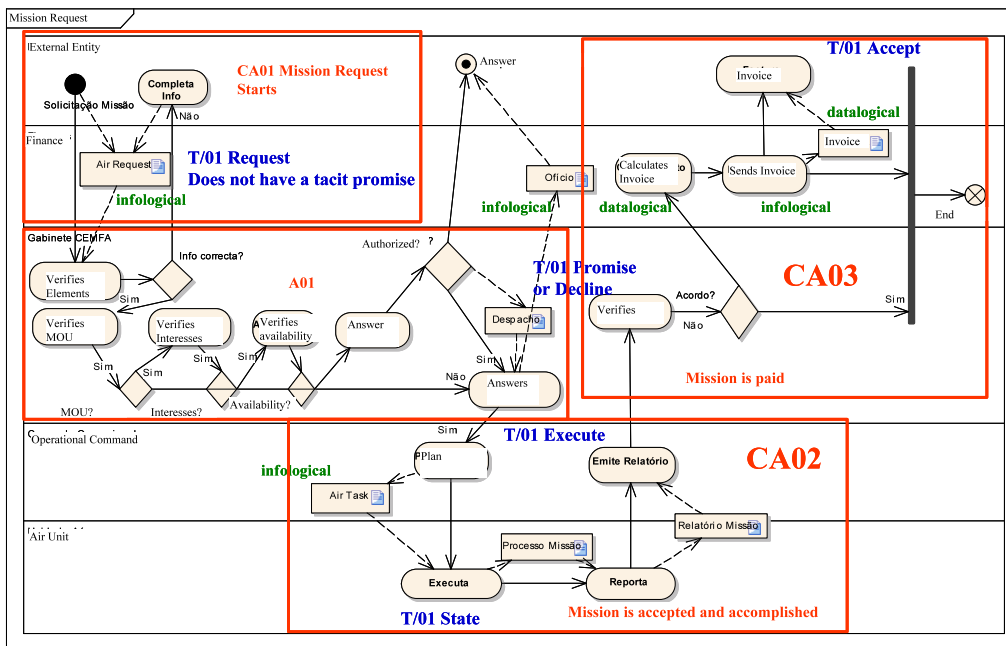


Figure 8 – The Process Model of PoAF's Mission Request

Figure 8 shows that Dietz *Transaction* and *Process Models* can be represented by a BPMN diagram given that further elements are drawn as depicted in the diagram. Notice that, although not present, the BPMN model can represent data elements which could bring a detailed representation of data and infological aspects of the process.

What about the State Model? Does BPMN represent state as accurately as Dietz diagram? A state model for the mission request process can be represented in Figure 9.

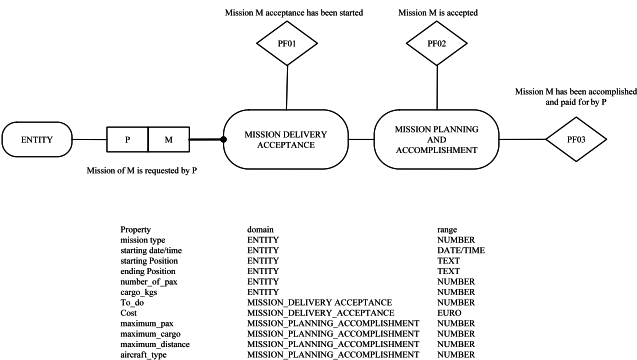


Figure 9 – The State Model of PoAF's Mission Request

What can be seen if a comparison is made between Figure 8 (Process Model represented in BPMN) and Figure 9 (State Model) is that the states shown in Figure 9 are also shown in Figure 8 represented by the red squares. The attributes that are defined in Dietz State Model (CA01 to CA03) can also be included in the BPMN diagram if the data elements are included.

Thus, Figure 8 BPMN representation, can replace Dietz case analysis flow charts, the Process model (Figure 4) and the State model (Figure 6).

Naturally, all the representation languages have its advantages and disadvantages. One BMPN diagram that shows all the actions has to be overloaded with annotations which, in the case of complex processes, can be hard to read – minimizing annotations can be achieved, for example, by coloring BPMN activities. On the other hand representing the transaction pattern and the four models equals drawing five different models, reading each one (which implies knowing five different notations) and comparing each representation to produce an understood representation of reality.

Referring the transaction pattern consistency there is no answer to the requestor until the decision has been made and it is assumed that, after the mission has been performed, that everything went according to plan. Actually, there are some elements that can jeopardize mission accomplishment such as aircraft malfunction (Air Force responsibility), weather, political rules, and third party flight authorizations (third party responsibilities). However, when the requestor receives the “State” from the Air Force he already knows that he is due to “Accept” the mission even if it is not successfully due to third party responsibilities.

6. Conclusion

Dietz Enterprise Ontology introduces a new methodology for representing processes and decomposes its representation into four different diagrams while also verifies, based on the transaction pattern, the coherence of process actions.

Chapter two and three revisit the concept of ontologies and, in particular, the enterprise ontology formal defined terms and the TOVE organizational object taxonomy.

Dietz Enterprise Ontology proposes a “new” form of ontology that, while characterizing the elements that are involved also validates the actions present in the transaction pattern that comprehends four stages: “Request”, “Promise”, “State” and “Accept”. To fully represent a process, Dietz uses the Volley case to introduce new notations to four models (Process, Action,

State and Construction). A question arises: do existing notations permit the models representation?

Using the Air Force Mission Request process, more complex, than the Volley, the authors propose to represent, the Process and State models using standard BPMN diagram, while applying and discussing Dietz transaction pattern. Both the Mission Request and the Volley have two ontological statements, however the inside-tasks are different as they depend on one actor that has control over everything – Volley – and on several actors that perform different tasks that end up with a recommendation for a decision – the Mission Request.

The “Request” stage is equal for both (but different on the tacit acceptance) but the “Promise” stage differs significantly in terms of what has to be done and the path that has to be followed. On the other hand, there are some explicit differences on the “State” stage. On the Volley case after the validation phase is complete the clerk can promise the requestor that he is going to be a member. On the Mission Request, although the Air Force promises to perform the mission, there could be third party reasons either for not doing it at all or to deviate from the initial plan. In this case, the requestor has to informally accept the fact the he has to “Accept” the mission even if it does match the request.

Using Dietz’s Transaction Pattern proved to be very useful in analyzing and identifying process activities using the “Request”, “Promise”, “State” and “Accept” stages as it allows to verify consistency between activities and identify items that need to be changed in order to provide a clearer understanding of the actions performed by the process actors.

On the representation part, a BPMN diagram was used to draw both the Process and the State models (provided that the BPMN data elements are used). The diagram, after annotation, can also represent the transaction pattern. Naturally there are advantages and disadvantages in using one notation to represent the complexity of a process or using five diagrams to represent a pattern and four models, as proposed by Dietz. The way how BPMN could be used to fully represent Dietz models can be further brought to a level of more detail as people think about it involving more work and new ways of representing. This paper intent is to unveil the world of possibilities making a small initial contribution.

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Security Management Services Based on Authentication Roaming between Different Certificate Authorities

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Abstract: The purpose of our study is to incorporate the authentication roaming technology with existing social infrastructures from the perspective of users instead of that of service providers. By conducting experiments in the Business to Consumer (B to C) environment, our research demonstrated and confirmed the effectiveness of the authentication roaming technology to realize a safe and convenient network society. This technology contributes to the construction of a citizen-centric, reassuring system especially for mobile and transportation by proposing a cooperation system for the mobile information services based on the XML Web Services technology. Our aims to enable mobile users to access a variety of essential information for maintaining safety and comfortable management of networks and enable them to make an educated decision regarding the treatment they may receive in case of trouble.

Keywords: Security Management, Certificate Authorities, Authentication, Roaming; XML Web Services, Citizen Centric Services, Mobile Information

1. Introduction

It is essential to reinforce citizens' health management and disease prevention as well as to reduce increasing public share of medical costs, as Japan is well on the way to an aging society. In order to achieve them, it is essential to improve the quality of the health services as unifying force (hubs) to utilize a variety of functions such as authentication, security, procedures, and procurements. As has been the pattern, individual medical institutions including clinics and hospitals had independently responded to the medical needs of citizens. Currently, there are various services available that utilize the Internet. Additionally, more and more services are newly created to meet users' diverse needs by incorporating existing services and social infrastructures. Nonetheless, many of the existing services are often provided with specifications unique to each service provider, making it difficult or even impossible to integrate them with existing social infrastructures. Therefore, it is essential to develop a scheme that incorporates different services and infrastructures without boundaries of specifications.

Traditionally, many services were provided by locally connecting computers. However, with the rapid and widespread diffusion of the Internet, the demand for integration remotely or globally has increased. Consequently, there emerges an increasing need for the development of

technologies that incorporate different systems. However, implementing the same technology used for connecting computers locally into a system connecting computers globally is costly and time consuming. The social infrastructure is a wide concept, and it includes so many various entities. Today, not only information and communications technologies (ICT) including broadband networks and mobile phones but also the logistics and sales systems are prevailed as social infrastructures. Nonetheless, there are still few models that transcend the difference of business types and industries, and connect them altogether to provide a new service.

For the demonstration experiment, we selected the Business to Consumer (B to C) model. The model we built aims to utilize different social infrastructures, and coordinates with other services regardless of their business types and industries to offer convenient and effective services for users. We developed the Web Service that provides user-centric services as well as the authentication system essential for coordinating different systems. However, the current condition with advancing medical technology, deficit operation of medical institutions', and lack of doctors makes it nearly impossible to respond a variety of medical and healthcare needs of people. This issue is especially serious in countryside areas hence optimization of management resources for healthcare and medical services is very much in need. As a strategic solution for this issue, we propose creation of a cooperation network among municipalities, hospitals and clinics, nutrition counseling centers, corporations, and university research centers.

2. Background of this Study

With the rapid aging of population, Japan has the world's highest longevity rate today. As a result, a reform of the conventional healthcare at hospitals is required. That is, building a cooperative structure with related organizations, institutions, and citizens is strongly required to establish a total lifetime healthcare not only for sick people but also for healthy people to swiftly respond and figure out the medical, healthcare, and welfare needs of all the citizens. Conventionally, medical care has functioned specifically to diagnose and treat illness. Nonetheless, today's scope of medical care is required to include health maintenance and promotion, prevention of disease and early detection, early diagnosis and treatment, and elderly care. Furthermore, people have become more conscious about not only *cure* but also *care* to live a healthy life. It has long been difficult for patients and citizens to access a variety of information including insurance, illness, and treatment that are essential to choose appropriate medical institutions and receive proper treatment. Especially in countryside areas far from urban cities, there are much less medical resources such as healthcare centers and medical institutions.

From the perspectives of total optimization for medical and healthcare needs of people, it is essential to take a citizen-centric, patient-oriented approach to determine the appropriateness of functions and locations of medical institutions from the viewpoint of residents(Ohashi,edi,2005). In addition, it is highly important to create a cooperative network among not only medical institutions including hospitals and clinics but also among municipalities, corporations dealing with food, medicine/medical devices/care centre facilities, nutrition centers, and universities and research institutes to improve patients and residents' quality of life including health promotion, prevention of diseases, medical treatment, and rehabilitation (Hori & Ohashi,2006).

3. Objectives of this Study

Our goal is to explore patient's oriented medical system, that is to say, to develop a user-friendly application that enables information workers at their desktops to use XML Web Services to access

and use enterprise information in order to explore the full potential of the XML Web Services that streamlines the process of gathering information and makes it easier to reuse information throughout the organization. For proof of the concept, we introduce and review some useful health care systems which utilize the medical information services and develop solutions to meet the needs of patients and medical institutions in this study. Most healthcare organizations have almost hundreds of applications running in the enterprise. There is much information in silos across organization because these applications often do not “talk to” each other. Then clinicians find it extremely frustrating when they search information they required. In addition, every application has an extremely different user interface and work-flow. This may be especially troublesome for clinicians who travel from one hospital to another. Every hospital may have a different clinical information system that the clinician is expected to use. Therefore, it is very tiresome and too difficult for clinicians to learn how to use all these different systems with their unique user-interfaces and work flow interpretations.

Today, many key decision makers are often unable to make informed decisions because the information they need is trapped within documents or databases in another part of the organization. So technologies such as XML Web services have been helpful in improving business processes from server to server, but till now, they have not been connected directly to information workers at their desktops. This has meant that information workers have not had a way to interact with XML Web Services directly to access and use the enterprise information that they need. Therefore, it is essential to develop a user-friendly application that enables information workers at their desktops to use XML Web Services to access and use enterprise information in order to explore the full potential of the XML Web Services that streamlines the process of gathering information and makes it easier to reuse information throughout the organization. In this paper, we discuss the potentialities and expansibility of application of the XML Web Services technology to improve the quality of the Japanese medical services.

The purpose of this study is to confirm the validity of the Web Service we developed. Through the experiment conducted in the B to C environment, we aim to demonstrate the effectiveness of the Web Service which incorporates various social infrastructures being developed by enterprises in the private sector, and to proclaim that this is the new business model requiring less time and cost. For the experiment in our study, we selected three widely diffused social infrastructures: 1) convenience stores, 2) Internet connection, and 3) mobile phones. Furthermore, we intend to prove that the services utilizing the Web Service contributes to the building of the safe and convenient social system.

Another purpose of this study is to prove the effectiveness of the new roaming technology which shares authentication results among existing systems, as well as between different certificate authorities (CAs). In our experiment, the server of a convenience store and a mobile phone work together through a one-stop authentication process via the Internet connection. Our authentication roaming technology enables users to enjoy different Internet services by having different certificate authorities share their ID information. In this section we introduce the text format specifications.

4. Empirical Method and Results

We examined the possibility of collaboration among corporations, universities, and research institutions by building an information sharing environment prior to applying the XML Web Services into the data management system which utilizes the information stored within the iDC. Second, we examined the effectiveness of the data storage system and evaluated whether the external applications are capable of high-level utilization such as its proficiency of producing knowledge out of information, presenting data effectively, and storing know-how

(Ohashi.edi,2003b). The following criteria were examined by the demonstration experiment utilizing the collaborative work test bed.

1. The possibility of collaboratively creating digital visual image contents in the distributed environment. All the materials in the visual library were stored, managed, and safely backed-up in an integrated fashion without making duplications at organizations within in the distributed environment.
2. The potentialities of connecting different organizations through the iDC with high-speed network and of building a system with which users can exchange large amount of data on-line and on-time. Its effectiveness of arousing an academic curiosity for the further development of high-speed, large capacity data and information exchange and sharing.
3. The capability of the iDC and the proxy servers to operate interactive control functions even when clients and their servers are located in an IP unreachable area.
4. The efficiency of collaboratively developing educational materials, reducing the process dynamics before making it available to classes, and reducing the cost of security by examining the issues in operating with modified server applications to make them more suitable and useable within the iDC. The operationalization of the dynamic image archives.
5. The validity of the data structuralization, retrieval, extraction, supply, and utilization with XML in the knowledge management systems being developed in the platform.

Especially, the capability of prompting the collaborative work while protecting the data privacy by allowing users to switch the collaborative workplaces according to their object where access is controlled by each organization so that only permitted group members have the authority to share data. One-stop services is the original goal for promoting the Health Care System. As a means to realize one-stop services that integrates variety of services, portal has been reviewed and implemented from the beginning of the stage by government and with collaboration between public and private sectors. Implementing Web Services into the interface between servers and clients, and implementing not on the portal (server) but on clients (users) would bring about a new way to realize one-stop services (Figure1)(Web Services Initiative,2005). There are two main advantages of citizen-centric one-stop services:1)No need of the portal systems that could be a major burden to construct 2)No need for portal to posses personal information. Building of a portal system is very difficult. From the point of authentication and organizing interfaces, it is difficult to develop a portal after each service has been developed. Additionally, it is also difficult to build a portal before any service will be developed because it means to design a gigantic system from scratch.

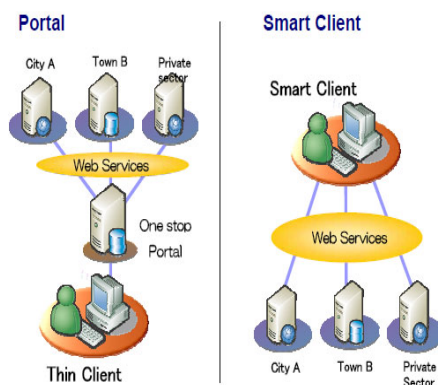


Figure 1 – One-Stop Services on Smart Client. Source: Web Services Application Guideline (English Ver.), Feb.,2005

In terms of the personal information necessary for one-stop services, though temporally, portal needs to acquire and possess all the information. On the other hand, the citizen-centric model would enable users to submit bare minimum of personal information from their PCs to receive individual service. On the other hand, the weak point is that it is required for users to equip themselves with a program that realizes one-stop services; hence it is not suited for the systems that are less used by general public. In general, portal model is suited for simple services that are less often used by general public. It is appropriate for the G2C services while citizen-centric model is suited for complicated services that are often used by specific users. Therefore, it is appropriate for the G2B services and in G services inside government offices.

Results for The Demonstration Experiment

The demonstration experiment proved that real-time discussion with sharing data and resources among the geographically-dispersed teams was possible. Furthermore, we confirmed that it is possible to collaboratively edit and process image data between remote locations using high-speed network and From the experiment, the following benefits of applying the XML Web Services were proved: 1) flexible cooperation and collaboration through sharing the ICT resources, 2) flexibility in data exchange, 3) automatic execution of modules, 4) applicability to existing internet-based technologies (vendor independent), 5) effective utilization of existing programs, and 6) low cost for implementation(Ohashi edi.2003,2004)

CA Roaming Technology Description

In order to protect the security of the B to C model, we implemented the following technologies(Takeda,Y. et al,2006) (Figure2 & Figure3):

1. Authentication Roaming

When integrating different systems with the Web Service, some systems require authentication of users. Therefore, we implemented the authentication roaming technology which is currently under development by the NiCT. The authentication roaming is the technology that shares the information being authenticated by one Website with other Websites.

2. Biometrics for mobile phones

The fingerprint authentication system is implemented into the mobile phone terminal in our study. With this technology, university can confirm that the person who requests the certification is the same person as who prints the certification at the store.

3. Tint-Block Printing

Tint-Block Printing is a special printing technique applied on a regular printing paper that shows the paper is being duplicated. When the Tint-Block Printing paper is being duplicated, the letters such as "Do Not Duplicate" show up in bold relief on the paper, confirming the duplication. This technique allows us to distinguish the originals and those duplicated. In our study, since the certificate issued by the university as well as one that is printed at the store had to be original, the Tint-Block Printing technique was applied onto the paper.

HTTP redirect is a convenient scheme to move a Web browser from one Website to another, and is widely used in identity management protocols, including newly emerging User-Centric Identity Management technologies. HTTP redirect, however, can cause a performance bottleneck in the identity management processes. Although this problem is already explored partially in OASIS SAML and the Liberty Alliance Project, this paper discusses how the approach used in them can be enhanced from the viewpoint of user centrist. We developed a new model to replace

HTTP redirect with server-to-server communication. Performance evaluation of our prototype implementation shows significant improvement of turnaround time for authentication by avoiding HTTP redirect over a 64kbps wireless communication channel.

Citizen-Centrism is an emerging principle to design solutions in digital identity management. There is, however, still no widely accepted definition of Citizen-Centric Identity Management. One example definition, which might not cover all aspects, is that Citizen-Centric Identity Management is about controlling one's identity data without central repository of his or her own personal data. We believe the concept of Citizen-Centric Identity Management includes at least two types of technologies. One type, including SXIP and OpenID, is to make users specify his or her identity repository. The other type, including Windows CardSpace (formerly InfoCard) and Higgins Trust Framework Project, is to shift the control of personal information (and the physical location of some part of them) from servers to users' own devices.

In the real world, many of us have already registered our personal information on a variety of Websites. Since it is unrealistic to imagine all the personal information distributed over the Internet can be immediately gathered up on our own computers, this paper focuses on identity management protocols to pass and receive identity information over the Internet, and discusses the potential bottlenecks and our solution approach. We explain why HTTP redirect is commonly used and thus is a common problem in the identity management protocols. Previous work, which was explored by The Liberty Alliance Project and was then adopted in OASIS SAML is also illustrated. The analysis of SAML profiles shows another problem, the selection of the Identity Providers (The entities that identify or authenticate users), from the viewpoint of user-centrism. We describe our approach, an enhanced Identity Provider (IDP) proxying protocol, and the design issues including the flexibility and the security of its system model. We evaluate our prototype implementation of this protocol, showing the results of performance measurement. As the name implies, our model implementation is based on Identity Federation mechanism, but is also applicable to non federation-based identity management protocols.

Note that HTTP redirect is also used in the other identity management protocols including OASIS SAML and Liberty. The following part of this section discusses current approach used in SAML and The Liberty Alliance Project.

To avoid negative side effects of HTTP redirect, Liberty introduced an entity, Liberty Enabled Client or Proxy (LECP) to its identity federation framework (ID-FF) and a similar concept, enhanced client or proxy (ECP) was introduced to SAML2.0 later. This paper refers to the ECP profile of SAML2.0, because it was ratified later than ID-FF1.2 of Liberty, and is expected to be more up to date. Before explaining more about ECP, we briefly explain about SAML and ID-FF. SAML was initially designed as a protocol to enable users to log on to multiple Web sites with single authentication by a Web site, exchanging the result of authentication using XML messages called assertions between the Web sites. The Liberty Alliance Project designed the initial ID-FF as the superset of SAML, and contributed it to OASIS. The efforts of these two organizations on Web single sign-on standard, along with a number of the related technologies on identity management including account linking and single logout, were then converged into the latest SAML, SAML2.0. Replace HTTP redirects with server-to-server communications (Takeda, Y. et al, 2006)

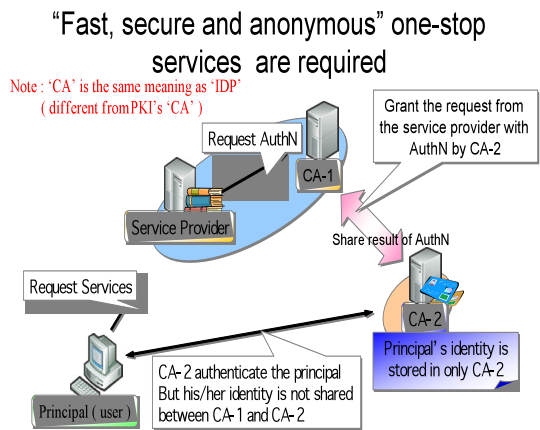


Figure 2 – “Fast, secure and anonymous” one-stop services are required(Takeda,Y. et al,2006)

- Allow the users to select their favorite CAs (IDPs)
- Replace HTTP redirects with server-to-server communications

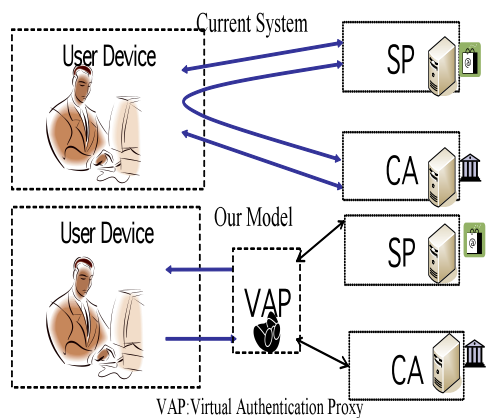


Figure 3 – Allow the users to select their favorite CA's(IDPs)

5. Case Example

In this chapter we discuss the case evidence on information system about the consolidation project at Ninohe Hospital (Iwate prefecture) in the northern district in Japan. This case shows how integrating information system was promoted regional coordination of medical systems by

realizing medical information system based on XML Web Services technology. And the results reveal the success in adopting and implementing the integrating information system.

Turning now to existing environment and issues of a prefectural hospital, which is controlled by local government, so hospital directors have no budget execution, this hospital has the close relationship with Iwate prefecture healthcare department and many other local hospitals and companies. As for common issues, they were as follows: 1) Difficulties in coordination of existing many systems in hospital: multi-vender systems in each department and dedicated interface for connecting to other system 2) Exponential increasing costs according to enhancement of scale of the hospital: Complicated each system and number of systems to be connected each other 3) Security and privacy: leak of medical information by establishing coordination

To solve these problems, this hospital has established integrating information systems based on XML Web services technology. The basic concept of plan for this integrating information system is: 1) Sharing patients information 2) Promoting the efficiency of business process by establishing coordination of many information systems 3) Aiming at improving services and patient's experience 4) Working with critical path 5) Input of the source of the outbreaks 6) Reducing costs

Results for The Case: Advantageous Effects of Integration

By adopting the integrating information system based on XML Web services technology, this case demonstrates and proves the advantageous effects of integration (Hori, Ohashi & Suzuki, 2005): 1) Information sharing of patients 2) Improving documents and forms development and management 3) Accessing data available in 24 hours 4) Improving effectiveness of business process 5) Reducing inquiry by phone call 6) Reducing memory transfer of each doctor's reservation, physical examination, injection 7) Improvement of services for patients 8) Reducing holding time of carte of ambulant patient 9) Abbreviating waiting time

In addition, as for integration of internal information systems, team medical activities, that is, collaboration with pharmaceutical, nutrition management, radiation ray, physical examination departments have been promoted for patient centric medicine.

The example is presented for realizing clinical management portal with using XML web services, that is, XML data (Figure 2).

The distinctive features are: 1) Patient information distributed institutions are to be displayed on each Web parts at regular intervals (via automatically detected by XML Web services) 2) Realizing both collaboration in making reports and data sharing 3) Various integrated information detection 4) Document sharing within medical team 5) Realizing communication by creating specific theme based Web site 6) Sharing discussion board (questionnaire) both in executives and secretariat

Each block of information is XML Web Service coming out of what may be entirely different applications; yet they are all synchronized and each block will change as the user drills down through the information he or she needs that is specific to a particular patient or problem. Clinicians can enter XML data that are stored on a server or relayed to a legacy clinical information system, and any column on the form can be added automatically (Hori, Ohashi & Suzuki, 2005).

6. Technical Perspective for the Mobile Security Management

This study can help many organizations and mobile system understand benefits by adopting XML Web services technology. They depend on large amount of information to effectively run their businesses, from tracking customer orders to gauging customer satisfaction. While collecting such information is critical, in many cases capturing necessary information is time consuming and results in inefficient business processes. Such practices vary from completely manual, paper-based systems to semi-automated steps involving standalone desktop applications, e-mail or redundant data entry practices dependent on human follow-through. In order to cope with this issue, the XML Web Services can be implemented to improve and centralize the process of gathering information using rich, dynamic electronic forms.

In general, Mobile system typically experience reduced acquisition cost for ICT solution and implementation, lower training costs, and fewer ongoing costs with implementations in weeks, instead of months, all yielding more immediate customer value. It is necessary to build a flexible foundation for providers to develop their ICT infrastructure. And it is ideal if there were integrating applications within and across hospitals and clinics. Aside from that Mobile Authentication providers concern about integration and messaging as a way to simplify their infrastructure and to reduce cost, they also seek greater flexibility to handle the demanding and changing healthcare field. They also concern about new and innovative components that are easy to use and implement. By reducing implementation and maintenance costs, provider organizations can get the right information at the right place so that they can deliver high-quality and timely care. Therefore, it is critical to create the foundation for integration that connects healthcare providers to information providers and to their systems. By using real-time application integration and efficient messaging across the organization, mobile organizations can support real-time collaboration, manage knowledge more effectively, and deliver personalized information.

Accordingly, development of user interface and framework that developers, business analysts, and administrators can all use to efficiently develop and apply rules and policies is vital for collaboration. Then, the framework needs to be extremely flexible and extensible, so that its functionality has to be fully exposed through public interfaces to allow users to reach higher stage in implementation to meet their business requirements. And, it is also important to construct massively scalable messaging and orchestration-based applications through scale-out architecture as well as to provide direct visibility into transactions to assure the correct and timely access to information for business analysts.

On the other hand, Web Services utilize the text data called XML data for sending and receiving data. This makes interoperability among different OS and programming languages much easier as text data are normally independent of OS and programming languages. Furthermore, as XML data allow users to add new meaning to data with tags, it makes it easier for the receivers to comprehend data. In contrast, Web Services send and receive the XML data via the internet protocols such as HTTP and SMTP for which most of organizations had already configured their firewall setting. Hence, they are not required to re-configure the firewall to pass the communications protocol, which alleviates security issues especially when the number of partner corporation increases.

Systems are applying Web Services as one of linking technologies to integrate systems within an organization and utilizing the existing application systems such as mainframes and client/server systems by wrapping them with Web Services when developing a new application system. Improving development productivity by utilizing ASPs that are developed with

component-based approach, and by turning the shared business logic into Web Services therefore can be shared among multiple system.

7. Conclusions

As expressed in the survey of the metropolis of Tokyo, many people recognize the need of improving the quality and efficiency of mobile healthcare system management. In order to improve the quality of the mobile management system and contribute to community transportation, it is necessary to share information among residents, patients, hospitals, clinics, medical institutes and pharmacies, nursing care, welfare centers and other related organizations. In the Ubiquitous Society, more accurate and prompt healthcare management and quality medical services are expected by utilizing advanced ICT. The system will be needed: effectively make appropriate counseling and educational information more accessible for the people so as to prevent them from suffering mental and/or physical health problems that may affect their work and life. XML Web Services enables many people to contact and stay in close touch with physicians and outside mental health professionals at any moment when necessary through network. Therefore, utilization of XML Web Services would generate innovative ways for the people to maintain and improve their mental and physical health. We believe that our proposal to apply the XML Web Services would make a substantial contribution to the healthcare and medical field to realize the patient-oriented services in the Ubiquitous Society.

HTTP redirect is a convenient scheme to move a Web browser from one web site to another, and is widely used in identity management protocols, including newly emerging Citizen-Centric Identity Management technologies. HTTP redirect, however, can cause a performance bottleneck in the identity management process. Although this problem is already explored partially in OASIS SAML and the Liberty Alliance Project, this paper discusses how the approach used in them can be enhanced from the viewpoint of user centrism. We tested a new model to replace HTTP redirect with server-to-server communication.

As the demand for better services increases, our study reveals important implications to many Internet services. We believe that our study that incorporates the Authentication Roaming Technology and different CAs is truly innovative and meets the urgent need in the Ubiquitous Society. In the future, with this technology, we expect the service to expand so as to enable printing of more official documents such as drivers' licenses. The high speed Internet connections as well as Internet services have become less expensive, and they are widely accessible for the greater part of organizations. The mobile phones, at the same time, have been equipped with multi-functions and become so advanced that they can identify the individuals with biometric authentication technologies. Convenience stores are so essential to people's everyday lives with their easy accessibility at any time of the day and in any part of the cities. In our study, we utilized the multi-copying machine at the Seven-Eleven in a way that it prevents prohibited duplication of the document while it prints out the document and retains its authenticity.

Furthermore, what is highly remarkable is that we provided a secure and protected service by incorporating existing technologies and social infrastructures. User can utilize a various services by registering his or her personal information to the Website with one-stop authentication. Moreover, by utilizing this model, corporations that digitalize their documents for storing and operation purposes can use the convenience stores as document issuance terminals for those corporations. As the service identifies the authenticity of individuals, it can also be incorporated with the Time-Stamp technology to exchange the documents requiring authenticity.

Our study proved the effectiveness of the Authentication Roaming Technology to combine different social infrastructures to create a new service. Though there are still issues to cope with

outside of the realm of technology including accountability of each participants and the level of the service, we expect this service to be soon available in the real world.

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A Method for Business Process Reverse-Engineering Based on a Multi-view Metamodel

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Abstract: In the current context of globalization and with the increasing need to automate the work, modeling business processes has become essential. Modeling helps not only to understand processes but also to anticipate changes and build a flexible structure. In this paper we adopt from software engineering the concept of reverse-engineering. For organizations with unmodeled BP, reverse-engineering is a way to provide process models ready for improvement or usage in other stages of the business process lifecycle. This paper proposes a method for business process reverse-engineering fulfilling these requirements. It consists of a multi-view metamodel, covering all perspectives of a process, and a detailed approach to guide the business process modeler. The approach was tested on a web application from the French academic Information Systems. This work was done under the project DÉSIT (<http://projet-desit.imag.fr>) which is supported by the cluster TTS of the region Rhône Alpes (France).

Keywords: business process, modeling, reverse-engineering, metamodel, business process lifecycle.

1. Introduction

The success of an organization depends on its control of its business processes throughout their lifecycle. But in some cases, business processes are running in the enterprise without being based on formal models. They could be based on out-of-date and unstructured documents or on knowledge of some participants. Then it is essential for these enterprises to reorganize information about processes in order to generate process models useful for the following steps of the lifecycle like automation and monitoring. As a consequence, relevant modeling methods are needed like reverse-engineering which is a solution to model existing business processes. The word reverse-engineering has been defined in 1990 by Chikofsky and Cross in (Chikofsky, 1990) as *“the process of analyzing a subject system to: a) identify the system’s components and their interrelationships and b) create representations of the system in another form or at a higher level of abstraction”*. Reverse-engineering is only a starting point in the lifecycle. A business process is never stabilized and it will be subjected to continuous improvements that are part of the Business Process Reengineering (BPR) approach. BPR aims to reform and redesign existing systems or applications to reach new ones more efficient and more adapted with the environment (Langer, 2007) (Barothy, 1995) (Tsalgatidou, 1995).

This paper proposes a method for business process reverse-engineering motivated by the need to collect and reorganize the existing knowledge and generate models while considering the differences between the strategies of the enterprises and their vision of processes. For example, some organizations need to model their processes to cope with communication problems between the participants in the process. Other organizations are involved in the current context of globalization which has created a competitive climate. Thus, they are forced to innovate which explains the need for flexible models of business processes ready for improvement. Organizations aiming to establish a collaboration policy need to model their internal processes to plan and structure external interactions. Other motivations may incite organizations to adopt a reverse-engineering approach like automating their business processes.

One of the strengths of our method is that it takes into account the motivations and highlights them to guide the modeling process. The method may be considered as an all-purpose method, as it is based on a generic metamodel capturing all the elements involved in a business process. The metamodel consists of 5 complementary views studying the process from different perspectives.

Some choices adopted for the proposed reverse-engineering method are described in section 2. Section 3 presents the multi-view metamodel. Section 4 describes the different phases of the proposed reverse-engineering process. Each phase is illustrated by examples extracted from an academic web application. This application is used to manage admission procedures of student applying for high-school diploma in university education. Concluding remarks are given in section 5.

2. Hypotheses for the reverse-engineering method

There are several languages for modeling business processes: OSSAD (Office support System Analysis and Design), EPC (Event Process Chain), IDEF (Integration DEFinition methods), UML (Unified Modeling Language), BPMN (Business Process Modeling Notation). We chose BPMN, a standard of the OMG, which is a specific language for business process modeling. It has the advantage of providing a rich vocabulary to present the process as a flowchart (OMG, 2006). BPDM (Business Process Definition Metamodel) is the metamodel for BPMN (a metamodel describes the rules, constraints and theories of a model, in other words, a model should conform to a metamodel). It is an UML profile including BPMN notations (OMG, 2007). The large vocabulary of BPMN makes BPDM supporting a wide variety of concepts related to business processes. Moreover, BPDM is considered as a generic metamodel for business processes allowing interoperability of different BPM languages and tools. It provides, also, XML syntax to exchange business process models. BPDM models can be transformed to BPEL files.

The use of a metamodel in a modeling process is important to identify the elements that must be considered. The elements are grouped in a definition given in (Morley, 2005) “*A business process is a set of activities undertaken for a specific goal. The responsibility of execution of the whole or some of activities by an actor corresponds to a role. The progress of the process uses resources and is conditioned by internal or external events*”. Therefore, the processes of different types (core, support or monitoring processes) collaborate together to fulfill global goals (WFMC, 1999) in agreement with the strategies of the enterprise. Several works were interested in integrating goals while modeling businesses. In (Samavi, 2008) a framework is proposed to facilitate the representation and analysis of business models and their strategies. G. Jean proposes in (Jean, 2000) an information system architecture identifying in a matrix the set of business processes resulting from each strategic invariant. Other works (Curtis, 1992) (List, 2006) study business processes from different viewpoints by proposing multi-view metamodels. Curtis in (Curtis, 1992) identifies 4 perspectives: functional, behavioral, organizational and informational.

List in (List, 2006) adds the contextual perspective consisting of goals of the enterprise and the business processes and measures for these goals.

In our method we chose to use BPDM because of its advantages listed above. Besides, BPDM presents some drawbacks preventing its use as such. Consequently we propose some modifications on the BPDM resumed in three points:

- *Removing details.* BPDM consists of 4 packages and uses an UML infrastructure consisting of 3 packages (OMG, 2007). These packages include 161 interdependant classes. Most of the classes correspond with particular notations of BPMN or aim just to draw links with the UML infrastructure. Our goal is to propose a simple metamodel (i.e a reduced metamodel). These classes and these links detrimental for the generic nature of our method were removed from the metamodel.
- *Enriching the metamodel.* BPDM does not include some meta-information on the process like its objective or its position in the organization. Thus, we enriched BPDM with classes in order to link the process with its environment and the context in which it operates.
- *Using view mechanism.* BPDM consists of packages built to separate different levels of abstraction or different semantics of the classes. We used these packages to construct views of processes that are weakly coupled between them.

3. A multi-view business process metamodel

The proposed metamodel consists of 5 complementary views. The transparent classes are new classes that we used to extend the BPDM metamodel.

3.1. The intentional view

The intentional view (see Figure – 1) is not included in BPDM. It was inspired from the contextual perspective proposed in (List, 2006) which we simplified. This view specifies the *Process Goal* and its position in the entire set of the *Enterprise Goal(s)*. The view determines the type of the process (*Core process*, *Monitoring Process*, *Support Process*). The intentional view specifies also the *Customer(s)* of the process which is the external beneficiary of the process and *Process Owner* which is the organism or the agent owning the process and having the right to modify it.

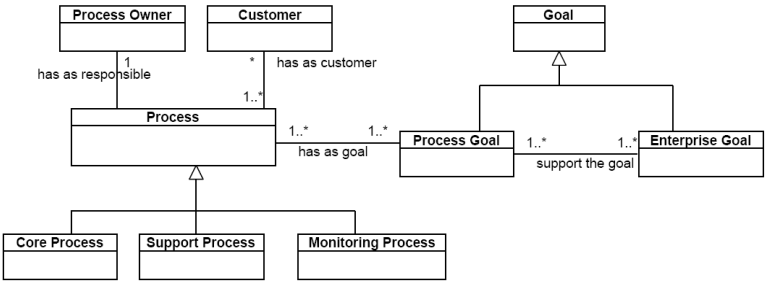


Figure 1 – The intentional view

3.2. The functional view

A process is a set of activities. Each activity may contain several levels of refinement. Some methods and languages require a specific number of levels in the hierarchy of a process, which lays to problems in the case of long and complex processes. The functional view of our metamodel solves this problem since it gives the modeler a certain degree of liberty to choose the number of modeling levels suitable for his issue. This view presented in the Figure 2, depicts the different functional entities of a process and the links of composition between them. We distinguish between *Global Process* and *Detailed Process*. A global process has not an internal structure but is composed of detailed processes that contain *Sub-processes* and *Activities*. An activity is a set of *Actions*. An action is the finest grained functional entity that cannot be composed any more.

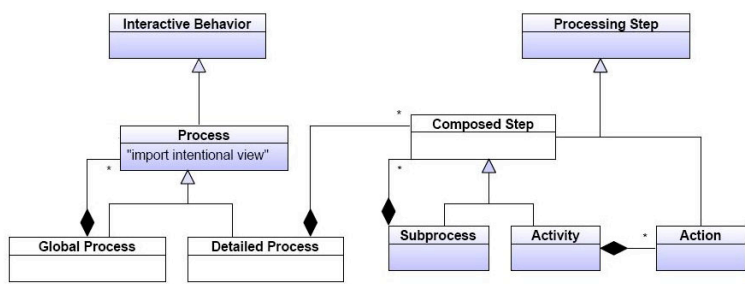


Figure 2 – The functional view

3.3. The organizational view

The actors in a business process may be humans or resources of different kinds (software, servers, machine, etc). These actors may be names of persons or resources or just their function in the organizational structure of the enterprise. Modeling processes by using the names of actors could lead the process to a non wished level of details and remove the generality character of the process. Therefore, we assigned abstract roles to process activities. Figure 3 shows the organizational view attributing roles to *External* and *Internal* actors. A *Performer Role* is a role responsible of some activities in the process. Every detailed process has a *Processor Role* that is responsible for delegating performer roles.

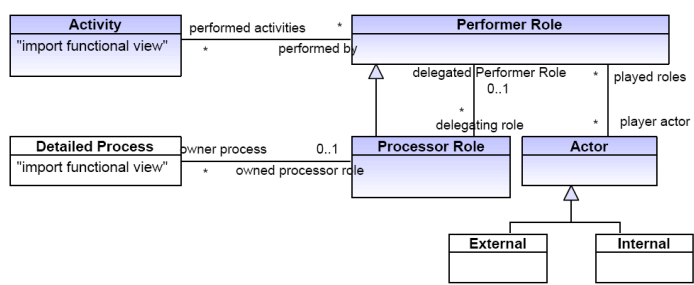


Figure 3 – The organizational view

3.4. The interactional view

Figure 4 depicts the interactional view which captures interactions between elements of a process. The elements of the process that can interact together are called Interactive Part(s). While interacting, these elements may exchange resources of different types.

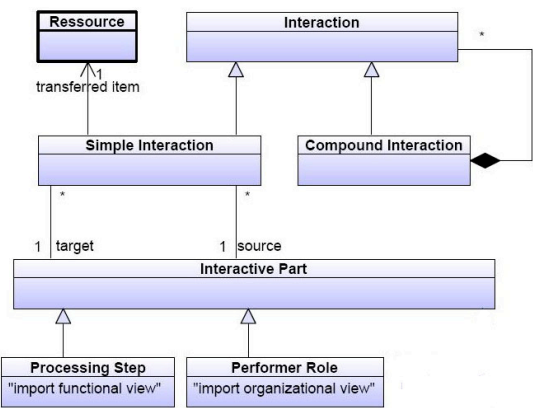


Figure 4 – The interactional view

3.5. The behavioral view

Figure 5 shows the behavioral view. The view captures the different elements for scheduling the process in time. It highlights the succession between different *Course Parts* of the process. The course parts are:

- *Processing Steps*: Sub-processes, activities and actions.
- *Interactions*: exchange of resources between interactive parts (see figure 4).
- *Event Monitor*: a punctual event that triggers in time and influence the flow of the process.
- *Gateways*: the control flows used to express complex specifications to order happening parts in time.

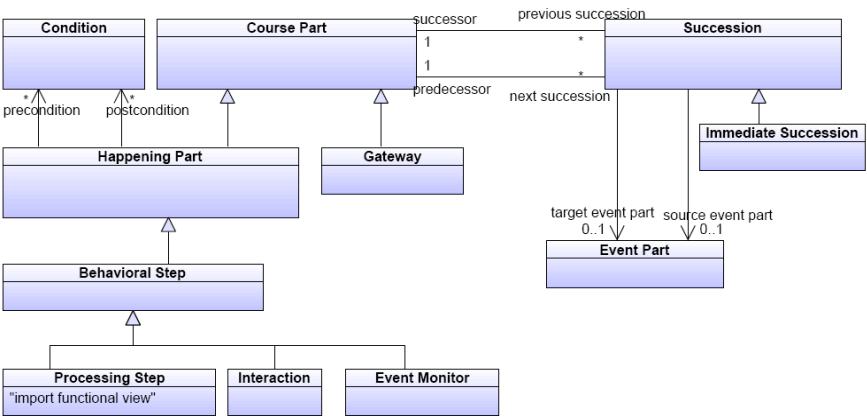


Figure 5 – The behavioral view

The five views complement to highlight the different elements necessary for defining a business process. In the next section we propose an approach to identify these elements to model them.

4. A process for reverse-engineering business processes

For organizations with unmodeled business processes the modeler must perform a hard work to collect the different information needed to reorganize and build efficient models. According to the functional view of the metamodel, several levels of composition must be identified to reach the final structure of the business process. In our approach, these composition levels correspond to abstraction levels as moving from one level to the other will eliminate details and preserve the most important functionalities. While collecting information the modeler should follow a Top-Down approach in order to identify the real vision of the enterprise about its processes. He will investigate the global processes and discover little by little their structure until meeting the structure of the activities of each process. Then, the modeler will use a Bottom-Up approach by identifying activities and composing them iteratively. The composition of activities should respect the two principles of coupling and cohesion (Papazoglou, 2007) to construct processes that are highly coherent internally and weakly coupled between them. The definition of the activity granularity and the criteria for coupling and cohesion will perhaps change the organization of the business components to build flexible and efficient models.

The modeling context may also influence the choice of the granularity of activities and the criteria of coupling and cohesion. We propose a reverse-engineering process composed of 3 phases. The originality of our approach lays in the use of the phase “Restructuring and modeling” used to organize and restructure collected information. Not only BPMN models will be constructed but also process models representing the other views of the business process. Each phase consists of several steps detailed below. Each step is illustrated with an example extracted from the academic web application.

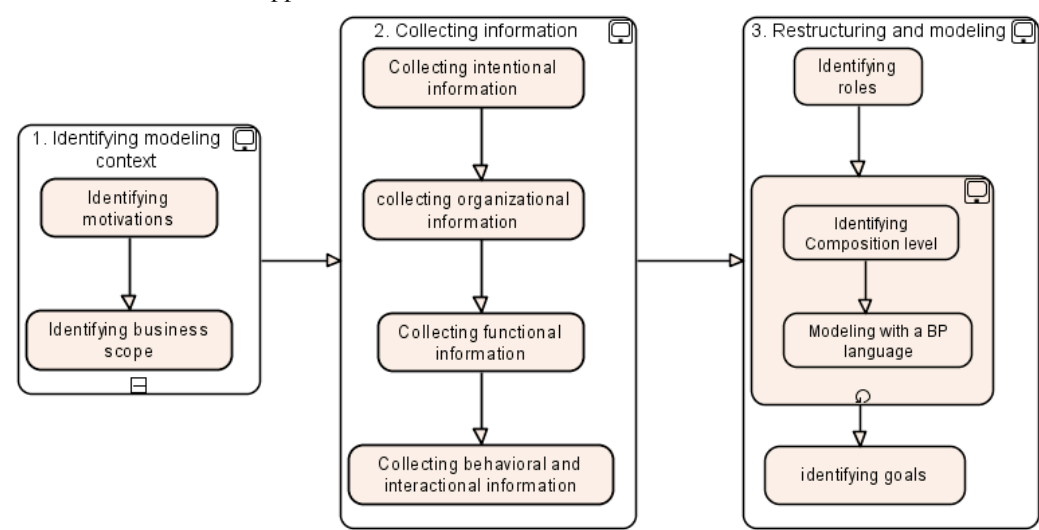


Figure 6 – The process of reverse-engineering

4.1. Identifying modeling context

In the first phase “*Identifying modeling context*”, the modeler must specify the modeling context: the motivation for reverse-engineering and its scope, i.e., the set of global processes that must be modeled.

4.1.1. Identifying motivations

Several motivations may enhance the leaders of organizations to adopt a reverse-engineering approach for their business processes. These reasons result from the need to change or reformulate the vision of the enterprise. Generally reverse engineering is followed by a phase of reengineering. Therefore, considering reverse-engineering motivations should allow flexible models to be constructed. These motivations may be classified in 4 categories:

- Enhance process comprehension and communication.
- Facilitate process management.
- Facilitate process execution.
- Adapt easily processes with their environment.

For example the objective of the reverse-engineering of academic the web application is to provide understandable process models by the managers of the application in the university institutions. Thus the objective is to enhance process comprehension and communication.

4.1.2. Identifying the business scope

In most cases the modeling scope is determined by the leaders of the organizations that specify the global processes to be studied. But sometimes the scope should be extended to include other processes and other structures of the enterprise that are related to the process models. Then the modeler should take into account the interrelations and the exchange between the business processes. It is also essential to consider the goals of the processes and their position in the enterprise to determine if two processes play the same role or complementary roles. In this case, these processes should be considered in the business scoping because modeling one process is affected by the other. Motivations may also affect the business scope since it may highlight some details to be integrated in the process models. For example, modeling business processes for execution purposes can put forward some requirements like considering execution equipments. Modeling business processes for collaboration reasons requires considering collaboration policies.

The identified business scope is a set of global processes if the organization has a primary classification of processes. Elsewhere the business process is a set of organizational parts of the whole organization.

In the case of the academic web application the business scope consists of the candidature procedures for the applicants (students) and the management procedures for the university institutions. On the other side it does not concern the management procedures of the application for the ministry of university education.

4.2. Collecting Information

In the second phase “*Collecting information*”, the modeler must collect different types of information (documents, manuals, interviews, organizational hierarchies, process simulation, etc) within the modeling scope. This phase may be hard and complicated if the organization does not possess documents and manuals describing its processes. In this case the modeler should simulate himself the processes if it is possible or conduct interviews with the actors involved in the process. For the academic web application we collected information by simulating the admission

procedures as a student. Then we used documents “applicant’s guide” or the information sheets for the academic institutions.

The collecting phase should be organized and planned in order to optimize efforts and time. Then, the modeler could know exactly the information he needs to structure and model the processes of the enterprise. This phase consists of 4 steps used to identify for each view of the metamodel the corresponding information within the business scope. The steps do not contain strict guidelines in order to take into account the differences between information resources within organizations with unmodeled processes.

4.2.1. Collecting intentional information

The purpose of this step is to report the vision of the organization of its processes. The modeler should conduct interviews with the leaders of the organizations in order to identify the goals of the different global processes and their contribution in the enterprise goal (see figure 1). Information may be summarized in tables. If there exists any inclusion links between the processes, the links may be represented in functional trees that will be used in the next step.

4.2.2. Collecting organizational information

In this step the modeler should identify for each global process the different actors involved in. If the global process contains more than one detailed process, there may be more than one processor role (see figure 3). The different actors responsible of the detailed processes should be identified. Later processor roles will be assigned to these actors. The actors participating in the process, as well as their categories (internal or external) should be identified. They will play performer roles (see figure 3). The delegation links between actors should be identified as well and represented for example with an UML object diagram (not shown here). In this step the hierarchical structure of the organization within the business scope should be retained to be used later in assigning role names to actors.

4.2.3. Collecting functional information

In this step, each global process should be studied to identify its components. If there is no available documentation about functional structure, interviews with actors responsible of processes may help to identify the different detailed processes, their sub-processes and activities. A functional tree for each global process should be constructed. These trees highlight the business structure of the enterprise as it is seen by its internal staff. As a consequence, this structure may be incorrect and improper. The restructuring and modeling phase will take in charge the restructuring of the business components.

4.2.4. Collecting behavioral and interactional information

The modeler will go through each functional tree and identify for each functional element (detailed process, sub-process or activity) its scheduling. The scheduling of the processes must be summarized in scenarios like those defined by Alistair Cockburn (see next section for more details about these scenarios). When dealing with a certain process, the modeler should specify all successions and interactional links between elements of the process. The internal structure of these elements should also be summarized in scenarios obtained from documents and manuals or after interviews and simulations.

For example, the “student’s guide” of the academic web application describes for the different tasks that must be fulfilled by the student and their deadline. When studying these documents, scenarios can be extracted. Scenario 1 presents an example of these scenarios. When

simulating the application, we obtained another scenario that was not exactly the same as the one described in the “student’s guide”.

Process n°1: first phase of candidature (from January 20th to March 25th)

1. enter n°INE and date of birth

2. fill in the form

3. enter e-mail address

4. receive a confidential code

5. reconnect on the application

6. enter confidential code

7. choose a formation

8. validate a formation

9. print formation file

}

repeated (maximum 36 choices)

Scenario 1– Process of the first phase of candidature

In the scenario 1, actions are combined with activities. Some rules can be found like “some tasks could not be repeated more than 36 times”. Then it is essential to restructure scenarios which will be done in the next phase presented below.

4.3. Restructuring and modeling

This phase constitutes the originality of our reverse-engineering process. The purpose of this phase is to study the global processes one by one in order to restructure the collected information and build process models with business process modeling languages. In our case we will use BPMN but it is possible to use any other language as the metamodel is generic. The process models will be documented with other models to illustrate concepts that are not considered by BPMN. This phase consists of 4 steps detailed below.

4.3.1. Identifying roles (organizational view)

The different actors involved in a process were identified in the previous phase. In this step the modeler should assign role names to these actors while distinguishing between processor roles and performer roles. The delegation links between processor roles and performer roles must be highlighted. It is possible to express organizational view with graphical business process modeling languages. For example, with BPMN, processor roles are represented by pools and performer roles delegated by the processor roles are represented by lanes within these pools. For the actor “student” executing the process “candidature in the application” we assigned the role applicant which is more general and can group also non-student persons applying for university education.

4.3.2. Identifying composition level (functional view)

An activity is a set of actions performed by a single role. As seen above, the granularity of activities depends on the motivation of the reverse-engineering. For example, an enterprise that models its process to collaborate with external partners does need to consider the details of operations carried out by the process, it is sufficient to consider the major features that interact with external actors. However to automate a production line, we must model the details considering the activities of finer granularity. In the first occurrence of this step, the modeler must give a clear definition of an activity. This definition may differ from the definition used in the organization and obtained in the collecting phase. Then, all activities must be identified with a

name, a number and some characteristic elements like the role, time constraints, preconditions, etc. All these activities with their characteristic elements must be grouped in a table. Table 1 summarizes the activities of the candidature process realized entirely by the applicant. The table contains the elements characterizing these activities.

Table 1 – Activities of the candidature process

Activity	Role	Temporal constraints	Preconditions	Frequency	Priority
<i>1. register in the application</i>	Applicant	From January, 20 th to March, 25 th	Valid INE number Web connection	1 time	Mandatory
<i>2. consult a choice</i>	Applicant	From January, 20 th to March, 25 th	Connected state	indifferent	Optional
<i>3. add a choice</i>	Applicant	From January, 20 th to March, 25 th	Connected state	From 1 to 36 choice	Mandatory
<i>4. validate a choice</i>	Applicant	From January, 20 th to March, 25 th	Connected state	From 1 to 36 choice	Mandatory
<i>5. order a choice</i>	Applicant	From January, 20 th to March, 25 th	Connected state	1 time for a choice	Mandatory
<i>6. delete a choice</i>	Applicant	From January, 20 th to March, 25 th	Connected state	1 time for a choice	Optional
<i>7. print choice file</i>	Applicant	From January, 20 th to March, 25 th	Connected state	1 time for a choice	Mandatory
<i>8. prepare and send folders</i>	Applicant	Until April, 4 th	Selective choice	1 time for a choice	Mandatory
<i>9. check reception of folders</i>	Applicant	From May, 8 th to 12 th	Connected state	indifferent	Mandatory
<i>10. send missing pieces</i>	Applicant	Institutions precise dates		1 time for an incomplete folder	Mandatory
<i>11. change choices order</i>	Applicant	From March, 25 th to May, 31 st	Connected state	indifferent	Optional
<i>12. reply to a proposition</i>	Applicant	3 phases of 72 hours from June, 3 rd to 19 th	Connected state	1 time for a phase	Mandatory

4.3.3. Modeling with a BP language (behavioral and interactional views)

Scenarios obtained in the collecting phase are obtained from the available documents or after interviews with the actors and may be improper or incorrect. Therefore, the user must restructure these scenarios and define a scenario for each activity. A scenario must be written to reorganize the scheduling information collected previously in ordered sentences. The used scenario model is that of use cases defined by A. Cockburn in (Cockburn, 1997). A scenario must contain all

behavioral and interactional elements of the functional component identified in the previous step. In the first occurrence of the previous step activities was identified. In this step we must identify scenarios of activities. The scenario must contain actions composing the activity, events and interactions. Control flows order the elements of the activity in time. Sometimes they do not correspond to a simple succession. Then they must be associated with workflow patterns which are defined by White in (White, 2004). These workflow patterns when identified in a process must be assigned to a gateway (see figure 5) and described by a sentence in the main scenario. Below, we present an example of two scenarios constructed from information collected from the academic web application. Scenario 2 corresponds to an activity executed by the applicant. Extensions in a scenario correspond to possible exceptions.

Activity n°1: register in the application

Main scenario

1. Action: enter n°INE and date of birth
2. Gateway: exclusive choice
 - 2a. valid data: jump to 3.
 - 2b. invalid data: return to 1.
3. Action: fill in the form
4. Action: enter e-mail address
5. Event: receive a confidential code

Extensions

- 5a. confidential code is not received: return to 4.

Scenario 2 – An activity

Detailed Process n°1: candidature in the application

Main scenario

1. Activity n°1: Register in the application
2. Sub-process n°1: manage choices
 - 2a. sub-process n°2: manage folders.
 - 2b. activity n°9: change choices order.
3. Gateway: parallel split
4. Sub-process n°3: answer propositions

Scenario 3 – A detailed process

After identifying activities and their scenarios, the previous two steps must be repeated to identify sub-processes and their scenarios and detailed processes and their scenarios (Scenario 3). Then the steps must be repeated until defining the complete structure of the studied global process. The structure of every global process may be saved in a functional tree containing all the components of the process (not shown here, but combined with intentional data in the next step in an object diagram represented by the figure 7). The scenarios should be modeled with a business process modeling language. BPMN models incorporate the behavioral, interactional, functional and organizational views. The different forms of data restructured in this phase (the scenarios, the functional tree, and the roles) must be used to construct business process models. Figure 7 depicts the BPMN diagram of the detailed process described by the scenario 3 and an activity of this process described by the scenario 2.

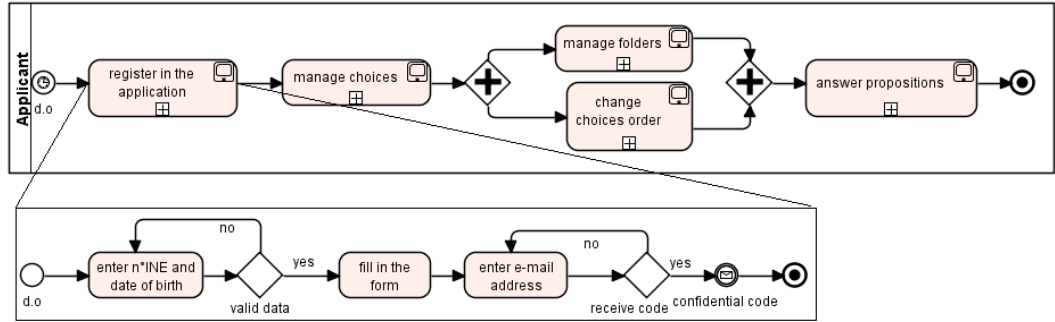


Figure 6 – BPMN diagram for the process “candidature in the application”

The intentional view cannot be modeled with a BPMN diagram. But, it will be modeled in the next step with an object diagram.

4.3.4. Identifying goals (intentional view)

The purpose of this step is to summarize the goals of all processes. After repeating the last two steps for the different composition levels of the global process the modeler can deduce a functional tree representing the different components of the global process. As the modeler restructured the collecting information, the obtained tree will differ from the functional tree obtained in the last phase. The modeler should use the original functional tree and the table of goals to deduce the goals for the obtained functional components. We propose to model these goals and functional components with an object diagram. Figure 7 depicts the object diagram obtained with the global process of the academic web application PostBac. The object diagram does not represent an instance of the intentional or the functional view of the metamodel as we transformed some classes (Customer, Owner, and Process Goal) related with the Process class by associations to attributes of this class.

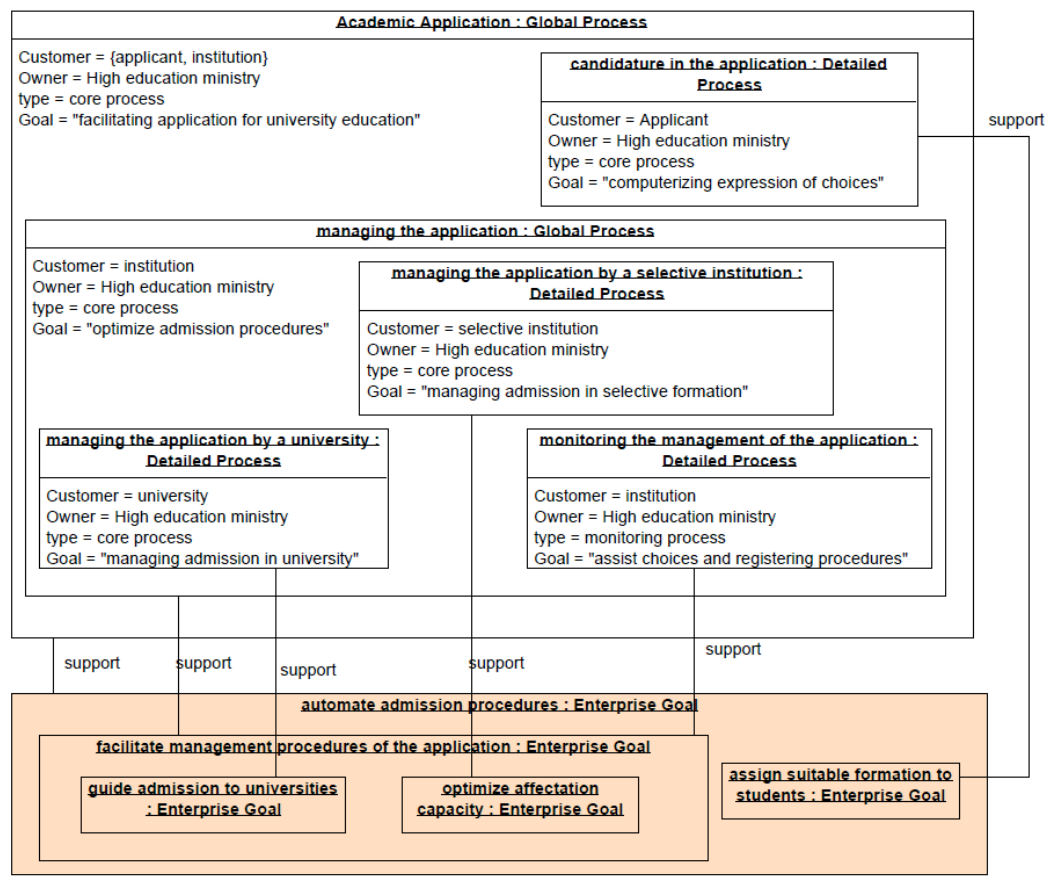


Figure 7 – Functional and intentional view combined in an object diagram

In this work we used an object diagram, but intention oriented languages such as Maps defined in (Rolland, 2007), may also be used to represent the intentional relationships between processes.

5. Conclusions

The method proposed in this article guides the modeler to better organize the modeling work and take into account several details needed to construct efficient process models. The method is based on a metamodel describing the business process from five perspectives and a detailed approach to construct business process models. The method was applied on a web application extracted from the French academic Information Systems. In future works, this reverse-engineering method will be refined in order to be adapted with specific modeling contexts. We aim to work also on a better usage of the views of our metamodel in order to integrate all of them in the business process diagram, especially the intentional view that is not considered in current modeling languages. We aim also to identify links between the views that may be useful in automation or reengineering approach in order to insure a better and easier management of business processes: indeed the results of any modification on a view will be better recognized in other views.

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Testing the Moderating Effects of Relational Interaction versus Reciprocal Investments in RFID Supply Chain Management Systems

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Abstract: This study looks at the perceived ability of two variables, reciprocal investments and relational interaction, to moderate the relationship between the independent variables, components of IT infrastructure integration and supply chain process integration, and two dependent RFID system variables, exploitation and exploration. Using the moderated regression procedure, this study seeks to test the ability of both reciprocal investments and relational interaction to moderate the relationship between the independent and dependent variables using data gathered from 87 firms using an online survey. Results show that relational interaction is an effective moderator between the dependent variable, exploitation, and the following independent variables: data consistency, cross-functional application integration, financial flow integration, physical flow integration, and information flow integration (Table 1). Neither reciprocal investments nor relational interaction effectively moderated the independent variables, IT infrastructure integration and supply chain process integration and the other dependent variable, exploration.

Keywords: radio frequency identification (RFID); supply chain management systems; information technology infrastructure integration; supply chain process integration; reciprocal investments; relational interaction; exploitation; exploration; moderated regression analysis

1. Introduction

The reintroduction of radio frequency identification (RFID) bodes well for supply chain management initiatives across industries that seek new ground for achieving higher level efficiencies and possibly, innovation and competitive advantage. RFID is considered superior to bar codes, the earlier technology it is gradually replacing because of its ability to identify individual items and the attendant promise of enabling end-to-end supply chain visibility especially when combined with sensor and global positioning system technologies (Dos Santos & Smith, 2008; Kamoun, 2008). Value chain visibility, in turn, can ensure the availability of the right products at the right place and time particularly in applications that require fast and accurate data collection, or when many data collection points are involved.

Movement of goods between and among distribution centers can be counter-checked to ensure shipping accuracy and decline in mismatches between invoices and receipts (Microsoft, 2006). Apart from achieving efficiencies in supply chain operations, RFID can be used to

enhance customer relationships through profiling and personalized services. In combination with data mining and business intelligence technologies, RFID data can generate useful customer behaviour insights that can be used to create a “positive feedback effect,” which leading-edge retailers such as Prada and Zara are experimenting with (Osterwalder, Ben Lagha, & Pigneur 2002). High-value, disposable fashion items, for instance, are particularly responsive to these initiatives since the displayed inventory needs to be changed practically weekly. For the more mundane and lower-cost consumer goods, RFID can help suppliers to optimize production and replenishment scheduling, based on real-time demand, in collaboration with distribution centers and retailers (Schwartz & Putta 2006).

At the current time, RFID has not yet reached wide scale diffusion; however, it has already been deployed in many sectors, including the supply chain, logistics, manufacturing, defense, healthcare, retail, transportation, and customs (Kamoun, 2008). Key institutions such as the U.S. Department of Defense and the U.S. Food and Drug Administration, among others, and world-class retailers like Wal-Mart have already mandated tagging at the case and pallet levels. Item-level tagging in the future will enable unprecedented real-time tracking and visibility capabilities. Thus far, spotty but real solid gains have already been reported: Wal-Mart was able to reduce out-of-stocks by 16 percent (Hardgrave, Waller, & Miller 2005) and Metro, a leading German retailer, reported a reduction in out-of-stocks by 11 percent (Johnson, 2005).

A key value proposition of RFID lies in its ability to forge linkages between the front-end (customer facing) and backend systems of members of a digitally linked ecosystem of suppliers, manufacturers, distribution centers, retailers, and customers, and realize a more efficiently managed supply chain (Kamoun, 2008). But doing so will not be easy as the work involved and the negotiations that need to take place to make possible workflow optimization and undertake the necessary reengineering of relevant business applications need to be made. Thus, supply chain trading partners are expected to make reciprocal investments and engage in varying levels of relational interaction in order to share information about supply chain events and thus, be better poised to undertake more advanced initiatives such as demand-driven ordering and collaborative promotion planning.

This study looks at the perceived ability of two variables, reciprocal investments and relational interaction, to moderate the relationship between the independent variables, components of IT infrastructure integration and supply chain process integration, and two dependent RFID system variables, exploitation and exploration.

The IT infrastructure and business process support that should undergird RFID systems are a great concern considering how supply chains are getting more complex and more international in their geographic scope (Simchi-Levi, Kaminsky, & Simchi-Levi, 2004). Firms that will be using RFID systems to gain exploitation-related goals seek to improve operational efficiencies, streamline activities, and achieve greater control over process execution. On the other hand, those that seek exploration-related outcomes will use RFID systems to find innovative ways of solving problems and meeting challenges. The demands on supply chain partners that will be participating in these RFID initiatives will be significant enough for these firms to consider using either relational interaction routines or reciprocal investments in ensuring the attainment of their goals. Reciprocal investments are transaction-specific investments made by supply chain trading partners in a business exchange intended to cement the relationship beyond what is ordinarily delivered by contractual agreements. Relational interaction routines are a combination of formal and informal mechanisms used to facilitate the exchange of information and knowledge between a focal firm and its trading partners.

This study uses the moderated regression procedure to test the ability of both reciprocal investments and relational interaction to moderate the relationship between the independent and dependent variables using data gathered from 87 firms using an online survey.

2. Independent Variables: IT Infrastructure Integration Capability and Supply Chain Process Integration Capability

2.1. IT Infrastructure Integration Capability

IT infrastructure integration is defined as the degree to which a focal firm has established IT capabilities for the consistent and high-velocity transfer of supply chain-related information within and across its boundaries. This study closely looks at the IT infrastructure integration requirements needed to support the use of RFID within a supply chain context. The formative construct introduced by Rai, Patnayakuni, and Seth (2006) was adopted in this study and used both conceptually and in the instrumentation as well. They define IT infrastructure integration in terms of two subconstructs, data consistency and cross-functional SCM application systems integration.

The extent to which data has been commonly defined and stored in consistent form in databases linked by supply chain business processes is referred to as data consistency (Rai, Patnayakuni, & Seth, 2006). Data consistency is a key requirement in creating a data architecture that defines the structure of the data and the relationships among data entities that is fundamental in establishing interorganizational data sharing (Van Den Hoven, 2004). Simchi-Levi, Kaminsky, and Simchi-Levi (2004) note that recently, many suppliers and retailers observed that despite the lack of variation in customer demand for products, inventory and back-order levels vary, nevertheless, across many supply chains, oddly enough. This observed variability up and down the supply chain is called the “bullwhip effect” (Moyaux & Chaib-draa, 2007; Simchi-Levi, Kaminsky, & Simchi-Levi, 2004). Sharing consistent data upstream and downstream in the supply chain is one major solution to overcoming the bullwhip effect.

Data from legacy systems of supply chain trading partners need to be accessed to produce useful, integrated data, and to be able to transport this data into various datawarehouse structures. Often, data from diverse sources is inconsistent and unusable for the integration purposes required for supply-chain wide initiatives.

Cross-functional supply chain management applications systems integration is defined by Malhotra, Gosain, and El Sawy (2005) as the level of real-time communication of a hub firm’s functional applications that are linked within an SCM context and their exchanges with enterprise resource planning (ERP) and other related interenterprise initiatives like customer relationship management (CRM) applications. At the lowest level, an ERP system is essential in enabling the seamless integration of information flows and business process across functional areas of a focal firm --- this is normally referred to as “ERP I” (Law & Ngai, 2007). ERP functionalities are important control and management mechanisms that are connected with the ERP systems of the firm’s trading partner --- referred to as “ERP II”. ERP implementations are growing more extensive and interconnected among firms in linked value chains. Karimi, Somers, and Bhattacharjee (2007) found that ERP projects with greater functional, organizational, or geographic scope result in higher positive shareholder returns.

To obtain optimum results, supply chain trading partners have to inevitably approach a collaborative posture in their relationships which would rely heavily on cross-functional interenterprise integration. To facilitate the realization of this goal, the Supply Chain Council (SCC), a not-for-profit corporation, has endorsed the Supply Chain Operations Reference Model (SCOR) as the cross-industry standard for supply chain management (Holloway, 2006).

2.2. Supply Chain Process Integration

In this study, supply chain process integration is defined following the construct used by Malhotra, Gosain, and El Sawy (2005): the degree to which a hub firm has integrated the flow of information (Lee, et al., 1997), physical materials (Stevens, 1990), and financial information (Mabert & Venkatraman, 1998) with its value chain trading partners. This formative construct has three subconstruct components: information flow integration, physical flow integration, and financial flow integration (Mangan, Lalwani, & Butcher, 2008).

Information has the potential to reduce variability in the supply chain, enable suppliers to make better forecasts (i.e., more accurately accounting for effects of promotions and market changes, for instance), enable the coordination of manufacturing and distribution strategies, enable lead time reduction, and enable retailers to service their customers better by providing preferred items and avoiding out of stock situations (Simchi-Levi, Kaminsky, & Simchi-Levi, 2004).

This study uses the construct, information flow integration, to mean the degree to which a firm exchanges operational, tactical, and strategic information with its supply chain trading partners (Malhotra, Gosain, & El Sawy, 2005). The instrument used in this study measures the sharing of production and delivery schedules, performance metrics, demand forecasts, actual sales data, and inventory data, for information flow integration.

Malhotra, Gosain, and El Sawy (2005) define physical flow integration as the level to which the hub firm uses global optimization with its value chain partners to manage the flow and stocking of materials and finished goods. Raw materials, subassemblies, and finished goods constitute downstream physical flows, whereas returned products for defects or repairs make up the upstream physical flows. In this study, physical flow integration is measured in terms of multi-echelon optimization of costs, just-in-time deliveries, joint management of inventory with suppliers and logistics partners, and distribution network configuration for optimal staging of inventory (Malhotra, Gosain, & El Sawy, 2005).

Financial flow integration is defined as the level to which a hub firm and its trading partners exchange financial resources in a manner driven by workflow events (Malhotra, Gosain, & El Sawy, 2005). Value chain participants that do not have well-designed business processes often do not have consistent views of important financial downstream flows such as prices, invoices, credit terms and upstream financial flows that could include payments and account payables (McCormack & Johnson, 2003).

3. Dependent Variables: Exploitation versus Exploration

Drawing from the theory of learning and action (March, 1991) this study uses the two main categories of IT employed by firms in their value chains: exploitation and exploration. "Exploitation" activities seek to improve operational efficiencies (i.e., through increased standardization, tighter process controls, and reduced manual intervention), streamline activities, and achieve greater control over process execution. "Exploration" activities, on the other hand, involve risk taking, experimentation, and innovation to find novel ways of solving old problems (Pitoura & Bhargava, 1999). Recent literature in management has pursued the idea that "ambidexterity," meaning the ability to pursue both exploitation and exploration activities by a firm and its expected positive effect on firm performance. He, Wong, and Kam (2004) tested this ambidexterity hypothesis by examining how exploration and exploitation can jointly influence firm performance in the context of firms' approach to technological innovation. Using a sample of 206 manufacturing firms, the authors argue for a balanced approach towards both and found that the interaction between explorative and exploitative innovation strategies is positively related to

sales growth rate, and that the relative imbalance between explorative and exploitative innovation strategies is negatively related to sales growth rate.

The concepts of exploitation and exploration have been used in a number of studies (Kyriakopoulos & Moorman, 2004; Rothaermel & Deeds, 2004; Holmqvist, 2004; Ozsomer & Gencturk, 2003) but none of them involves RFID within a supply chain context.

4. Moderator Variables: Reciprocal investments versus Relational interaction

Reciprocal investments are transaction-specific investments made by trading partners in a business exchange relationship (Artz, 1999). Williamson (1996) suggested that a mutual reliance relationship develops when both parties invest assets in each other and put them at risk, thus, discouraging the occurrence of opportunistic behaviors on the part of both parties. Thus, reciprocal investments appear to reduce the transaction costs associated with writing, monitoring, and enforcing contractual agreements (Bromiley & Cummings, 1991) and encourage long-term, stable cooperative relationships (Zaheer & Venkatraman, 1995). When a focal firm makes such investments in a small number of business exchange partners, the intention to commit is even more credible (Bakos & Brynjolfsson, 1993).

Relational interaction routines are defined as a combination of both formal and informal mechanisms used to facilitate the exchange of information and knowledge between a focal firm and its trading partners (Patnayakuni, Rai, & Seth, 2006). Organizational routines or a formalized set of procedures put in place so that the firms in the relationship could explore opportunities for improvement by promoting predictable task performance and enabling coordination patterns, process configurations, and communication processes that support the sharing of information and knowledge. One such opportunity lies in planning and coordinating supply chain activities using information flows (Okhuysen & Eisenhardt, 2002). Siemenieniuch, et al. (1999) in fact, found that the integration of information flows between supply chain partners, in fact, resulted when the firms focused on know-how involved in collaborative planning.

5. Hypotheses

This study purports to test the following hypotheses:

H1: The positive relationship between IT infrastructure integration (i.e., data consistency and cross-functional application integration) and exploitation will be moderated by reciprocal investments--- i.e., the higher the level of reciprocal investments, the greater the positive relationship between IT infrastructure integration and exploitation.

H2: The positive relationship between IT infrastructure integration (i.e., data consistency and cross-functional application integration) and exploration will be moderated by reciprocal investments--- i.e., the higher the level of reciprocal investments, the greater the positive relationship between IT infrastructure integration and exploration.

H3: The positive relationship between IT infrastructure integration (i.e., data consistency and cross-functional application integration) and exploitation will be moderated by relational interaction--- i.e., the higher the level of relational interaction, the greater the positive relationship between IT infrastructure integration and exploitation.

H4: The positive relationship between IT infrastructure integration (i.e., data consistency and cross-functional application integration) and exploration will be moderated by relational

interaction--- i.e., the higher the level of relational interaction, the greater the positive relationship between IT infrastructure integration and exploration.

H5: The positive relationship between supply chain process integration (i.e., financial flow integration, physical flow integration, and information flow integration) and exploitation will be moderated by reciprocal investments--- i.e., the higher the level of reciprocal investments, the greater the positive relationship between supply chain process integration and exploitation.

H6: The positive relationship between supply chain process integration (i.e., financial flow integration, physical flow integration, and information flow integration) and exploration will be moderated by reciprocal investments--- i.e., the higher the level of reciprocal investments, the greater the positive relationship between supply chain process integration and exploration.

H7: The positive relationship between supply chain process integration (i.e., financial flow integration, physical flow integration, and information flow integration) and exploitation will be moderated by relational interaction--- i.e., the higher the level of relational interaction, the greater the positive relationship between supply chain process integration and exploitation.

H8: The positive relationship between supply chain process integration (i.e., financial flow integration, physical flow integration, and information flow integration) and exploration will be moderated by relational interaction--- i.e., the higher the level of relational interaction, the greater the positive relationship between supply chain process integration and exploration.

6. Research Methodology

Data for this pilot research study was collected using a survey questionnaire administered online to members of the Council of Supply Chain Management Professionals (CSCMP). The data analyzed for this paper was drawn from a convenience sample of 87 firms that responded to a certain part of the survey questionnaire --- these are organizations that had not yet implemented RFID but are knowledgeable about it or may be implementing RFID in the future. The specific items used for IT infrastructure integration (i.e., data consistency and cross-functional application integration) and supply chain process integration were borrowed from Rai, Patnayakuni, and Seth (2006); items for exploitation and exploration were borrowed from Subramani (2004); and items for reciprocal investments were drawn from Son, et al. (2005) and the items for relational interaction, from Patnayakuni, et al. (2006).

Since the organizations have not yet implemented RFID, the survey respondent was asked to indicate their perceptions of the importance of the independent, dependent, and moderator variables using multiple items per construct. Seven-point Likert scales were used with minimum-maximum anchoring points appropriate to the construct being measured. The computer program SPSS version 15 was used in conducting a series of simple regression data analyses and their associated moderated regression analysis runs.

7. Data Measurement Properties

The internal consistency of the items constituting each construct was assessed using Cronbach's alpha and the results are in conformance with Nunnally's (1978) guidelines of getting values of .70 or above. Generally speaking, the items have internal consistency with values beyond the .70 threshold recommended. The different variables used in the study showed the following reliability results: data consistency (Cronbach alpha=.944); cross-functional application integration (Cronbach alpha=.930); exploitation (Cronbach alpha=.918); exploration (Cronbach

alpha=.936); reciprocal investments (Cronbach alpha=.964); and relational interaction (Cronbach alpha=.962).

To establish convergent and divergent validity, the item-to-total correlations of the constructs were examined and, in general, the specific items have a stronger correlation with the construct than with other items (Rai, Patnayakuni, & Seth, 2006).

8. Sample Profile Description

The convenience sample consists of a total of 87 firms from the membership of the Council of Supply Chain Management Professionals that responded to a certain part of the survey questionnaire --- these were the firms that constitute the convenience sample of organizations that are knowledgeable about RFID or may be implementing RFID in the future. About 51.06 percent of the firms had 1,000 or less employees and 32.62 percent had more than 1,000 employees. The following profile shows the membership of the firms in different industry sectors: service (78.57 percent), manufacturing (21.43 percent).

9. Moderated Regression Procedure

Moderated regression analysis tests whether the relationship between two variables changes depending on the value of another variable (i.e., interaction effect) (Aguinis, 2004). The moderator variable explains changes in the nature of independent variable to the dependent variable effect, and provides information concerning the conditions under which an effect or relationship is likely to be stronger.

Regression analysis was conducted to test the hypotheses presented in this study. The moderated regression procedure requires testing first order effects, which in this study, will be referred to as “model 1.” A model 1 simple regression tests the direct effects of a predictor variable on a dependent variable. Simple regressions, therefore, were ran between each of the independent and the dependent variables. The variance in the dependent variable on account of the independent variable is noted using the R^2 value. Then, the regression procedure testing second order effects is conducted, which will be referred to as “model 2” in this study. A model 2 regression duplicates the model 1 regression equation and adds the product term which includes the hypothesized moderator variable.

It is important to determine how large the change in R^2 should be in order to qualify as “practically significant” or one that should merit serious attention (Aguinis, 2004). After conducting a Monte Carlo simulation, Evans (1985) stipulated that “...a rough rule would be to take 1% variance explained as the criterion as to whether or not a significant interaction exists in the model...” (p. 320). Evans found that in conducting the simulation, when the population scores included a moderating effect, results based on samples consistently demonstrated an R^2 change that was 1 percent or higher. On the other hand, when the population scores did not include a moderating effect, the change in R^2 was usually smaller than 1 percent. In conclusion, empirical and simulation results appear to indicate that a statistically significant R^2 change of about 1 percent to 2 percent demonstrates an effect size worthy of consideration. The results in this study include significant R^2 change values within the range with a maximum value of 5.5 percent and a minimum value of 2.1 percent, which indicate considerable significant moderating effects of one of the proposed moderator variables, relational interaction.

SPSS was used to run the regression equations and model 1 was specified for block 1 and model 2 was specified for block 2. The resulting R^2 values need to be noted for models 1 and 2.

If the R^2 value is greater for model 2 than for model 1, then, the moderator variable included in the product term is demonstrating a moderating effect.

10. Findings

Hypotheses 3 and 7 were supported by the study findings. Results show that relational interaction is an effective moderator between the dependent variable, exploitation, and the following independent variables: data consistency, cross-functional application integration, financial flow integration, physical flow integration, and information flow integration (Table 1). Neither reciprocal investments nor relational interaction effectively moderated the independent variables, IT infrastructure integration and supply chain process integration and the other dependent variable, exploration.

Results are shown here in descending order of importance based on the percent R^2 change resulting from the introduction of a product term, *RelaInteract3Cat1*, in the regression equations. “*RelaInteract3Cat1*” is the categorical variable that represents the mean of the different items that constitute this construct. Table 1 shows the results of running two regression models: model 1 shows the relationships between the predictor variables and exploitation, without the product term, and model 2, the regression results with the inclusion of the product term. In predicting exploitation, relational interaction appears to be the more powerful moderator variable compared to reciprocal investments in accounting for the variance in the increase in exploitation over and above the variance explained by the independent variables data consistency, cross-functional application integration, financial flow integration, physical flow integration, and information flow integration, as separate independent variables in model 1 equations. As Table 1 shows, with relational interaction as the moderator variable, the percentage increase in variance for exploitation were both considerable and significant for the following independent variables: 1) financial flow integration (5.5 percent, $p < .00$); 2) cross-functional application integration (5.2 percent, $p < .01$); 3) data consistency (3.4 percent, $p < .01$); 4) information flow integration (2.9 percent, $p < .01$); and 5) physical flow integration (2.1 percent, $p < .05$).

The table column labeled “% Variance Explained by Moderator with Product Term” indicates the contribution of the product term --- which is the product of the moderator variable, in this case, relational interaction and the specific predictor variable. And so, for instance, in the case of financial flow integration, the product term would be the product of coordination information exchanged and IT infrastructure integration (i.e., *FinancialFlow3XRelaInteract3Cat1*). The next column label shows “F Value of Model 2 (degrees of freedom), which means that the F value of model 2 which includes the product term is shown along with the degrees of freedom for that regression model. The significance of the F change from model 1 to model 2 is indicated by the last column.

Table 1 Moderated Regression for Exploitation as Dependent Variable with Relational Interaction as Moderator (N=87)

Independent Variables: Data consistency, cross-functional application integration (both are components of IT infrastructure integration); financial flow integration, information flow integration; physical flow integration (all are components of supply chain process integration)					
Dependent Variable: Exploitation					
Moderator Variable: Relational Interaction whose variable name is "RelaInteract3Cat1" (Nominal variable for the mean for relational interaction items)					
Independent Variable	Model 1: R2 Without Product Term	Model 2: R2 With Product Term	% Variance Explained by Moderator with Product Term	F Value of Model 2 (degrees of freedom)	Significance of F Change
Financial flow integration	.614	.669	5.5%	56.023 (3,83)	p<.000
Cross-functional application integration	.475	.527	5.2%	30.829 (3,83)	p<.003
Data consistency	.557	.591	3.4%	40.026 (3,83)	p<.01
Information flow integration	.631	.660	2.9%	53.631 (3,83)	p<.01
Physical flow integration	.659	.680	2.1%	58.852 (3,83)	p<.023

The relationships between the predictor variables and exploitation as moderated by relational interaction should be interpreted accordingly. Let's take the case of financial flow integration, the predictor variable whose relationship with exploitation is significantly moderated to the greatest extent by relational interaction (i.e., largest percentage increase in variance of 5.5 percent). About 61.40 percent of the variance in exploitation is explained by financial flow integration and relational interaction as indicated by model 1 in Table 1. Model 2 is, then, introduced by including the product term (i.e., i.e., FinancialFlow3XRelaInteract3Cat1) which represents the interaction between financial flow integration and relational interaction. As shown on Table 1, the addition of the product term resulted in an R^2 change of .669, $F(3,83) = 56.023$, $p<.000$. This result supports the presence of a moderating effect. In other words, the moderating effect of relation interaction explains 5.5 percent in the increase in exploitation over and above the variance explained by financial flow integration and relational interaction as separate independent variables.

The relationships between the remaining predictor variables and operational efficiency should be conducted accordingly as well: business process modularity; privileged information exchanged; and standard electronic business interfaces.

11. Discussion and Conclusions

The overall study findings support the importance of relational interaction as a moderator variable between the two elements of IT infrastructure integration, data consistency and cross-functional application integration, and the three elements of supply chain process integration, namely, financial flow integration, information flow integration, and physical flow integration and one of the two dependent variables, exploitation. The descriptive data shows that the reported means for relational interaction items were greater than the means for reciprocal investments: 1) relational

interaction (item 1 mean = 4.65; item 2 mean=4.61; item 3 mean=4.84; item 4 mean=4.61; overall mean for relational interaction = 4.6775); reciprocal investments (item 1 mean= 3.67; item 2 mean= 3.93; item 3 mean = 4.00; overall mean for reciprocal investments = 3.8667). A one sample T test indicates a significant difference between the relational interaction and reciprocal investments means ($p < .000$). It appears that the relationships between the respondent firms and their trading partners (TP) are in the early stages of development as study respondents are not yet confident that their TPs would make the reciprocal investments needed for education in the use of RFID, initial support in developing RFID linkages, and exchanging business documents using the RFID linkages within a long-term partnership context. Study participants expressed more self-assurance that both their firm and their TPs would have relational interaction routines that would put in place organizational mechanisms that would facilitate information exchange, encourage quality and improvement initiatives, sharing of best practices, and learning about new technologies and markets. It is important to note that it is not necessary to make asset specific and trading partner-specific reciprocal investments in order to put these relational interaction routines in place. Firms could use digital and electronic linkages that already have in place in dealing with other supply chain trading partners to support relational interaction coordination mechanisms.

The firms in the sample intend to use the RFID system primarily for exploitation (mean = 4.5160) rather than exploration (mean = 3.7423); once again, t tests indicate a significant difference between the two means ($p < .000$). This study's major finding that highlights the significant results for exploitation rather than for exploration reconfirm findings of current and past studies. From the Sanders study (2008) involving 241 first-tier suppliers, it was found that majority of the firms used IT mainly for exploitation rather than exploration as IT activities are more conducive for exploitation which mainly involves business process automation to promote task efficiency. The author also surmised that IT may not be as well suited for exploration, which appears to require more face-to-face interaction. In their longitudinal dataset of firms involved in networked alliances active during 1987-96, Vanhaverbeke, Gilsing, Duysters (2007) found that the optimal number of alliances is larger for those pursuing exploitation as opposed to exploration. This may very well encourage the participation of firms in collaborative exploitation initiatives as well. Even way back in the early nineties, March (1991), one of the major proponents of the exploitation/exploration concepts, observed the preponderance of firms engaging in exploitation rather than exploration due to the fact that exploitation results in immediate positive local feedback.

These study's findings should alert supply chain managers involved in forthcoming RFID system implementation initiatives to design in relational interaction coordination mechanisms to assure the attainment of their exploitation goals.

The study has a number of limitations. First of all, study participants that were knowledgeable about RFID or may be implementing RFID in the future were asked to report their perceptions of the importance of the variables used in the study: IT infrastructure integration, supply chain process integration, exploitation, exploration, reciprocal investments, and relational interaction. A future study should capture these perceptions from firms that have actually implemented RFID systems. Second, the data was gleaned from a convenience sample of 87 firms that responded to those items in the survey questionnaire. In the future, a random sample is needed in order to arrive at representative implications and generalizations.

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EIS adoption

Researching the Adoption and Implementation of Innovative Enterprise Information Systems

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Abstract: An Information System must be adopted before it can be used, and this paper discusses issues involved with the adoption of technological innovations. In understanding what is involved in adoption it is important to determine the factors that go towards enabling or inhibiting this adoption. Apart from the details and characteristics of the technology itself, of necessity this investigation involves socio-technical research where human interactions with other humans and with the technology are important. The paper briefly discusses several approaches to the theorizing of technological innovation, and proposes Innovation Translation, informed by Actor-Network Theory, as an approach that can be particularly useful in investigating cases of adoption by individual organisations. Finally, the paper makes use of Innovation Translation to analyze a number of cases of the adoption of Information Systems.

Keywords: Innovation; adoption; enterprise information systems; innovation translation; actor-network theory.

1. Introduction

Just because a new Enterprise Information System (EIS) has been built and made available, this does not mean that it can automatically be assumed that organisations or individuals will want to adopt or to use it. Even if an organisation does adopt a new innovation, it also cannot be assumed that its employees will want to use it, and even if they have no choice and are made to use it, that they will get the most out of it. A new Information System will only be adopted if potential users make a decision to do so, and the adoption of any technological innovation, including a new Information System, occurs for a variety of different reasons.

A large amount of the research in the discipline of Information Systems involves an investigation of the implementation, adoption and use of new or updated systems. The first step in researching the adoption of a new Information System by an organisation (or an individual) is thus to investigate why it was adopted, and so consider the new system as a technological innovation. This can best be done by examining the adoption through the lens of innovation theory (Tatnall, 2009a).

There is, of course, no value in designing and building an enterprise information system that is either not adopted in full or not used to capacity. Much of the design and development is then just wasted, and so the issue of adoption is crucial to any form of information systems research. This paper will illustrate why an appreciation of some of the more subtle points of technological innovation is important, as are the socio-technical issues involved in facilitating or inhibiting this

adoption. The paper discusses several different approaches to theorizing technological innovation and gives some examples of using one such approach.

Before going any further we should distinguish between invention and innovation. Whereas invention refers to creating and building new artefacts or the discovery of new ideas, innovation involves making use of these artefacts or ideas in commercial or organisational practice (Maguire, Kazlauskas, & Weir, 1994). Obviously a new Enterprise Information System can be seen as an invention, but the important point here is that it will not be used unless it is adopted, and that means looking at it also as a technological innovation.

The application of innovation theory to any technological adoption assumes, of course, that the potential adopter, whether this is an organisation or an individual, has some choice in deciding whether or not to make the adoption. Further, if a business does decide to make the adoption then it should be considered whether or not its employees will have some choice in using it. The old saying: *'You can lead a horse to water but you can't make it drink'* comes to mind here. All this said, I have found that in my research the application of innovation adoption theory can be very useful when considering the adoption, implementation and use of Enterprise Information Systems.

2. Socio-Technical Research

The methodological approach used in Information Systems research depends, of course, on the type and nature of research being undertaken, and will most likely differ depending on whether this relates to EIS technology adoption, implementation or use. In this paper however, I will consider research that in some way relates to the adoption and use of an EIS by some particular organisation, and this will probably involve some form of case study.

There are a variety of approaches to socio-technical research, but I have found actor-network theory (Callon, 1999; Latour, 1993, 1996; Law, 1991) to be particularly useful. While many other approaches to research in technological areas treat the social and the technical in entirely different ways, actor-network theory (ANT) proposes instead a socio-technical account in which neither social nor technical positions are privileged (Tatnall, 2007; Tatnall & Gilding, 1999).

In the previous section I argued that research into the implementation and use of Information Systems should see these as innovations which must be adopted before they can be used. I further argued that this is best handled by taking a socio-technical, innovations-based stance. In the next section I will briefly examine several different approaches to theorising innovation.

3. Theoretical Approaches to Innovation Adoption

As previously discussed, to investigate the adoption of new ideas or technologies it is useful to follow one of the theories of technological innovation (Al-Hajri & Tatnall, 2007). One important difference between some of these theories is the degree to which the adoption decision is seen as completely rational, and whether provision is made for partial adoption (Tatnall, 2009b). A brief discussion of the main approaches to theorising innovation follows.

A number of approaches exist to modelling how technological innovation takes place, including the Theory of Reasoned Action (Ajzen & Fishbein, 1980), the Theory of Planned Behavior (Ajzen, 1991), the Technology Acceptance Model (F. D. Davis, 1986), Diffusion of Innovations (Rogers, 1995, 2003) and Innovation Translation (Callon, 1986; Latour, 1996). In particular, both the Diffusion of Innovations and the Technology Acceptance Model (TAM) are very well known and widely used approaches to theorising technological innovation.

3.1. The Technology Acceptance Model (TAM)

The *Technology Acceptance Model* (TAM) assumes that a computer user normally acts rationally and uses information in a systematic manner to decide whether or not to adopt a particular technology. Davis (1986) identifies major determinants of technology acceptance and, beginning with the Theory of Reasoned Action (Ajzen & Fishbein, 1980), specifies a basis for causal links between the technology's perceived usefulness and perceived ease of use along with the individual's attitude towards using technology and behavioural intention to explain technology adoption (F. D. Davis, 1986, 1989; Fred D. Davis, Bagozzi, & Warshaw, 1989).

Benefits claimed for the use of TAM suggest that it provides EIS designers with information about how and where to modify design to enhance information systems (IS) acceptance, and that it provides EIS implementers with information about how and where to manage IS implementation (Al-Hajri & Tatnall, 2008). Many studies of Information Systems adoption, implementation and use (such as F. D. Davis, 1989; Lederer, Maupin, Sena, & Zhuang, 2000; Segars & Grover, 1993; Taylor & Todd, 1995) have made use of TAM.

3.2. Diffusion of Innovations

Rogers' classic work on the theory of *Diffusion of Innovations* has been evolving now for over forty years, and his well known book is now in its fifth edition (Rogers, 2003). Rogers describes diffusion as: "... the process by which an innovation is communicated through certain channels over time among the members of social systems" (Rogers, 1995 :5), and so a decision not to adopt an innovation relates to the rejection of the new idea. Rogers asserts that a technological innovation embodies information that has the potential to reduce uncertainty and that diffusion is thus an information exchange process amongst members of a communicating social network driven by the need to reduce uncertainty. He considers the main elements of diffusion to be: characteristics of the innovation, the communication channels, the passage of time and the social system. To explain the rate of adoption of innovations Rogers (1995) suggests consideration of the following perceived characteristics of innovations: relative advantage, compatibility, complexity, trialability and observability (Tatnall, 2005).

3.3. Problems with TAM and Innovation Diffusion

One of the difficulties faced in investigating the adoption of technological innovations is that not all innovations are adopted in the form in which they were proposed – not all are adopted without change. This raises the question of just what was adopted in each case if it was in some way different from what was proposed by its instigator. Neither TAM nor Innovation Diffusion, however, take this into account to any degree (Tatnall, 2009c).

Another problem with each of these theories is that they assume that much of the reason for the adoption, or non-adoption of the technology is due to characteristics of the innovation itself. While not presenting too much of a problem for large scale adoptions spanning whole countries or regions, for individual instances of adoption this essentialist view (Grint & Woolgar, 1997) leaves little room for a consideration of socio-technical issues and an investigation of why individual humans and organisations react differently to adoption of the same technology.

4. Actor–Network Theory and Innovation Translation

An alternative approach that I have found to be very useful is that of *Innovation Translation*, informed by actor-network theory (ANT). This approach considers the world to be full of hybrid entities (Latour, 1993) containing both human and non-human elements and offers the notion of heterogeneity to describe projects, such as the adoption of an Enterprise Information System, that involve many actors such as: computer technology, the Internet, broadband connections, Internet service providers (ISP), users and the individuals or organisations considering the adoption. Unlike TAM and Innovation Diffusion, rather than recognising in advance supposed essential characteristics (Grint & Woolgar, 1997) of humans and of social organisations and distinguishing their actions from the inanimate behaviour of technological and natural objects, ANT adopts an anti-essentialist position in which it rejects there being some difference in essence between humans and non-humans. ANT makes use of the concept of an actor that can be either human or non-human, and that can make its presence individually felt by other actors (Law, 1987).

More specifically though, it is often the case that when an organisation (or individual) is considering a technological innovation they are interested in only some aspects of this innovation and not in others (Tatnall, 2002; Tatnall & Burgess, 2002). In actor-network terms it needs to *translate* (Callon, 1986) this piece of technology into a form where it can be adopted. This may then mean choosing some elements of the technology and leaving out others. ANT makes use of a model of technological innovation which considers these ideas along with the concept that innovations are often not adopted in their entirety but only after translation into a form that is more appropriate for the potential adopter. The result is that the innovation finally adopted is not the innovation in its original form, but a *translation* of it into a form that is suitable for use by the recipient (Tatnall, 2002).

I would argue that Innovation Translation has many advantages as an explanatory framework over both Innovation Diffusion and TAM in small scale socio-technical studies like this. A researcher using an Innovation Translation approach to studying innovation would concentrate on issues of network formation, investigating the human and non-human actors and the alliances and networks they build up. They would attempt to identify the actors and then to follow them (Latour, 1996) in identifying their involvement with the innovation and how they affect the involvement of others. The researcher would then investigate how the strength of these alliances may have enticed the individual or organisation to make the adoption or, on the other hand, to have deterred them from doing so (Tatnall, 2002; Tatnall & Gilding, 1999).

5. Examples EIS Adoption Explained Using Innovation Translation

Several examples of using the Innovation Translation approach to research the adoption or implementation of Enterprise Information Systems will now be offered (Tatnall, 2009b). In this paper these will, of necessity, be brief but references to the full studies are given.

5.1. Adoption of Internet Banking in Oman

Oman is a developing country committed to economic growth but with a banking industry that is yet to embrace Internet technology. A recent study (Al-Hajri & Tatnall, 2008) investigated reasons why this might be the case by looking at banks in Oman and comparing them with banks in Australia where the adoption of Internet technology was well advanced. Interviews were

conducted with strategic, tactical and operational managers at each of nine major banks, five in Oman and four in Australia.

Bankers in both countries saw the use of Internet technologies as offering considerable advantages including: convenience of available service and location, being able to rapidly develop innovative ideas, and the ease with which requests and complaints could be followed up. Both saw improvements in productivity of bank employees and customer satisfaction as important enabling factors, but issues of customer trust relating to privacy and Internet security as inhibitors. There were, however, some important differences. While profitability was regarded as an enabler by Australian banks, which had already installed this technology, it was regarded as an inhibitor by the Omani banks due to the high cost of setting this up. Customer commitment (loyalty) was seen as an enabler by Australian banks but as an inhibitor in Oman where bank customers still appreciate the personal attention available in local bank branches (Al-Hajri & Tatnall, 2008).

Initially, this study was analysed using TAM, but its socio-technical nature was recognised and well understood. Details of the technology were important here, but so were other factors and an actor-network analysis suggests that these were, in many ways, more important than the technology itself. Interactions between bank employees and between bank employees and customers were found to be equally, if not more important than considerations of the technology. Also, issues of dealing with the humans involved, and not just the technology, should not be overlooked, and an ANT approach assures this.

5.2. Adoption of Medical Information Systems by GPs in Australia

Although many clinical informatics products have been developed to support medical general practitioners (GP) in all aspects of their work, it is apparent that while most medical general *practices* are using information and communication technology (ICT) for administrative purposes, general *practitioners* themselves are not making as much use of these systems as they could (Deering & Tatnall, 2008). An ANT study of the adoption of medical informatics by rural GPs in a region just to the north-west of Melbourne (Deering, 2008) found that in one medical practice, the non-adoption of technology had nothing to do with the nature or characteristics of the technology itself, but because the father of the present Practice Principal was not comfortable with technology. As he was not far off retirement, but still practicing at the time, no one wanted to make him feel uncomfortable by introducing technology with which he was not familiar. He was an important part of the Practice that they could not afford to lose.

This case clearly illustrates the human side to adoption decisions. In this case the decision to delay adoption had nothing to do with any perception that the software might be immature or that the patients would not accept it. It had nothing to do with any need for training of the staff, but everything to do with the respect for one particular doctor. Studies of other practices in the region produced similar results.

5.3. Adoption of a Business-to-Business Portal by SMEs in Melbourne

Another example of EIS adoption is provided by a not-for-profit organisation's implementation of a Business-Business (B-B) Web Portal almost ten years ago in the Western region of Melbourne (Tatnall & Burgess, 2002): we will call this organisation Westernesse. The idea was to develop a B-B portal, complete with a payment gateway, to facilitate trading between small to medium enterprises (SME) in the local area.

The Portal was created primarily with an internal regional focus: to use the Portal you had to be from a business in Melbourne's West. The SMEs in this region, however, proved reluctant to fully adopt this new facility and a number of reasons for this can be postulated. I will begin by considering whether this was due to the characteristics of the Portal, as a simplistic view would

have it that businesses make their adoption decisions primarily because of the Portal's characteristics (Tatnall, 2009a). Interviews with stakeholders, however, dispelled this view and indicated that business needs and expectations were a much more significant factor.

Other interviews indicated that reasons for adoption were not closely related to the characteristics of the technology itself as Innovation Diffusion (Rogers, 1995) would suggest. Most of the companies that adopted the Portal early knew little about the technology but were excited by the concept of getting onto the Web and just wanted to be involved. A typical response was from a small printing company: "I think that we saw that the opportunities are just fantastic, I went into it straight away and we received a lot of assistance. The other thing was that being a small company, advertising can be quite expensive, and we thought that if we can get this free it would be fantastic." This business wanted to *translate* (Callon, 1986) the Portal primarily to become a means of advertising and were not really interested in some of its other features. Another response was from the IT Manager of a small textile company: "I think the way that we will go is like many businesses; we will dip our toe in the water and do some basic ordering: stationery that's a common one." This also involved a translation of the Portal to become a means of ordering supplies. Some of the businesses were just beginning to use ICT, an example being a cold storage and transport company: "We have just finally got all our computers in the office here networked in the last three weeks ... and we'll have everyone linked into the Portal." The manager indicated that a major reason that this company adopted the Portal was the hope that it would provide a better opportunity to deal with people in the local region (Tatnall & Burgess, 2002). This was important to him. He could see use of the Portal changing his business by enabling it to use people in the local region, and that "working together for the benefit of everybody" would be advantageous for the region.

5.4. The Greypath Portal

The GreyPath Portal (Lepa & Tatnall, 2002, 2006) is a community Portal set up to fill the Web access needs of 'older people'. GreyPath was designed to provide information, services, facilities and useful links for use by these older people and although carrying some advertising and offering some services for a charge, use of the Portal is free.

One reason often given by older people for adopting Internet technologies (Bosler, 2001; Gross, 1998) through devices such as use of the GreyPath Portal is, quite simply, so that the world does not pass them by and so that they won't be left out of things (Lepa & Tatnall, 2006). The means of social interaction is increasingly moving away from posted letters to e-mail, and those not using e-mail are finding it harder to keep in touch. A growing number of older people are finding that an e-mail address has become essential (Lepa & Tatnall, 2006; Perry, 2000). Many older people also consider that being able to keep in touch and to converse sensibly with their grandchildren is very important (Alexander, 2000). As this requires that they spend some time coming to grips with, and using the technology they make adoption decisions for this reason.

These, and related reasons for adoption of Internet technologies such as "All my friends use e-mail and I'll be left out if I don't" (Council on the Ageing, 2000) suggest that characteristics of the technology have less to do with things than do social interactions and the creation and maintenance of interpersonal networks. For older people the issue of whether or not to adopt Internet technologies has been problematised (Callon, 1986) in this context, not as one that relates to diverse characteristics of the technology, but as one *specifically* of communication and keeping in touch with family and friends. The Portal has been *translated* here to include just the means by which these people can maintain their place in society and keep relevant to their family and friends. What they have adopted is not the Portal as a business might know it, but a translation resulting in technology that offers a means of maintaining contact with the world (Tatnall, 2009a).

5.5 Other Current ANT Adoption Research

A number of other research projects looking into the adoption of Enterprise Information Systems are currently in progress at Victoria University. These include a study investigating the adoption of business intelligence by Australian companies that make use of Enterprise Resource Planning (ERP) systems, investigation of the adoption of ICT in schools of the indigenous Mapuche tribes in the southern region of Chile, use of ICT in special schools in Melbourne for children with learning disabilities, and the adoption and use of knowledge management software by a Government Department in Thailand. These studies will be reported on at a later date.

6. Actor–Network Theory and the Research Process

The main method advice offered by Latour in conducting an ANT research project is to “Follow the Actors” (Latour, 1996), but this is just a beginning. When using ANT the research process that is followed is far from linear and not just simply a matter of collecting data, analysing the data then writing it up. The process could better be seen as an iterative one, something more like that shown below:

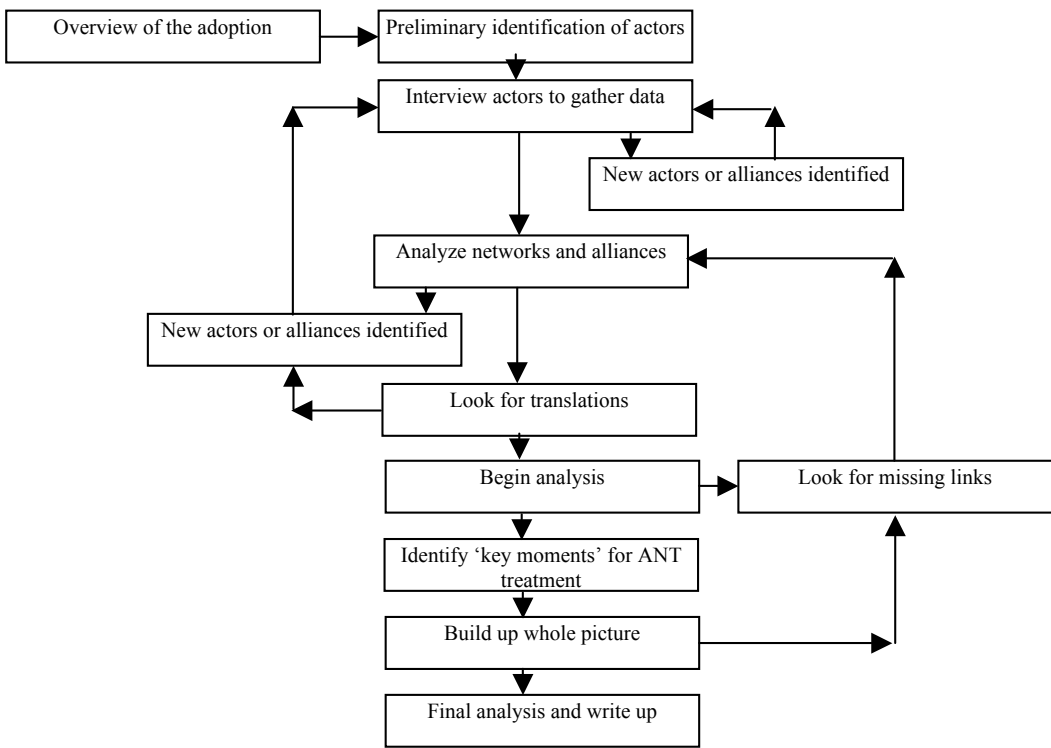


Figure 1 The ANT Research Process (Tatnall, 2007)

After the actors have been identified and ‘interviewed’ and networks of interactions between actors have been examined, the process continues to look for new actors and for how the technology may have been translated in the process of adoption. The figure above attempts to illustrate something of the complexity and iterative nature of this process.

7. Implications for EIS Management

As mentioned earlier, there is no point spending time, effort and money on designing and developing an EIS if it is then not used properly. In managing this development process it is thus important to understand something of how technological innovation occurs, and why some technologies are adopted in full but others only in part. It is most useful for managers to have an understanding of the process of technological innovation and in particular of the sorts of things that can facilitate or inhibit adoption.

In the Banking Industry in Oman, for example, an understanding of the factors that would make adoption of Internet technologies more likely would allow those involved to pursue some approaches rather than others. For instance they could look at ways to convince their customers that use of these technologies would be a good thing, so removing one inhibiting factor. With the adoption of medical ICT the example given in this paper suggests that it is important for management to look at human as well as technology issues. Management likewise at Westernesse and GreyPath would be well advised to look at human rather than just technology issues.

What all this comes down to is that if a manager understands the process of innovation adoption and of the likely enablers and inhibitors then she can act so as to identify forces of each type that are operating and then attempt to promote the driving forces while removing the restraining forces (Lewin 1947). Unfortunately, although this is easy to say it is not so easy to do!

8. Conclusion

In this paper I have outlined some of the advantages of using an Innovation Translation approach to theorising innovation adoptions. This is not to suggest, however, that Innovation Translation offers a better approach than Innovation Diffusion or TAM to theorising innovation in all situations, as many studies have shown the explanatory value of Innovation Diffusion in relation to large scale adoptions across large regions or over long periods of time (Tatnall, 2009c), and of TAM in other situations. I see the value of Innovation Translation particularly in relation to investigating adoption in individual organisations and by individual people.

The case study examples given of adoption and its interpretation using ANT give some idea of the power of this approach to theorising the complex socio-technical process of innovation. They show that much more than the characteristics of the technology itself must be considered when investigating why an innovation has been adopted, and that while one organisation might make its adoption decisions for one reason, another might have quite different motivations. The processes followed in conducting an ANT study mean that after identifying all relevant human and non-human actors and examining their interactions, it should become clear what really constitutes the decisions affecting adoption.

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Importance of ERP Selection Criteria in Companies in Slovenia

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Abstract: The paper presents the importance of ERP selection criteria, which were investigated in companies in Slovenia. Altogether 27 ERP selection criteria were identified and investigated in the research. The investigated criteria are grouped into the ERP benefits criteria, system quality criteria, vendor related criteria and ERP package criteria. The research was done in large, medium sized and small companies in Slovenia. The paper starts with introduction, which is followed by literature review. The central point of this paper are research results, which are presented by companies' profile data, ERP selection criteria importance and companies' factors impacting on ERP selection criteria. Companies' factors impact on ERP selection criteria was investigated by ANOVA multivariate analysis, where company size, representation of the IT department on the board level (CIO), implemented information strategy and turnover impact on ERP selection criteria was investigated. The results are commented and compared with other research results.

Keywords: ERP, implementation, importance, selection criteria, companies, Slovenia, benefits, system quality, vendor, ERP package

1. Introduction

Nowadays, organizations face a rapidly changing business environment with raised customer expectations in expanded markets with increased competition. This increases the pressure on companies to change their existing business practices and procedures to achieve lower total costs of operation in the entire supply chain, shorten throughput times, drastically reduce inventories, expand product choice, provide more reliable delivery dates and better customer service, improve quality, and efficiently coordinate global demand, supply, and production (Umble et al., 2003; Jafari et al., 2006). From the information systems perspective, coordination of the individual elements of the overall set of business processes could be done by enterprise resource planning (ERP) systems.

Enterprise resource planning (ERP) systems can be considered as the most important development in the corporate use of information technology and are beginning to be the backbone of organizations. Also referred to as enterprise-wide systems due to their enterprise-wide scope, they provide seamless integration of all the information flows and business processes across functional areas within a company such as finance, human resources, manufacturing, logistics, sales, distribution and purchasing (Davenport, 1998; Markus & Tanis, 2000; Law & Ngai, 2007; Bernroider, 2008). Thus ERP systems aim to integrate business processes and ICT into a

synchronized suite of procedures, applications and metrics which goes over firms' boundaries (Wier et al., 2007).

Due to their nature (complexity and high implementation costs), ERP systems used to be mostly a domain of large companies. However, for the past few years ERP vendors face challenges in providing ERP systems also to the medium sized and small organizations (Malie et al., 2008). The reasons for this trend lie in a saturation of the market, as most large organizations have already implemented an ERP system, increasing possibilities and need for the integration of systems between organizations (pressures of large organizations) and the availability of relatively inexpensive hardware (Gable and Stewart, 1999).

The ERP market consists of many different products, services and methodologies, not all of them applicable to different organizations (Malie et al, 2008). While selecting the ERP system, organizations need to consider different criteria related to ERP systems. Knowing the importance of these criteria could help organizations to select more suitable ERP system and to avoid mistakes and large costs of failed implementations. .

In this paper, we present the criteria that companies consider as important in the phase of ERP system acquisition. The importance of criteria is presented on the basis of research done in Slovenia in 2007/2008. The findings are useful for organizations considering the ERP solution implementation and for ERP system providers to better understand different customers' needs and expectations.

2. Literature review

ERP selection criteria investigated in this research were mainly adopted from Bernroider and Koch (2001) and supported by other research results in the field of ERP selection criteria. Although the evaluation of information systems investments began already in 1960's (Frielink, 1961; Joslin 1968), very little had been written recently about packaged software selection criteria in academic journals (Keil & Tiwana, 2006). The ERP selection criteria identified by prior research are summarized in the Tables 1 – 4. ERP criteria are grouped into the ERP benefits criteria, system quality criteria, vendor related criteria, ERP package criteria.

Table 1 – ERP benefits criteria

ERP benefits criteria	Author(s)
<i>Enhanced decision making</i>	Bernroider (2008); Nah & Delgado (2004)
<i>Reduced cycle times</i>	Bernroider (2008); Bernroider & Leseure (2005);
<i>Business process improvement</i>	Bernroider (2008); Bernroider & Leseure (2005); Kumar et al. (2002, 2003), Nah & Delgado (2004); Bernroider & Koch (2001)
<i>Enabler for desired business processes</i>	Bernroider (2008); Bernroider & Leseure (2005); Kumar et al. (2002, 2003)
<i>Integrated and better quality of information</i>	Bernroider (2008); Bernroider & Leseure (2005); Nah & Delgado (2004)
<i>Increased organizational flexibility</i>	Bernroider (2008); Umble et al (2003); Bernroider & Koch (2001)
<i>Increased customer satisfaction</i>	Bernroider & Koch (2001); Bernroider & Leseure (2005)
<i>Improved innovation capabilities</i>	Bernroider (2008); Bernroider & Leseure (2005); Bernroider & Koch (2001)

Table 2 – System quality criteria

System Quality Criteria	Author(s)
<i>System flexibility</i>	Bernroider (2008); Malie et. Al (2008); Bernroider & Leseure (2005); Kumar et al. (2002, 2003); Wei, et al (2005); Verville & Halington (2003); Bernroider & Koch (2001); Bernroider (2008);
<i>System functionality</i>	Bernroider (2008); Malie et. Al (2008); Bernroider & Leseure (2005); Botta-Genoulaz et. Al (2005); Kumar et al. (2002, 2003); Wei, et al (2005), Han (2004); Liao et al. (2007); Lall & Teyarachakul (2006); Verville & Halington (2003); Bernroider & Koch (2001)
<i>System usability</i>	Bernroider (2008)
<i>System interoperability</i>	Bernroider (2008); Kumar et al. (2002, 2003); Verville & Halington (2003); Bernroider (2008);
<i>Internationality of system</i>	Bernroider (2008); Bernroider & Leseure (2005); Verville & Halington (2003); Bernroider & Koch (2001)
<i>System reliability</i>	Bernroider (2008); Malie et. Al (2008); Bernroider & Leseure (2005); Kumar et al. (2002, 2003); Wei, et al (2005);
<i>Operating system independency</i>	Bernroider & Leseure (2005); Bernroider & Koch (2001)

Table 3 – Vendor related criteria

Vendor related criteria	Author(s)
<i>Improved Service Levels/Quality</i>	Bernroider (2008); Bernroider & Leseure (2005); Wei et. al (2005)
<i>Vendor support</i>	Malie et. Al (2008); Bernroider & Leseure (2005); Kumar et al. (2002, 2003), Wei, et al (2005); Liao et al. (2007); Ubmle et al (2003); Rao (2000); Fisher et al. (2004); Lall & Teyarachakul (2006); Verville & Halington (2003)
<i>Vendor reputation / Market position of vendor</i>	Malie et. Al (2008); Malie et. Al (2008); Kumar et al. (2002, 2003); Wei et al (2005); Han (2004); Liao, et al. (2007); Lall & Teyarachakul (2006); Verville & Halington (2003); Bernroider & Koch (2001)

Table 4 – ERP package criteria

ERP package criteria	Author(s)
<i>Short implementation time</i>	Malie et. Al (2008); Wei et al (2005); Umble et al (2003); Fisher et al. (2004); Lall & Teyarachakul (2006); Verville & Halington (2003); Bernroider & Koch (2001)
<i>Software costs (licenses, maintenance, etc...)</i>	Bernroider (2008); Bernroider & Leseure (2005); Kumar, et al. (2002, 2003); Wei, et al (2005); Umble et al. (2003); Fisher et al. (2004); Lall & Teyarachakul (2006)
<i>E-business enablement</i>	Bernroider & Leseure (2005);
<i>Organizational fit of system</i>	Malie et. Al (2008); Botta-Genoulaz et. Al (2005); Kumar et al. (2002, 2003); Nah & Delgado (2006); Umble et al (2003); Lall & Teyarachakul (2006)
<i>Connectivity (Intra/Extranet, Mobile computers, ...)</i>	Bernroider & Leseure (2005);
<i>Advanced technology</i>	Bernroider & Leseure (2005); Kumar et al. (2002, 2003); Liao, et al. (2007); Rao (2000)
<i>Incorporation of business best practice</i>	Bernroider & Leseure (2005); Kumar et al. (2002, 2003)
<i>Availability of an industry focused solution</i>	Malie et. Al (2008); Bernroider & Leseure (2005);
<i>Enabling technology for CRM, SCM, etc...</i>	Bernroider & Leseure (2005); Botta-Genoulaz et. Al (2005); Kumar et al. (2002, 2003)

3. Data and methodology

The research was conducted in 2007/2008. The questionnaires with introduction letters were sent to 300 large companies, 300 medium sized companies and 600 small companies. The number of questionnaires mailed to small companies was double the number of medium and large companies because small companies constitute the highest proportion of companies and based on experience, they are less likely to respond. Lists of addresses and information about the number of employees and turnover were retrieved from National Statistical Bureau.

The questionnaire survey is based on criteria identified by Bernroider and Koch (2001). Criteria used in the research are reduced cycle times, enhanced decision making, improved service levels/quality, incorporation of business best practices, business process improvement, integrated and better quality of information, e-business enablement, increased organizational flexibility, increased customer satisfaction, improved innovation capabilities, enabler for desired business processes, organizational fit of system, software costs (licenses, maintenance, etc.), system functionality, system flexibility, systems reliability, advanced technology, operating system

independency, system interoperability, internationality of software, system usability, vendor reputation, vendor support, market position of vendor, availability of an industry focused solution, short implementation time, enabling technology for CRM, SCM, etc., connectivity (intra/extranet, mobile comp., ...). These dependent variables are measured on Likert scale 1-5, where 1 is of very little importance and 5 is of very high importance.

Compared to (Sudzina, 2007), besides company size, representation of the IT department on the board level (CIO) and information strategy, also turnover growth was used as independent variables. Analyzed are small and medium sized companies, where companies from 10 to 49 employees are considered to be small and companies from 50 to 249 employees are considered to be medium sized.

Information strategy stands for formal information strategy and representation of the IT department on the board level means that in companies there is a CIO or alike director position for IT. Growth was divided in to (1) reduction in turnover, (2) stable, (3) growth of 0-5%, (4) growth of 5-10% and (5) higher growth than 10%.

All analyses (tables 9-15) are ANOVAs, a multivariate approach is used and results are commented on confidence level $\alpha = 0,05$. In order to discover between what instances of an independent variable there are significant differences, Tukey-Kramer multiple-comparison test is used. In this paper we present only ANOVA tables, where significant impact was identified.

4. Research findings

4.1. Companies profile data

Altogether 68 (22,6%) large companies, 36 (12%) medium sized companies and 27 (4,5%) small companies responded to the questionnaires. Altogether 47 chief information officers, 27 chief executive officers, 15 IT managers, 6 accounting officers, 6 managers, 4 chief financial officers and 22 other employees have participated in this research.

From the company sector perspective, the most respondents from large companies are from manufacturing sector (57,4%), followed by trade (14,7%) and by services sector (5,9%). The most respondents from medium sized companies came from manufacturing (41,7%), trade (22,2%), services (8,3%) and building and construction (8,3%). In case of small companies, most respondents came from trade (22,2%), IT services (18,5%), building and construction (11,1%), manufacturing (14,8%) and transport (7,4%).

37,1% of large companies had higher revenue growth than 10%, 27,4% had revenue growth from 5-10%, 12,9% from 0-5% of growth, 12,9% had stable revenue and 9,7% had reduction of turnover in the previous year of the research study. 29,4% of medium sized companies had higher revenue growth than 10%, 26,5% had revenue growth from 5-10%, 29,4% from 0-5% of growth, 8,8% had stable revenue and 5,9% had reduction of turnover in the previous year of the research study. 23,1% of small companies had higher revenue growth than 10%, 26,9% had revenue growth from 5-10%, 11,5% from 0-5% of growth, 30,8% had stable revenue and 7,7% had reduction of turnover in the previous year of the research study.

70% of large organizations indicated that they have CIO represented at the board level in the company, while CIO is represented only in half of the medium sized companies and only in 33% of small sized companies. Half of the large and medium sized companies and only 15% of small companies reported that they have formal IS/IT strategy implemented in the companies.

From all participated companies 85 (64,8%) indicated that they already use ERP solution in the company (75% of large companies, 66,7% of medium sized companies and 37% of small companies). In large companies most frequently used ERP solution is SAP (29%), MS Dynamics NAV (14%) and Perftech Largo (10%) from local ERP solution provider. In most of medium

sized companies use Perftech Largo solution (17%), followed by SAP and MS Dynamics NAV (12%). This is followed by usage of ERP solutions from Slovene providers e.g. Datalab Pantheon and RCL (both 8%). Only 6% of large and 4% of medium sized companies reported to use in-house developed ERP solutions. In small companies the most commonly used ERP solution is MS Dynamics NAV (30%), followed by Datalab Pantheon and in-house developed ERP solutions (both 20%). Due to the small number of respondents from small sized companies, using ERP solutions, this data are not representative. Data from other sources show that only 10% of small and 50% of medium sized companies in Slovenia use ERP solutions (Sulčič, 2008).

In 33,8% of large companies have stable use of ERP solution for some years. ERP solution has just been recently implemented in 23,5% of large companies. Medium sized companies in most cases have recently implemented ERP solutions (48,6%). In 25,7% of medium sized companies have stable use of ERP solution for some years. Most of small sized companies have only recently implemented ERP solution (40%). 32% of small companies are in the stage of considering ERP solution implementation.

4.2. ERP selection criteria importance

In the Tables 5 – 8, the importance of ERP selection criteria is presented by mean values, ordered from very high importance to very little. The importance of ERP selection criteria was investigated by 5 point Likert scale, where 1 is of very little importance and 5 is of very high importance. The data are analyzed and presented for all companies together as the company size impact on importance of ERP criteria was separately investigated by ANOVA multivariate approach. ANOVA analysis results are presented in the section 3.3..

Table 5 – Importance of ERP benefits criteria

ERP benefits criteria	N	Mean	Std. Deviation
<i>Integrated and better quality of information</i>	109	4,59	0,641
<i>Business process improvement</i>	109	4,25	0,683
<i>Enhanced decision making</i>	109	4,11	0,885
<i>Reduced cycle times</i>	109	4,07	0,836
<i>Increased customer satisfaction</i>	109	4,03	0,967
<i>Increased organisational flexibility</i>	109	3,90	0,781
<i>Enabler for desired business processes</i>	109	3,80	0,869
<i>Improved innovation capabilities</i>	109	3,26	0,976

Table 6 – Importance of system quality criteria

System quality criteria	N	Mean	Std. Deviation
<i>Systems reliability</i>	109	4,61	0,624
<i>System functionality</i>	109	4,37	0,689
<i>System usability</i>	109	4,31	0,836
<i>System flexibility</i>	109	4,22	0,821
<i>System interoperability</i>	109	4,09	0,967
<i>Internationality of Software</i>	109	3,70	1,182
<i>Operating system independency</i>	109	3,36	1,126

Table 7 – Importance of vendor related criteria

Vendor related criteria	N	Mean	Std. Deviation
<i>Vendor support</i>	109	4,39	0,805
<i>Improved Service Levels/Quality</i>	109	4,21	0,746
<i>Vendor reputation</i>	109	3,50	1,051
<i>Market position of vendor</i>	109	3,44	1,049

Table 8 – Importance of ERP package criteria

ERP package criteria	N	Mean	Std. Deviation
<i>Organizational fit of system</i>	109	4,16	0,945
<i>E-business enablement</i>	109	4,15	0,803
<i>Software costs (licenses, maintenance, etc.)</i>	109	3,92	0,818
<i>Short implementation time</i>	109	3,90	0,793
<i>Incorporation of business best practices</i>	109	3,87	0,747
<i>Advanced technology</i>	109	3,84	0,796
<i>Connectivity (Intra/Extranet, Mobile Comp., ...)</i>	109	3,83	0,948
<i>Availability of a industry focused solution</i>	109	3,79	0,872
<i>Enabling technology for CRM, SCM, etc.</i>	109	3,53	1,175

4.3. Companies' factors impacting on ERP selection criteria

With ANOVA multivariate analysis we investigated company size, representation of the IT department on the board level (CIO), implemented information strategy and turnover impact on ERP selection criteria (Figure 1). Growth was divided in to (1) reduction in turnover, (2) stable, (3) growth of 0-5%, (4) growth of 5-10% and (5) higher growth than 10%. In tables 9 – 15 we present the ANOVA multivariate analysis results. The results (tables) are presented only for selection criteria, where the impact of one or more companies' factors was identified. These selection criteria are: business process improvement, e-business enablement, increased organizational flexibility, systems reliability, advanced technology, operating system independency, and system interoperability.

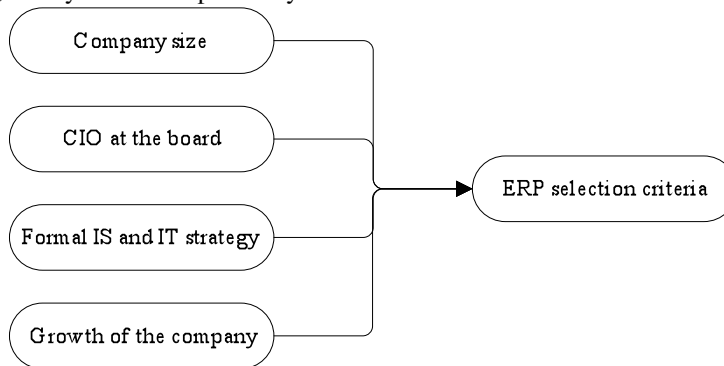


Figure 1 – Companies' factors impacting on ERP selection criteria

Business process improvement

The analysis of the impact of company size, representation of the IT department on the board level (CIO), information strategy and growth on importance of business process improvement have shown that importance of business process improvement depends on information strategy (Table 5). Importance is higher in companies with information strategy (4,34) than in companies without one (4,05). Importance is lower in companies with stable turnover (3,77) than in companies with growth of 5-10% (4,45), 10%+ (4,30).

Table 9 – Business process improvement

Style name	DF	Sum of Squares	Mean Square	F-Ratio	P-value
<i>Company size</i>	2	0,06367563	0,03183782	0,08	0,925988
<i>CIO</i>	1	0,06323607	0,06323607	0,15	0,696643
<i>Information strategy</i>	1	2,192879	2,192879	5,30	0,023335*
<i>Growth</i>	4	5,2559	1,313975	3,18	0,016668*
<i>S</i>	103	42,61518	0,4137397		
<i>Total (Adjusted)</i>	111	51			
<i>Total</i>	112				

* Term significant at $\alpha = 0,05$

E-business enablement

The analysis of the impact of company size, representation of the IT department on the board level (CIO), information strategy and growth on importance of e-business enablement have shown that importance of e-business enablement depends on company size (Table 10). The importance is lower in large (4,04) than in small companies (4,51).

Table 10 – E-business enablement

Style name	DF	Sum of Squares	Mean Square	F-Ratio	P-value
<i>Company size</i>	2	3,841785	1,920892	3,63	0,029926*
<i>CIO</i>	1	1,612522	1,612522	3,05	0,083822
<i>Information strategy</i>	1	0,3438284	0,3438284	0,65	0,422035
<i>Growth</i>	4	2,267272	0,5668181	1,07	0,374646
<i>S</i>	104	55,03207	0,5291545		
<i>Total (Adjusted)</i>	112	65,13274			
<i>Total</i>	113				

* Term significant at $\alpha = 0,05$

Increased organizational flexibility

The analysis of the impact of company size, representation of the IT department on the board level (CIO), information strategy and growth on importance of increased organizational flexibility have shown that importance of increased organizational flexibility depends on company size (Table 11). The importance is lower in large (3,71) than in midsize companies (4,29).

Table 11 – Increased organizational flexibility

Style name	DF	Sum of Squares	Mean Square	F-Ratio	P-value
<i>Company size</i>	2	6,306276	3,153138	5,39	0,005915*
<i>CIO</i>	1	0,7661105	0,7661105	1,31	0,255016
<i>Information strategy</i>	1	0,02746195	0,02746195	0,05	0,828866
<i>Growth</i>	4	4,00039	1,000098	1,71	0,153319
<i>S</i>	104	60,81945	0,5848024		
<i>Total (Adjusted)</i>	112	72,28319			
<i>Total</i>	113				

* Term significant at $\alpha = 0,05$

Systems reliability

The analysis of the impact of company size, representation of the IT department on the board level (CIO), information strategy and growth on importance of systems reliability have shown that importance of systems reliability depends on company size (Table 12). Impact is lower in small companies (4,33) than in large companies (4,71).

Table 12 – Systems reliability

Style name	DF	Sum of Squares	Mean Square	F-Ratio	P-value
<i>Company size</i>	2	2,20308	1,10154	3,39	0,037501*
<i>CIO</i>	1	4,068135E-02	0,04068135	0,13	0,724210
<i>Information strategy</i>	1	0,732296	0,732296	2,25	0,136372
<i>Growth</i>	4	2,523214	0,6308035	1,94	0,109151
<i>S</i>	104	33,8009	0,3250087		
<i>Total (Adjusted)</i>	112	39,84071			
<i>Total</i>	113				

* Term significant at alpha = 0,05

Advanced technology

The analysis of the impact of company size, representation of the IT department on the board level (CIO), information strategy and growth on importance of advanced technology have shown that importance of advanced technology depends on representation of the IT department on the board level (it is lower in companies without a CIO or alike (3,73) than in companies with one (4,17)) and on information strategy (it is lower in companies without a formal information strategy (3,79) than in companies with one (4,11)) (Table 13).

Table 13 – Advanced technology

Style name	DF	Sum of Squares	Mean Square	F-Ratio	P-value
<i>Company size</i>	2	0,6338901	0,316945	0,57	0,568595
<i>CIO</i>	1	4,679244	4,679244	8,38	0,004629*
<i>Information strategy</i>	1	2,736629	2,736629	4,90	0,029035*
<i>Growth</i>	4	4,418611	1,104653	1,98	0,103279
<i>S</i>	103	57,50521	0,558303		
<i>Total (Adjusted)</i>	111	71,49107			
<i>Total</i>	112				

* Term significant at alpha = 0,05

Operating system independency

The analysis of the impact of company size, representation of the IT department on the board level (CIO), information strategy and growth on importance of operating system independency is presented have shown that importance of operating system independency depends on company size (Table 14). The importance is lower in large (2,99) than in small companies (3,84).

Table 14 – Operating system independency

Style name	DF	Sum of Squares	Mean Square	F-Ratio	P-value
<i>Company size</i>	2	11,35308	5,676538	4,67	0,011444*
<i>CIO</i>	1	0,3809693	0,3809693	0,31	0,576803
<i>Information strategy</i>	1	2,361447	2,361447	1,94	0,166369
<i>Growth</i>	4	3,902208	0,9755521	0,80	0,526257
<i>S</i>	103	125,1977	1,215511		
<i>Total (Adjusted)</i>	111	140,7768			
<i>Total</i>	112				

* Term significant at alpha = 0,05

System interoperability

The analysis of the impact of company size, representation of the IT department on the board level (CIO), information strategy and growth on importance of system interoperability is presented have shown that importance of system interoperability depends on information strategy (Table 15). The importance is lower in companies without implemented formal information strategy (3,85) than in companies with one (4,24).

Table 15 – System interoperability

Style name	DF	Sum of Squares	Mean Square	F-Ratio	P-value
<i>Company size</i>	2	0,4142835	0,2071417	0,23	0,795753
<i>CIO</i>	1	0,1628703	0,1628703	0,18	0,672221
<i>Information strategy</i>	1	3,893648	3,893648	4,30	0,040493*
<i>Growth</i>	4	0,3771625	9,429064E-02	0,10	0,980802
<i>S</i>	104	94,08573	0,9046705		
<i>Total (Adjusted)</i>	112	99,68142			
<i>Total</i>	113				

* Term significant at alpha = 0,05

5. Conclusions

The research results have shown that ERP solutions are more present in large companies than in small and medium sized companies. However we can observe the trend that high proportion of small and medium companies recently adopted ERP solution.

Paper further examines ERP selection criteria importance studied by Bernroider & Koch (2001) and Bernroider & Leseure (2005). Altogether 27 ERP selection criteria were identified and investigated in the research. The investigated criteria are grouped into the ERP benefits criteria, system quality criteria, vendor related criteria and ERP package criteria.

In analysis of companies' factors impacting on ERP selection criteria have shown that company size impact on e-business enablement criteria (the importance is lower in large (4,04) than in small companies (4,51). Company size also impact on importance of increased organizational flexibility criteria, where importance is lower in large (3,71) than in medium sized companies (4,29). Company size also impact on importance of operating system independency where the importance is lower in large (2,99) than in small companies (3,84). Also the importance of systems reliability depends on company size. Impact is lower in small companies (4,33) than in large companies (4,71).

The importance of business process improvement depends on information strategy and growth. Importance is higher in companies with information strategy (4,34) than in companies without one (4,05). Importance is lower in companies with stable turnover (3,77) than in companies with growth of 5-10% (4,45), 10%+ (4,30).

The importance of advanced technology depends on representation of the IT department on the board level (it is lower in companies without a CIO or alike (3,73) than in companies with one (4,17)) and on information strategy (it is lower in companies without a formal information strategy (3,79) than in companies with one (4,11)).

System interoperability depends on information strategy. The importance is lower in companies without implemented formal information strategy (3,85) than in companies with one (4,24).

Compared to other research (Bernroider & Koch, 2001; Bernroider & Leseure, 2005) examined criteria confirms importance of the following ERP criteria: system reliability, vendor support, functionality of the system, business process improvement, improved service levels, integrated and better quality of information. These criteria are perceived as most important ERP solution selection criteria.

According to the study of Bernroider & Leseure (2005) we have also identified some differences on importance of ERP selection criteria e-business enablement, which was in our case more important ERP selection criteria than in previous mentioned research study. E-business enablement is becoming more and more important ERP solution criteria as the need for better business integration, supported by ICT, of all partners in supply chain to achieve competitive advantage in the market is urgent.

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Experiences of ERP risk management in SMEs

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Abstract: Information and communication (ICT) technology related projects, such as enterprise resource planning (ERP) projects have been found to be complex and risky to implement in business enterprises, especially in small and medium size enterprises (SMEs). ERP projects have a high failure rate. The principal reason for failure has often been associated with poor management of ERP projects. Several standardised methods and techniques have been developed to help enterprises to better manage their ERP projects. This paper presents two risk management methods for ERP projects through the case study of three manufacturing small and medium size enterprises (SMEs). By using company-specific risk analysis method (RAM), the critical risks of the ERP projects have been identified and assessed. Then, by using characteristics analysis method (CAM), the recommendations of how to divide the ERP projects into manageable sub projects have been given.

Keywords: Enterprise resource planning; ERP project; small and medium size enterprise; SME; Risk analysis method; Characteristics analysis method.

1. Introduction

Enterprise resource planning (ERP) systems, when successfully implemented, links all functions of an enterprise including order management, manufacturing, human resources, financial systems, and distribution with external suppliers and customers into a tightly integrated system with shared data and visibility (Chen, 2001). Potential benefits include drastic declines in inventory, breakthrough reduction in working capital, abundant information about customer wants and needs, along with the ability to view and manage the extended enterprise of suppliers, alliances and customers as an integrate whole (Escalle, *et al.*, 1999). Especially small and medium size enterprises (SMEs) adopt ERP systems with the goal of replacing inefficient standalone legacy systems, increasing communications between business functions, increasing information processing efficiencies, improving customer relations, and improving overall decision making (Cereola, 2008).

Despite the significant benefits of ERP systems, the Statistics show that under 30 % of ERP implementations have been successful (Standish Group, 2004). Many ERP implementations have been difficult, lengthy and over budget, were terminated before completion, and failed to achieve their business objectives even a year after implementation (Somers & Nelson, 2004). ERP implementation requires the allocation of special competences, and a number of financial and human resources. The implementation is usually carried out concurrently with the daily business, which already ties up the available resources (Vilpolo, 2008). Especially in SMEs, scarce resources are badly needed in the daily business operations. SMEs also differ from larger

enterprises in important ways affecting their information-seeking practices. These differences include lack of information systems management, concentration of information-gathering responsibilities to a small number of individuals, lower levels of resources available for information-gathering, and in the quantity and quality of available environmental information (Buonanno, *et al.*, 2005).

An ERP project is a major and risky exercise for any size of enterprise, however, risks are higher for SMEs as the cost overruns during implementation may put financial strain on the firm and thus substantially impact firm performance (Cereola, 2006). In addition, SMEs have less of a chance of recovering from a failed ERP implementation attempt than large enterprises (Muscatello, *et al.* 2003) The main risk effects are budget exceed, time exceed, project stop, poor business performances, inadequate system reliability and stability, low organisational process fitting, low user friendliness, low degree of integration and flexibility, low strategic goals fitting and bad financial/economic performances (Aloini, *et al.*, 2007).

There is a substantial difference between an ERP project and a simple software project (Aloini, *et al.*, 2007). An ERP project involves several components of software and business systems, thereby raising organisational problems. ERP project is interdisciplinary; it affects interdependencies between business processes, software and process reengineering (Wright & Wright, 2001; Xu, *et al.*, 2002). To be effective a risk management method should consider several potential aspects; technology, market, financial, operational, organisational, and business, and link them to the project life cycle. Critical factors include technological and management aspects, both psychological and sociological.

Several standardised methods and techniques have been developed to help companies to better manage their ICT projects, though they are often too general for ERP application (Aloini, *et al.*, 2007). In this study, we present experiences of company-specific risk analysis method (RAM) and characteristics analysis method (CAM) through the case study of three manufacturing SMEs. First, by using RAM, the critical risks of the ERP projects are identified and assessed. Second, by using CAM, the recommendations of how to divide the ERP projects into manageable sub projects are given.

2. Risks of the ERP project

One main reason for any information and communication (ICT) project failure is that managers do not properly assess and manage the risks involved their projects (Mark, *et al.*, 1998). Most project managers perceive risk management processes as extra work and expense, thus, risk management processes are often expunged if a project schedule slips (Kwack & Stoddard, 2004). Also, enterprises do not realise the full benefits that the ERP system offers because they are not organised in the correct fashion to achieve the benefits. Many enterprises that attempt to implement ERP system run into difficulty because the organisation is not ready for integration and the various departments within it have their own agendas and objectives that conflict with each other (Langenwaller, 2000).

Several research studies have investigated the ERP risks and have attempted to classify them in various ways. Six main dimensions of risk in ERP implementation have been identified by (Poba-Nzaou, *et al.*, 2008), namely, 1) organisational, 2) business-related, 3) technological, 4) entrepreneurial, 5) contractual and 6) financial risks. Organisational risk derives from the environment in which the system is adopted. Business-related risk derives from the enterprise's post-implementation models, artefacts, and processes with respect to their internal and external consistency. Technological risk is related to the information processing technologies required to operate the ERP system – for example the operating system, database management system,

client/server technology and network. Entrepreneurial or managerial risk is related to the attitude of the owner-manager or management team, while contractual risk derives from relations with partners and financial risk from cash-flow difficulties, resulting in an inability to pay license fees or upgrading costs, for example. (Poba-Nzaou, *et al.* 2008) In the research of Sumner (2000), following six risk categories have been presented: 1) organizational fit, i.e. failure to redesign business processes, 2) skill mix, i.e. insufficient training and reskilling, 3) management structure and strategy, i.e. lack of top management support, 4) software systems design, i.e. lack of integration, 5) user involvement and training, i.e. ineffective communication, and 6) technology planning/integration, i.e. inability to avoid technological bottlenecks. Later, Huang, *et al.*, (2004) develop the risk identification list based on the category of Sumner (2000).

According to Aloini, *et al.*, (2007), the ERP risk factors are: 1) inadequate ERP selection, 2) poor project team skills, 3) low top management involvement, 4) ineffective communication system, 5) low key user involvement, 6) inadequate training and instruction, 7) complex architecture and high numbers of modules, 8) inadequate business processes, 9) bad managerial conduction, 10) ineffective project management techniques, 11) inadequate change management, 12) inadequate legacy system management, 13) ineffective consulting services experiences, 14) poor leadership, 15) inadequate ICT system issues, 16) inadequate ICT system manutenibility, 17) inadequate ICT supplier stability and performances, 18) ineffective strategic thinking and planning, 19) inadequate financial management.

To minimize the risk of the ERP project, Markus & Tanis (2000) have recommended the application of a risk management plan at different ERP implementation project stages; selection, implementation, and usage. A planned and systematically adopted risk management procedure throughout the ERP project reduces the possibility to risks occurring. Consequently, Bernroider & Leseure (2005) suggest that major mistakes are made in the early stages of the ERP project, even prior to the implementation process. Kliem (2000), however, emphasizes the efficiency of risk management when it is introduced at the earliest possible opportunity in the life cycle of the system in question, when planning issues are most important and the criteria for system selection are determined.

Instead of using abovementioned ready-made risk lists, a company might consider identifying their own, company-specific ERP implementation risk list. These risks could be complemented by common risk lists.

3. Risk management tools

3.1. Risk Analysis Method

Risk analysis method (RAM) identifies the most essential risks and their probability in the company context. The risk list for the case study has been formed based on the risk list of Vilpola (2008). In this study, the risk list is formed out of 63 questions or statements dealing with the ERP selection, implementation, and usage (appendix 1). The basic aim is to identify the ERP risks arising from the company's reality and therefore the employees from various levels of organisation have been interviewed and observed. The company-specific risk list has been filled in close interaction with company personnel. Risk assessment for the risk list is done by evaluating each risk's probability and effect in a scale from one to five. The number one means very small probability and effect, and number five means high probability and catastrophic effect. Then, the risk multiplication as an indicator of risk significance has been used. It is calculated as multiplying the value of the probability by the value of the effect. Range of this value is from one to twenty-one. (Vilpola, 2008)

3.2. Characteristics Analysis Method

Characteristics analysis method (CAM) is a tool to ensure that the ICT project is manageable and consistent by its different goals content and development approaches. The result of the CAM is a recommendation of how to split the large and complex ICT project, such as ERP project, into manageable sub projects. Further, the inputs of the CAM are the project proposition document, the knowledge and experience from prior development projects, and the requirements of the of the project portfolio. (Forselius, 2008)

In this paper, the CAM analysis is formed out of 90 questions dealing with the ERP project (appendix 2). The basic aim is to find out the manageable size of the ERP project of the case companies. Also, CAM provides recommendations what management aspects should be put more attention to successfully manage ERP project (management of a project as a whole, management of integration, project scope management, time management, cost management, quality management, human resource management, management of communication, risk management, management of purchase). The questions are either positive or negative statements for which their applicability to the project will be evaluated (0 = fault, not true, 5 = exactly right; N/A = don't know). The tool has been implemented as an MS Excel worksheet with automatic tabulation based on decision rule sets. The result is can also be illustrated graphically (see figures 1 and 2). (Forselius, 2008)

4. Case study

This study has been carried out as a case study of three manufacturing SMEs. The case SMEs are in different phases of the ERP project. Company A is still contemplating the ERP implementation, Company B is in the selection phase, and Company C is already in the usage phase. In practice, this study has been carried out during 1.1.–30.12.2008.

4.1. Company A

Company A develops blast cleaning technology and manufactures automated blast cleaning machines and robots (turnover about 1,2 M€ and number of personnel approximately 20). Company A has not an ERP system, but is contemplating the ERP implementation in near future. The need for the new ERP system has grown internally because of the problems in the current ICT system. Today, the company is using an excel-based ICT system, which includes e.g. the following ERP functions: customer relationship management (CRM), product data management (PDM), purchase and order management, and product lifespan management. The problem of the current system is how to manage over 100 different versions and variations of Excel, Word, and AutoCAD documents. Main problems are in the tendering and purchase processes, and in production capacity planning. The purpose of company A is to adopt an ERP system, which helps production capacity planning and control so that the scheduling and resource allocation for different projects can be planned in detail before the project is started. Furthermore, the new system should include warehouse and stock management functions and it have to support purchase process.

The risk list (appendix 1) has been filled with company personnel and the effect and probability of risks have been assessed. In the *ERP selection phase*, the most critical risks which may be realised in company A are: misunderstanding between buyer and customer (12), system not flexible enough under processes' exceptional circumstances (12), and special needs of a company not defined (10). In the *ERP installation phase*, the most critical risks are: company's

project manager is not a full time PM (20), data transfers from old to new system is difficult (16), connecting system to other systems creates problems (16), and supplier is not committed enough to system implementation (15). In the *ERP usage phase*, the most critical risks are: system not felt as helping the business (12) and the system supplier does not develop the system in the future (10). Company A is just contemplating to acquire an ERP system. In the RAM results, in every phase (selection, implementation, usage), the crucial factors are depended on the decision of the ERP system itself and the ERP supplier. The technical and functional factors related to the system and the factors related the chosen system supplier are considered the most critical. Even a company A has very few employees, under 20, the lack of resource, skills and expertise, and other factors related personnel have - surprisingly – not aroused as a potential risk in this analysis.

According to CAM, Human resource management (HRM) is the management/leadership field that clearly exceeds the critical level. Company A should direct special attention to this factor in ERP project management. In addition, several other management/leadership fields, such as ‘Communications management’, ‘Purchase management’, ‘The project as a whole’, ‘Integration management’, ‘Project scope management’ and ‘Quality management’ are right at the critical level. Only ‘Cost management’ and ‘Time management’ and ‘Risk management’ are clearly under critical level. According to CAM, factors connected with personnel training and increasing personnel skills and knowledge require more from managing the ERP project, although they are not considered to be amongst the most potential risk factors according to RAM. On the basis of the CAM, it can be deduct that Company A has a clear view of the costs caused by the ERP project, the time spent for it, as well as the technical and operational risks involved. The results analysed by CAM is presented in Figure 1.

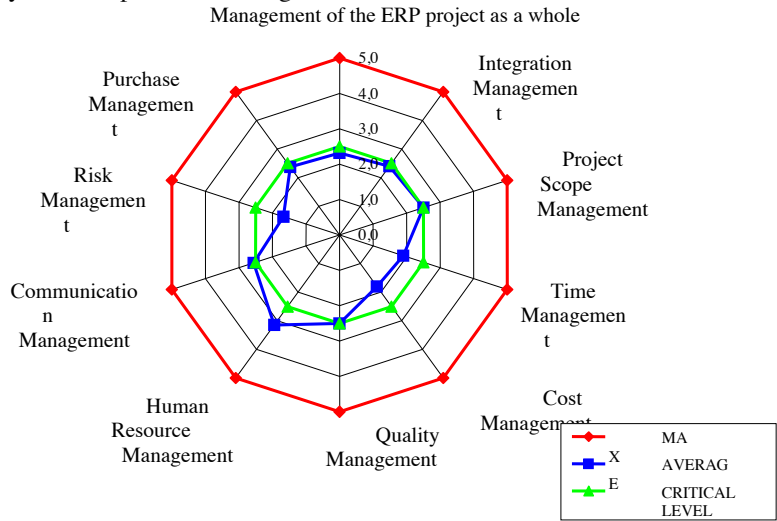


Figure 1 – CAM diagram of the company A

4.2. Company B

Company B provides demanding sheet metal work, welding, and heavy metal works, specialising in steel, paper, chemistry, and ship manufacturing related machinery and equipment. In addition, the company manufactures offshore equipment and ship propellers. The company B employs ca. 150 people. Company B is in the selection phase of ERP project. The company has interviewed several ERP suppliers and has already gone through more detailed discussions with two potential

suppliers. The company B has made a preliminary requirement specification, a type of demand list, through which they are able to limit their ERP suppliers to two options. Also, some consultants have worked for the company. Company B is very aware that their existing ICT systems are already in the end of their life cycle, and they had to invest in a new ERP system.

The risk list has been filled with company personnel and the effect and probability of risks have been assessed. In the *ERP selection phase*, the most critical risks which may be realised in company B are: system is poor compromise for all parties (12), choosing poor project manager or project group, and misunderstandings between buyer and customer (10), choosing improper ERP system (10). In the *ERP installation phase*, the most critical risks are: normal business disturbs ERP project activities (20), ERP project disturbs normal business (16), timetable falls behind schedule (16), Software configuration and testing don't function swiftly (16), disciplined use of the system (data entry is not achieved) (16). In the *ERP usage phase*, the most critical risks are: ERP system not used in a disciplined manner (12), and only part of the system used and benefits realized (12). In the RAM results, the crucial factors are mostly depended on the personnel (including project manager/team and top management level) behaviour, skills, and experience. Company B is also worried of the changes what the new ERP system will affect to the company's normal business, and in opposite, how the normal business hinders the ERP project progress.

According to CAM, Communications management is the management/leadership field that clearly exceeds the critical level. Company B should direct special attention to the factor considered people skills, knowledge and expertise. In addition, 'Human resource management' and 'Quality management' are right at the critical level. To manage ERP project successfully, the company should pay attention to these three management/leadership factors. The results analysed by CAM; is presented in the figure 2.

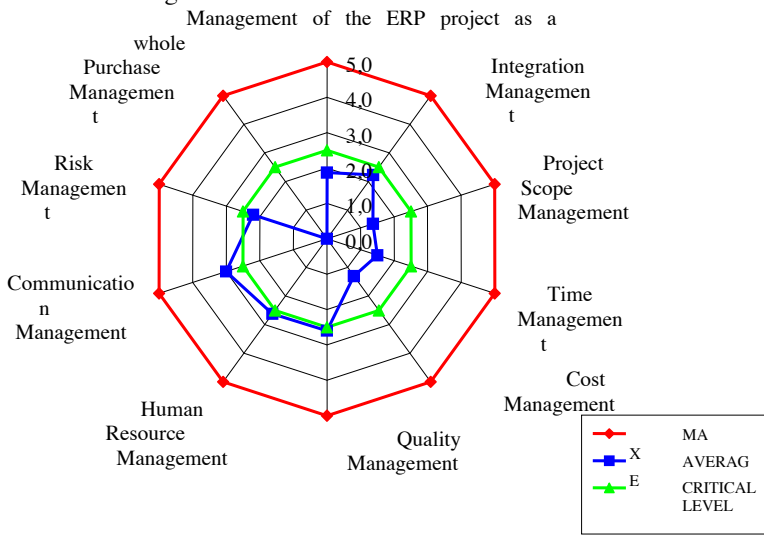


Figure 1 - CAM diagram of the company B

4.3. Company C

Company C has implemented an ERP system a few years ago but only part of the system was functioned complete. Company C is going to continue the ERP project and adopt several new functions of the ERP system in use. The risk list has been filled with company personnel and the effect and probability of risks have been assessed. The risk analysis has been done focusing on the

main risks considered the new modules adoption. Also, because the company C already has the ERP system in use, the selection phase was skipped.

In the *ERP installation phase*, the most critical risks which may be realised in company C are: normal business disturbs ERP project activities (25), cost rise compared to initial estimations (25), supplier is not committed enough to system implementation (25), software configuration and testing don't function swiftly (25), company is not important customer for supplier and don't get the best effort (25), and supplier don't understood the customer needs (25). In the *ERP usage phase*, the most critical risks are: all needed information is not entered into the system (15), only part of the system used and benefits realized (12), and system not felt as helping the business (12). Company B estimates several risks and their probability with maximum rates. This estimate is possibly coloured by the partial failure of their old ERP project, and the communication difficulties they experienced with their ERP supplier. Company B also has few employees (under 20), and when the contact person of the system supplier disappeared in the middle of the project, the risks came true.

The CAM was not carried out in the company C, since they were already at the usage phase of their ERP project. Main usage phase problems occur because of the poor requirements specification phase, and lack of documentations in the implementation phase related to configuration and parameterisation. Also, the key person of the ERP supplier shifted to another company middle of the project.

5. Discussion

The ERP project should not be viewed merely as a project of acquiring and implementing a new ICT system but as a framework project for the company's all business processes. According to McAdam & Galloway (2005), twofold approaches should be taken for ERP projects: 1) Change the business processes to fit the software with minimal customisation. On one hand, fewer modifications to the software application should reduce errors and help to take advantage of newer versions and releases. On the other hand, this choice could mean changes in long-established ways of doing business (that often provide competitive advantage), and could shake up important people roles and responsibilities; and 2) modify the software to fit the processes. This choice would slow down the project, could affect the stability and correctness of the software application and could increase the difficulty of managing future releases, because the customizations could need to be torn apart and rewritten to work with the newer version. Conversely, it implies less organizational changes, because it does not require dramatically changing the company best practices, and therefore the way people work.

SME companies usually have great difficulties in their ERP through. The most common risk that may entail project failure is the ubiquitous lack of resources and ICT skills or the company personnel (Cereola, 2006). ERP systems are typically designed for large companies, and the ERP suppliers do not necessarily understand the special characteristics and operational processes of small companies (Bernroider & Leseure, 2005). The success of an ERP project also largely depends on how well SMEs can manage changes in their business and how well personnel can adopt new way of operations. This change process is best to start already in the early phase of the ERP project, because many risks can be eliminated before the ERP project system starts. The SMEs can e.g. hire temporary staff to perform the routine operations so the key persons get more time to concentrate on the ERP system characteristics and new work practices.

The most potential risks can be divided in the following categories: 1) ERP supplier, 2) ERP system, and 3) a customer company. The most potential risk related to the ERP supplier, is simple to choose the wrong supplier, which doesn't understand the company's special wants and needs, or are not interested enough to committed to the ERP project of small customers. Also, the high

potential risk is that the ERP supplier chosen ends the development and/or support of the system. Most potential risks related to the ERP system are depended on its technical and functional performance and features; how well the system can be implemented, configured, parameterised, and integrated.

Most potential risks related to the company itself are connected with the factors of company personnel and company top management; their skills, knowledge, and experience. Also, resistance to change is a typical potential risk factor. Personnel may not see the benefits of the system in their own work and, thus, are not committed to the new business model, and don't use the system in a disciplined manner. Normal business also disturbs the ERP implementation, and personnel may be unwilling to put time or effort to the development work. Top management support to the project is the most important success factor for the ERP project, and the second success factor is the proper, full-time project manager. Similar results can be also found in the literature, e.g. Aloini, *et al.*, 2007; Buonanno, *et al.*, 2005).

According to the CAM, the biggest investments in terms of bringing the ERP project to the finish line should be directed at Human resource management and Communications management. In such a large change project ERP project is, the challenge is to make the employees stand behind the change. The ERP project changes the company modes of operation and working processes. For this reason the commitment of staff should be strong, so that new operational models are taken into use and the system can therefore be exploited to its full potential.

The risk of sticking to old ways of doing things after ERP implementation is often high. People are experts at finding reasons why there is no need to change things or why it is better to stick to the old way of doing things, when they do not fully understand the purpose for the change. The change process is as a ground rule condemned to failure if people do not understand the need for change. For this reason it is important to create a clear vision of the desired change and to communicate this really actively to the people involved in the change.

In a long ERP project it is also important to obtain short-term successes so that people do not lose interest in the change process and the final aims are reached. Hence, it is good to divide the project into smaller sub projects. It is typical for change processes that a process is declared a success too soon, at a stage when the first goals of the process are reached. For example, in the case of ERP projects, it is erroneous to proclaim the project a success at the stage when the ERP system they have has managed to run the system successfully and they have just started using it. Only when the system can be fully exploited and the original goals have been achieved can you consider the project to have succeeded.

It is possible to enhance staff commitment to the change process and the new operational model by communicating the change and by training staff. It is very typical that the need for communication and training is underestimated. The importance of communication can also be seen in the fact that communications enhance the commitment of the management level in the process. It also pays off to communicate issues during the project that are not being done. In this way you can diminish the potential of misunderstandings and to be in control of expectations. At the beginning of the ERP project it is recommended that a communications plan be drawn up, in which target groups, means and timing are outlined. In the case that everything possible in the project is outsourced the company staff will not consider the operational model to be their own.

6. Conclusions

This study presents experiences that are obtained in case studies in which three SME companies were drawn an ERP project risk analysis method and characteristics analysis method. The case companies considered both of the methods as good tools for risk management; they forced the company to think of potential risks that might go off at the different stages of the ERP project,

whether these risks had to do with the technical and functional characteristics of the system itself, or with the expertise and commitment of the staff, top management or ERP supplier. The CAM helped the case companies in dividing their ERP project into manageable entities and provided them with recommendations on what leadership or management aspects they should devote special attention to. The CAM also showed inadequacies in the fields of management and leadership that the implementation of ERP system causes in companies.

This study has been done in deep cooperation with researchers and company staff. Cooperation with the research group provided companies new skills and support to continue their own ERP project. Company A will take the next step in their ERP project and is faced with an extensive requirement specification process with the objective of mapping out the suitable ERP solutions for the company and to choose their ERP in 2010. Company B made their decision on which ERP system they will choose at the end stage of this study (2008). Implementation will commence in 2009. Company C aims at enhancing the ERP system they already have in use and to adopt new modules in 2009. Company B has initiated new contacts with their system supplier and commenced the change requirement specification phase of adjusting their current system.

The RAM presents crucial risks in a form and language that is understandable, because the analysis have been done in the company context. As negative aspect of RAM is that it requires a significant amount of work, and also support from external experts. As a conclusion, company-specific risk analysis is recommended, especially for SMEs with low ICT skills and scarce resources.

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Appendix 1. Risk analysis list (E = Effect; P = Probability, ExP=Critical risk)

COMPANY	A	B	C
RISK	E x F	E x F	E x F
ERP selection phase			
Misunderstandings between buyer and customer	12	10	-
System is poor compromise for all parties	3	12	-
Poor integratability with other systems	8	4	-
Choosing wrong ERP supplier	5	4	-
Concern level goals and business unit goals are not coherent	-	-	-
System not flexible enough under processes' exceptional circumstances	12	8	-
Suppliers project manager/trainers are not met before the project is started	5	3	-
Choosing improper ERP system	5	10	-
Choosing poor project manager or project group	4	12	-
Inadequate competence in making a contract	8	4	-
Terms of contract agreed considering the changes in a system	8	6	-
Reasons behind system acquiring are unclear	4	5	-
Special needs of a company not defined	10	9	-
Lack of senior management support	5	5	-
System requires enormous IT investments	3	5	-
System technically difficult to implement	4	4	-
Pressure and influence of the cooperation network affects system choice	4	4	-
ERP implementation phase			
ERP project disturbs normal business	12	16	6
Timetable falls behind schedule	10	16	16
Data transfers from old to new system is difficult	16	12	1
Supplier's project manager is improper	8	8	16
Personnel don't see the benefits of the system in their every day work	8	10	16
ERP project don't have a steering committee / or it functions improperly	10	6	16
ERP project documentation is heavy	6	8	16
Personnel lack of basic IT skills required to comprehensive system usage	3	3	6
Connecting system to other systems creates problems	16	2	1
Company's project manager is not a full time PM	20	8	1
Normal business disturbs ERP project activities	12	20	25
Company is not successful getting disciplined use of the system	6	10	20
Lack of time to attend education in implementation	12	12	16
Supplier is not committed enough to system implementation	15	5	25
Insufficient communication in the organisation	2	4	1
Mistakes in transferring data from the old system to the new one	2	8	1
Poor training available	3	10	20
Training is not taken all the way through	4	12	20
Personnel is not committed to new way of working	6	15	5
Cost rise compared to initial estimations	12	6	25
Personnel is not enough supported in order to use new system properly	6	9	8
Poor choices of project management and/or project team	4	6	16
Software configuration and testing don't function swiftly	6	16	25
Company is not important customer for supplier and don't get the best effort	12	12	25
Training is not proper for the company	8	12	4
Company is not challenging enough for supplier	4	12	16
Disciplined use of the system (data entry is not achieved)	6	16	4
Project documentation is not completed	9	4	15
Personnel install their own uncontrollable adaptations into the system	1	1	1
There is not enough chance management skills and managership	8	12	8
Disciplined use of the system (data entry) is not achieved	12	4	12
Top management is not giving enough support/resources to project	10	10	6
Supplier don't understood the customer needs	15	4	25
ERP usage (and maintenance) phase			
Informal communication parallel with formal	6	8	8
System not felt as helping the business	12	8	12
System makes operations too stiff and this weakens key workers motivation	8	8	9
Maintaining the old system connections into the new system is laborious	6	2	1
System don't support new ways of working and changes in business	4	2	8
System not used in a disciplined manner	4	12	10
All needed information is not entered into the system	4	8	15
System supplier don't develop the system in the future	10	5	5
Only part of the system used and benefits realized	6	12	12
System not easily developed	4	4	8
System don't provide documents to support decision-making	4	5	6

Broad use of the system on the worker level is not started in the beginning	2	8	6
System creates data security risks	1	8	4
System supplier stop to provide support for the system	5	5	5

Appendix 2. Challenge analysis (0 = Fault, not true, 5 = Exactly right; N/A = don't know)

Please evaluate the validity of the following statements	Company A	Company B
1. The quality requirements for the outcome of the project can change	3	2
2. The outcome of the project can include segments that were not agreed on	0	2
3. The desired end date of the project can change	5	5
4. It is acceptable to decrease the amount of resources provided for the project	5	1
5. It is acceptable to divert more resources for the project in the middle of the project	4	1
6. Key persons in the project can change	4	5
7. The project timetable is determined by law	0	5
8. The project has access to a good project management tool	0	0
9. Certain segments that were originally a part of the project can be omitted in the end	4	N/A
10. The project forms a part of a larger undertaking	5	1
11. The client organization can experience a major organizational change	0	1
12. The type of business operation in question has not previously been automatized	2	3
13. The users have never used a similar kind of IT service before	4	0
14. The area of business is well-established as well as are the products in the field	1	5
15. The project phase division is clear and according to standard	1	3
16. The services required from the product have been listed in detail	4	5
17. The connections and interfaces that fall under the project's sphere of responsibilities have been listed in detail	N/A	N/A
18. There are similar competing products under development in the market	5	5
19. There are written instructions concerning the alteration procedure relating to the outcome of the project	N/A	N/A
20. It is not the custom to put price tags or time restrictions on any changes in content	4	0
21. The project must absolutely be finished by a certain date	1	0
22. The project can easily be divided into consecutive stages	5	4
23. It is easy to draw up a working plan for a stage	5	4
24. The project timetable strongly depends on the timetable of other projects	4	3
25. The project timetable strongly depends on the availability of certain resources	5	5
26. The project timetable is strongly dependent on external projects such as procurements	2	3
27. It is possible to build buffers into the project timetable	4	5
28. In this project we use Project Management Software to assist us	0	5
29. If need be, a considerable amount of the project can be done through outsourcing	4	4
30. Holding onto a rigid timeframe is part of our culture	5	4
31. The project must absolutely not exceed a certain figure in euros	5	1
32. All cost factors related to the project are known to us	0	4
33. We are able to control all cost factors related to the project	0	4
34. It is possible to establish the desired outcome of the project in many different ways of different cost effects	5	3
35. The accounting systems of the organization provide monthly information about the realized costs of the project and the amount of funds still available	5	5
36. It has been possible to determine the capacity requirements of the machinery, equipment, data communications etc. so that no sudden additional costs will incur	5	5
37. It has been possible to determine the amount of users and other factors that have an effect on procurements	4	5
38. You can shift the costs of the project to the customers and/or elsewhere within the organization	4	0
39. You can shift the costs of the project from one budget period to another	4	3
40. Our organization is very cost conscious	5	4
41. The needs of the different stakeholders amongst the interest group of the project are well known	4	4
42. There is a good consensus concerning the aims of the project between the different stakeholders of the project	N/A	4
43. The views of the stakeholders on the importance and meaning of the project are contradictory	N/A	1
44. The quality of the outcome of the project bears special significance	5	5
45. The project and its outcome has been set clear and incontradictory quality requirements	4	2
46. The quality requirements of the outcome of the project have been set high	4	2
47. The consensus is that fulfilling the quality requirements is possible and that the principal actions in securing this are known.	4	2
48. An instance or party who are experts in systematic Quality Management support the project in order to secure its quality and outcome	2	0
49. The skills and experience of the project stakeholders in terms of analog projects are not known.	3	3
50. Project stakeholders have a sufficient degree of experience and success in analog projects	3	3
51. Staff turnover in the provider/integrator organization is high	N/A	1

52. The client organization might experience major organizational restructuring	0	1
53. The labour market situation in terms of the employee is good, there are vacancies available	N/A	N/A
54. There is high unemployment in the area of business	0	0
55. No real special skills are required in the project	3	0
56. The project management have many different kinds of reward systems in place	5	1
57. Project members have been freed from assignments that are unrelated to the project	0	4
58. The Project Manager is fully concentrated in this project	0	5
59. During the project its members must train themselves in new equipment	5	4
60. Earlier projects led by the Project Manager have experienced human resource problems	N/A	N/A
61. All the stakeholders and key personnel of the project are known	2	4
62. The project includes several stakeholders whose mutual cooperation for the project is important	5	5
63. There is no previous experience concerning the cooperation of the stakeholders of the project	5	4
64. The corporate cultures of the stakeholders of the project (values, language issue, governance, etc) are known and they coincide sufficiently in terms of the project's success	N/A	N/A
65. The communicational demands of the project stakeholders (image, its relationship with public administrative bodies, trade unions etc.) pose special challenges on communication	0	N/A
66. The project does not have a provider/integrator body or client body who bear main responsibility	0	0
67. Anticipating the progress of the project and a corresponding reporting system is especially important	5	4
68. Phasing the project is related with strenuous approval or confirmation procedures	0	3
69. Several different channels are used for communicating or the internal need for the integration of communication is high	1	4
70. In order to make use of the outcome of the project involves major changes in process or organizational adjustments	4	N/A
71. The project is strategically important and there are no alternatives to its success	5	5
72. The project bears an independent status	5	5
73. Management in the different stakeholders are committed to the project and support the cooperation required between the different bodies	3	5
74. The resource instances of the project and the end users of the product are committed to the project	4	4
75. The expectations and goals of the different parties of the project are structured and coinciding	4	4
76. The project is vast (stakeholders, resources, costs, time)	5	5
77. The project structure is simple and solid (phasing, timeframe, goals).	5	1
78. The project makes use of new and untested technologies.	0	0
79. The project goals, timeframe, resources and expenses are in harmony with each other	N/A	2
80. The project management is experienced and the project sticks to an approved project model and to project methods that have been tested in practice	4	2
81. The project mostly applies subcontracting	4	0
82. We know the project subcontractors well	0	N/A
83. There are several different options to choose from in terms of the subcontractors	5	N/A
84. We are able to shift subcontractors with very little negative effect	0	N/A
85. The subcontractors abide by the same quality standards as we do.	5	N/A
86. The subcontracts are clear and act in support of project success	5	N/A
87. We have our established ways of monitoring the success of procurements and our satisfaction	0	N/A
88. Our organization excepts the use of subcontractors	5	N/A
89. We have experience from previous projects concerning the people our subcontractor has appointed to this project	N/A	N/A
90. Our subcontractor and their personnel have sufficient experience of our line of business	N/A	N/A

Factors influencing users' intention to continue using ERP Systems: Evidence from Egypt

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Abstract: There has been an increasing interest in ERP systems in the last decade. The Egyptian market is no different. However, in many occasions companies stop using the system after they go-live and finish the implementation. This study is an attempt to reveal the factors influencing users' intention to continue using the ERP system. A survey was sent to respondents gaining a number of 223 responses. A hypothesized model was developed based on three theories; TAM, ECT, and TPB. The model was tested using regression analysis of the collected responses. Results showed that users' intention to continue using the ERP systems are affected by: perceived usefulness, satisfaction, subjective norm, and perceived behavior control. Meanwhile, perceived usefulness is affected by confirmation and subjective norm while satisfaction is affected by perceived usefulness and confirmation.

Keywords: ERP; factors influencing users' intention; TAM; ECT; TPB.

1. Introduction

In the last decades business relied more on information and communication technologies to handle their day-to-day operations in an efficient manner. So management and business organizations spend a great amount of resources on information technology (IT) with expectation of increasing productivity, efficiency and long term benefits (Alshare et al., 2004) to adapt such substantial growth. This huge investment made IT puts increasing pressure on management to justify the outlay by quantifying the business value of information technology.

To cope with such changes, Egyptian organizations paid attention to the importance of using IT to gain advantage in competitive market. *Enterprise Resource Planning systems* (ERP) are one of the highly complex information systems (IS) which have been transferred by multinational companies to the Egyptian environment recently (Elsawah et al., 2008).

Enterprise Resource Planning systems (ERP) may well count as "the most important development in the corporate use of information technology in 1990's" (Davenport, 1998). A typical ERP system may combine inventory data with financial, sales and human data, allowing organizations to achieve many works like pricing products, producing financial statements and managing human, material and financial resources effectively (Markus et al., 2000). This means

that ERP system is integrated, enterprise wide system, which automated core corporate activities. It helps organizations to replace the present IS –isn't integrated one- to an integrated system. ERP implementations are very complex and expensive, but once they are implemented successfully, significant improvement in business processes, communication and interaction between users and customers may occur. In addition to better production scheduling and reduction in manufacturing cost. Also management can observe reduction of cycle times of documents and elimination of redundant data and operations (Zhang et al., 2003).

It was reported that 75% of the ERP projects are classified as failures and many ERP projects ended catastrophically (Griffith et al., 1999). In Egypt, the failure rate of implementation problems is extremely higher than that in the western companies because of the challenging Egyptian culture which is entirely different from where these systems were developed (Elsawah et al., 2008; Rasmy et al. 2005).

Accordingly the objective of this paper is studying some of the factors that influence the formation of users' intention to continue using ERP system which can aid the system designer to examine any system before implementation to do any modification on it if need it.

From the above we can address the research questions as follow:

1. What are the salient factors underlying ERP users' intention to continue using ERP system after its initial acceptance?
2. How do these factors influence continuance intention?

This paper is structured as follows. We first introduce literature review of similar studies then describing the relevant theories which will help us to build our research model. Then we will introduce our research model and its hypotheses. Survey and statistical analysis will follow and finally ideas for future research are presented.

2. Literature Review

The last two decades has seen an increasing in the investment in Information Technology (IT) to the point where it represents about half of all capital investment on a global basis (Mahmood et al., 2000). In addition, growing numbers of strategic IS that shape or critically support organizational processes have also been reported (Mahmood et al., 2000). This led to the growing body of academic research examining the determinants of information acceptance and utilization among users.

Information Systems (IS) are general concepts. Since IS has different functions, so different industries and different organizations use different information systems (Yeh, 2007). Davenport (1998; 2000) has defined ERP systems as "Programs that aim to provide integrated software to handle multiple corporate functions including finance, human resources, manufacturing, materials management, and sales and distribution. This means they incorporate information and information-based processes in and across organizational functions areas in the organization. This is important to point out that ERP systems are different from the others IT systems as:

- The integrated nature of ERP systems causes dramatic changes in the procedures and processes of the business (reengineering);
- As ERP system are not built but adopted, this involves the need to introduce customizations to the users (Wu & Wang, 2006);
- The user becomes dependent on the ERP vendor for assistance and updates (Wu & Wang, 2006).

In addition, ERP implementation includes changes in technological, operational, strategic, managerial and organizational related components (Ifinedo, 2007).

ERP implementation is risky and the cost of the technology is expensive. In addition, the implementation environment is affected by a large number of software, complexity of the

requirements from those systems and the need to adopt any existing or future software to the core ERP technology (Gyampah, 2007). But once it is successfully implemented, it allows organizations to:

- Integrate all their activities together with supply chain and customer services;
- Facilitate information flows;
- Consolidation sources of data and data entries to eliminate multiple sources of data;
- Communicate different organizational units to help meeting the requirements of employees and customers alike.

Thus, researchers have devoted more efforts at identifying factors that might be important to avoid ERP failures. Specially, it was reported that only one quarter of ERP projects are successful and the other three quarters are considered as failures projects (Rasmy et al., 2005).

A number of explanations for ERP implementation failures have been offered in different research. Yeh (2007) summarized them in his research as technical (e.g. lack of technically knowledge staff and problems in software customization and testing), economic (e.g. lack of economic resource, underestimated the economic resources needed and lack of planning and justification), finally human/organizational (e.g. lack of strong and committed leadership).

The most important and common reason in most ERP project failures is human resources (Nah et al., 2004). The main and the common problem is resistance to change. This seems the main obstacle the organizations are facing. Employees are often reluctant to learn new technology or the IT department is reluctant to change to due their involvement to the existing product.

This raises the question: which factors influence the decision to accept ERP system and to continue using it in the post-acceptance phase? In the acceptance phase, the initial adoption of ERP is an organizational decision although employees are the ones who are going to use it (Tan & Siau, 2006). Prior studies, e.g. (Orlikowski, 1991; 1992), suggested that employees sometimes decide not to use ERP system, although the organizational decision is to adopt it. In other words, the long-term viability of an ERP system and its radical success depend on its continued and extensive use by individual. That's because if the individual are unwilling to use ERP, their work would be worsted which in turn would affect the productivity (Frey, 1993). In similar lines, Jaspersen et al., (2005) advice that more research should focus on the post acceptance usage and continues phenomenon. Also Recker & Rosemann (2007) suggest a theoretical model studying factors that influence the formation of an intention to continue using a process modeling technique.

Their suggestion had been a motivation for us to develop a model studying the factors influence users' intention to continue using IS (ERP in our study).

3. Description of Relevant Theories and Concepts

Investment in information systems is a real value to organizations if the information systems are used by a manner achieving the strategic objectives. Thus the acceptance of the user of IS is a key factor for the success of the investment in IS. Although the initial acceptance of IS is the first step and important to the success of IS, but the continuous use of those systems for a long period of time depends on the continuous use and not the first use only. So when implementing an information technology, the ultimate goal of the manager is the technology intended level of usage is achieved. As the system can't be considered successful if the technology is not used or the intended level is not achieved (Gyampah, 2007).

As stated by Markus & Keil (1994: pp.11-12), "because use is not build in, these systems never achieve their true potential for improving organizational performance". They also noted if the system is technically successful but it is unused or under used, it will cost the organization too much. Davis et al. (1989: p.982) reported "computer systems can't improve organizational

performance if they are not used". On the same sequence Yi & Davis (2001: p.522) noted "Organizations will not realize desired returns on their investments in information technology designed to improve decision-making unless users are able to use them". Lastly Gyamah (2007: p.1234) noted "An implementation project can achieve technical, budgetary and schedule success, but if the users of the technology do not use it, the intended benefits for implementation that technology are not likely to be obtained".

In this section, we introduce three complementary theoretical model on the acceptance and continues decision in the IS discipline. These theories will be the base of our model of process ERP continuance.

We focus in our study on the three models. First, Technology Acceptance Model which shows the determinants of formation of users' intention to accept IS. Second, Expectation-Confirmation theory that explains post-adoption behavior with respect to its match with pre-adoption beliefs and expectations. Lastly, Theory of Planned Behavior which explain user intention and behavior through added factor Perceived Behavior Control.

3.1. Technology Acceptance Model

The primary underlying model for this research is the technology acceptance model (TAM). TAM is specifically meant to explain behavior of computer usage. "The goal of TAM is to be capable of explaining user behavior across a broad range of end-user computing technologies and user populations, while at the same time being both parsimonious and theoretically justified" (Davis et al., 1989: p.985).

Although TAM was introduced in 1986 by Davis -from nearly twenty three years- and was tested by Davis et al. (1989) it continues to be the "most applied theoretical model in the IS discipline" (Lee et al, 2003). It is derived from Theory of Reasoned Action (TRA) by Fishbein & Ajzen (1975). While TRA is a general theory of human behavior, TAM is a model specific to IS usage. It explains technology acceptance quite well (Wang, 2005). As note by Venkatesh & Davis (2000: p.186), "TAM consistently explains a substantial proportion of the variance (typically about 40%) in usage intentions and behavior and that TAM compares favorably with alternative models such as the Theory of Reasoned Action and the Theory of Planned Behavior".

The model suggests that users' decisions to accept new IS are influenced by two core constructs. These two constructs are Perceived Usefulness and Ease of Use. *Perceived usefulness (PU)* is defined as "the degree to which a person believes that using a particular system would enhance his/her performance" (Davis et al., 1989, p. 985). *Ease of use* is "the degree to which user expects the target system to be free of effort" (Davis et al., 1989, p.985). Related studies have reported in the post-acceptance stage, perceived usefulness directly influence users' intention to reuse (continue using) system provided. On the other hand perceived ease of use has significant influence on intention in pre-acceptance stage but once user begin actually use the system, it rationally becomes less important in formation his intention (Szajna, 1996).

TAM has been identified as a very commonly employed theoretical framework for studying IS acceptance (Lee et al., 2003). There are great amount of research related to TAM has reportedly made it one of the most influencer IS theories overall. In short, if the central goal to predict IS usage, it can be argued that TAM is preferable (Taylor & Todd, 1995).

Some current research on ERP implementation has used TAM or various factors from it in trying to understand user acceptance and continues use to ERP system. It is also used in some many researches to examine the successful story of ERP implementation in the organization (Gyampah & Salam, 2004).

3.2. Expectation–Confirmation Theory

Expectation-Confirmation Theory (ECT) is widely used in consumer behavior literature to study consumer satisfaction, post-purchase behavior (e.g. complaining, repurchase) and service marketing in general (Anderson & Sullivan, 1993; Dabholkar et al., 2000). ECT posits that initial pre-usage *expectations* coupled with *perceived performance*; lead to post-adoption satisfaction which in turn forms the user intention to continue using IS system. Satisfaction is mediated through positive or negative confirmation which formed by comparing expectation and perceived performance (Oliver, 1980). Perceived performance is often conceptualized as perceived usefulness of using IS (Bhattacharjee, 2001). In our research model, we are going to assess the impact of confirmation on perceived usefulness and satisfaction.

3.3. Theory of Planned Behavior

Theory of Planned Behavior (TPB) was introduced by Ajzen (1991). It extends the Theory of Reasoned Action. A key purpose of TPB is to provide a basis of tracing the impact of two primary factors on user intention. These factors are Subjective Norm and Perceived Behavior Control. TPB posits that user's intention is formed due to attitude toward the system, subjective norm and perceived behavior control. *Attitude (A)* defined as the user's evaluation of the desirability of his or her using the system (Mathieson, 1991, p.175). *Subjective Norm (SN)* reflects perceptions that significant desire the individual to perform or not perform a behavior (Taylor & Todd, 1995; Mathieson, 1991). Lastly *Perceived behavior Control (PBC)* refers to the individuals' perceptions of the presence or absence of requisite resources and opportunities (Ajzen et al., 1986, p. 457) necessary to perform the behavior. In our research model, we are going to assess the impact of subjective norm and perceived behavior control on users' intention to continue using the ERP.

4. The Research Model and Hypotheses

From the above discussions of the three theoretical perspectives upon the continuance decision we will introduce in the following section our hypotheses:

Confirmation of users' expectation of using IS can indirectly influence IS continuance use mediated by satisfaction or perceived usefulness.

Just as in IS acceptance contexts perceived ease of use can affect perceived usefulness. Confirmation can also influence perceived usefulness in the post-acceptance contexts. The users in the acceptance phase are unsure of what to expect as they do not have enough information about the system. This leads to low initial usefulness perceptions of new IS (Bhattacharjee, 2001; Bhattacharjee & Premkumar, 2004) which are easily confirmed. Such perceptions may be adjusted higher as they know more about the system. In summary, users often adjust their perceptions to be consistent with reality. This means confirmation can elevate perceived usefulness.

Expectation confirmation theory posits that user satisfaction is determined by two factors: expectation of IS and confirmation of the expectation which will lead to reusing the IS. As noted by Bhattacharjee, "Confirmation is positively related to satisfaction with IS use because it implies realization of the expected benefits of IS use while disconfirmation denotes failure to achieve expectation" (Bhattacharjee, 2001, pp.355-356). Based on the above discussion the following hypotheses are proposed:

H1a: In an ERP implementation environment Confirmation of Expectation has a positive effect on Perceived Usefulness.

H1b: In an ERP implementation environment Confirmation of Expectation has a positive effect on Satisfaction.

Satisfaction is a key variable to measure the extent of the continuing use of the IS or repurchase a product/ services. It is considered as the basis of building and strengthening the users' loyalty to long-term using IS or product/services. Cheung & Limayem (2005) presented a study on students using Blackboard as a course management system (CMS). His objective is to gain a better understanding of the factors influencing students' continued usage of a news technology. Their results present strong support for the direct impact of satisfaction on users continues intention and they noted in their research that satisfaction is the strongest factor to continue system usage. Satisfaction has been widely adopted as an important determiner of IS success. Danaher & Rust (1996) found that a customer (user) who is more satisfied with a service (system) will have higher subsequent usage levels. Satisfaction lead to using the system but using the system can not lead to satisfaction (Baroudi et al., 1986). This leads to the following hypothesis:

H2: In an ERP implementation environment Satisfaction has a positive effect on Users' Intention to continue using ERP system.

Subjective Norm is one direct determinant of theory of Planned Behavior (Ajzen,1991) which is defined as the degree to which an individual believes that people who are important to him/her think he/she should perform the behavior in questions. Thus, employees are likely to be influences when deciding to continue use ERP by both what their peers think, due to the competitive nature with organization; and what their supervisors and managers may think, due to possible affect on their work performance. In addition, they are affected by the need of team work with other employees.

According to previous researches, Subjective Norm has a significant effect on users' intention, either directly or indirectly through perceived usefulness (Taylor & Todd, 1995; Karahanna et al., 1999; Venkatesh & Morris, 2000; Venkatesh & Davis, 2000). Also (Lai et al., 2005) confirm that Subjective Norm had the second largest total effect on user intention to use a system, suggesting that employee are likely to be influenced by their managers, supervisors, friends and peers when deciding whether to use the system provided or not. As subjective Norm shape the potential adopters' beliefs about when and why to adopt an innovation. When a supervisor or peers suggest the usefulness of a particular system in the post acceptance stage, the individual would accept the idea even if they realize this during the acceptance stage. According to the above discussion, the following hypotheses are presented:

H3a: In an ERP implementation environment Subjective Norm has a positive effect on Users' Intention to continue using ERP system

H3b: In an ERP implementation environment Subjective Norm has a positive effect on Perceive Usefulness.

Perceived Behavior Control was added into the theory of planned Behavior to answer the limitation of theory of Reasoned Action, to deal with individuals that may lack complete volitional control over behavior (Ajzen, 2002). So according to Ajzen (1991), the more resources (money; computer, time, network) and opportunities individuals think they possess, the greater would be their perceived control over their behavior, and therefore, the greater the likelihood for these individuals to behave accordingly, in this study is ERP system. Perceived Behavior Control is based partly on past experience and partly from the second hand information, through the exchange of information by family, friends and factors that may control the level of perceived difficulty of performing the behavior of interest (Ajzen, 1991). Many studies have shown common results regarding Perceived Behavior Control as a predictor of intention. According to Wang et al (2007), Perceived Behavior Control influence users' intention to shop line. Also Gopi

& Ramayah (2007) noted in their research that Perceived Behavior Control influences investors' intention (users' intention in our study) toward internet stock trading (ERP in our study). Hence, the hypothesis formulated is:

H4: In an ERP implementation environment Perceived Behavior Control has a positive effect on Users' Intention to continue using ERP system.

Technology acceptance research has shown that perceived usefulness is the salient belief influencing individuals to accept an IS. Also IS Continuous Model (Bhattacharjee, 2001) has shown that perceived usefulness is an important variable impact individual intention to continue using IS. Prior studies found that perceived usefulness influences an individual intention during both acceptance and post-acceptance stage of IS use (Davis et al, 1989; Karahanna et al., 1999). Also Szajna (1996) reported that, there are two factors influence users' intention in the acceptance stage -Perceived Usefulness and Perceived Easy of Use- but in the post-acceptance stage Perceived Usefulness is the only variable affect users' intention. Attitude is a pre-acceptance affect, while satisfaction is a post-acceptance affect. It is confirmed that perceived usefulness can directly impact attitude in the acceptance stage. Like wise, perceived usefulness is expected to be the most salient ex post expectation influence users' post-acceptance affect (satisfaction) Bhattacharjee (2001). It is noted by Bhattacharjee (2001) that perceived usefulness is based on others' opinions or information proposed through mass media in the acceptance stage, while perceived usefulness in post-acceptance stage is formed through users first-hand experience and is, therefore, more reliable. Based on the above discussion, the following hypothesis is proposed:

H5a: In an ERP implementation environment Perceived Usefulness has a positive effect on Users' Intention to continue using ERP system.

H5b: In an ERP implementation environment Perceived Usefulness has a positive effect on satisfaction of using ERP system.

We summarize the proposed relationship to be tested in this research in Figure 1.

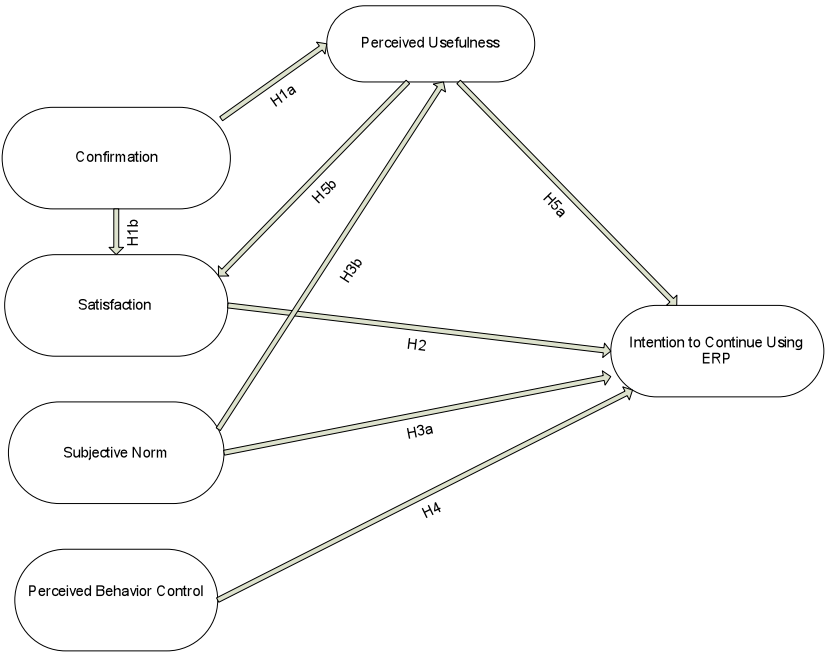


Figure 1 – the Research Model

5. Research Methodology

Survey

Data was collected through online questionnaire. Online survey has the advantages of speeding up large amount of data collection and allowing for electronic data entry (Parasuraman & Zinkhan, 2002). The unit of analysis is end-users of an ERP system within organizations. Participation in this study was voluntary.

All used instruments had been validated by prior studies. These instruments were modified for the adaptation to ERP usage. The scales of confirmation and users' intention to continue using ERP were measured using three items derived from Bhattacharjee (2001). While perceived usefulness and satisfaction derived from Zvirian et al. (2005). Subjective norm and perceived behavior control derived from Taylor and Todd (1995). All scales used five-point Likert scales anchored between “strongly disagree” (1) to “strongly agree” (5) with “uncertain” (3) except satisfaction anchored from “almost never” (1) to “almost always” (5) with “about half of the time” (3).

The demographic and other data included information about the respondent's gender, age and years of using ERP system in his/her current organization. In addition to his/her current position, the kind of industry and the kind of ERP system he/she is using.

The data was collected through online questionnaire on Survey Monkey website. We collected the data for a whole month by forwarding the link of the questionnaire to the companies implemented any kind of ERP, either international ERP (Oracle, SAP, Microsoft, and Focus) or local ERP (ALMOTAKAMEL). The companies, we have chosen, implemented ERP at least for one year.

Results

A total of 223 responses were obtained. Some demographics were collected and the analysis of which is presented in the following tables. Table 1, gender distribution is presented showing great percentage of male users of ERP.

Table 1 – Gender distribution

Gender	Frequency	Percent
Male	177	79%
Female	46	21%

Table 2 presents the ERP systems surveyed in our research study. The results show that the majority of users are using Oracle ERP with next level using SAP and Microsoft while the group of users utilizing local (ALMOTAKAMEL) and emerging Indian ERP (Focus) is still in its infancy.

Table 2 – ERP systems

Vendor	Frequency	Percent
ALMOTAKAMEL	5	2.5%
FOCUS	1	0.5%
SAP	39	17%
MICROSOFT	19	9%
ORACLE	157	70%
UNKNOWN	2	1%

The industries represented in the study are reasonably versatile reflecting different interests and backgrounds. Results indicating industry and its frequency are presented in table 3.

Table 3 – Profile of industry

Industry	Frequency	Percent
Oil and Gas	25	11%
Manufacturing	30	13%
ICT	37	17%
Audit firm	5	2.5%
Call Centre	32	14%
Pharmaceutical	12	5%
Food & Beverage	28	12%
Travel & Airlines	2	1%
Courier	1	0.5%
Banking	15	7%
Telecom	22	10%
Cement	5	2.5%
Others	9	4%

In table 4, respondents function is presented together with its frequency and percentage of occurrence. Again, the respondents belong to quite different backgrounds.

Table 4 – Profile of respondents' position

Users' function	Frequency	Percent
Finance	35	16%
ERP	8	4%
IT	9	4%
GM	13	6%
HR	15	7%
Logistics	19	9%
Marketing	5	2%
Production	5	2%
Customer Service	14	6%
Systems Admin	5	2%
Other user categories	95	43%

Survey validation

To test the research instrument reliability Cronbach Alpha was used. The overall reliability of the instrument is 0.89. All measures show acceptable reliability exceeding the cutoff value of 0.7 (Elsawah et al., 2008). Acronyms used to refer to survey measures as follows: (CONF: confirmation, P_USEF: perceived usefulness, SN: subjective norm, PBC: perceived behavior control, INTEN: intention to continue using ERP, SATISF: satisfaction). Table 5 has the details.

Table 5 – Reliability of the constructs

Measures	Items	Cronbach's Alpha	Cronbach's Alpha if Item Deleted
CONF	3	0.835	0.916
P_USEF	8	0.876	0.866
SN	2	0.954	0.881
PBC	3	0.832	0.869
INTEN	3	0.845	0.852
SATISF	12	0.964	0.843

Discussion and conclusion

Significant correlations found between all constructs. Significant correlation coefficient scores support the study hypotheses because it tells that there is a significant relationship between the constructs. To explain, for H1a the correlation between CONF and P_USEF is found to be 0.40 which indicates the significant relationship between CONF and P_USEF. However, the correlation coefficient does not explain the effect of a variable on another but rather it measures the strength and direction of the relationship. So, regression analysis will be used to measure the effect. Same logic applies to H1b (0.42), H2 (0.80), H3a (0.64), H3b (0.59), H4 (0.75), H5a (0.79), H5b (0.79). Table 6 shows correlation coefficients between survey constructs.

Here in this section, we have seen that the variables included in a certain hypotheses retained a significant positive relationship its strengths ranges from 0.40 to 0.80.

Table 6 – Correlation between constructs

	Mean	S.D.	CONF	P_USEF	SN	PBC	INTEN	SATISF
CONF	3.88	0.59						
P_USEF	4.28	0.59	0.40**					
SN	4.24	0.92	0.30**	0.59**				
PBC	3.76	0.89	0.18**	0.69**	0.55**			
INTEN	4.21	0.88	0.34**	0.79**	0.64**	0.75**		
SATISF	3.96	0.82	0.42**	0.79**	0.69**	0.78**	0.80**	

**. Correlation is significant at the 0.01 level (2-tailed).

Now the next step is to investigate the impact of a variable on another, for which we will use regression analysis. In the following section, we are going to test all study hypotheses in terms of whether they are supported or not.

We tested the hypothesized relationship using regression analysis. The first model to test is the one representing H2, H3a, H4, and H5a. In which we assume that INTEN is affected by P_USEF, SN, PBC and SATISF. Regression results show an R^2 of 74%; which means that the predictor variables are able to explain 74% of the changes in the dependent variable. The ANOVA results show that the model is significant at 0.00 meaning that the changes in INTEN are not due to chance and the entire model is significant. Finally, the coefficients table shows the following equation where all predictor variables are significant: $INTEN = -0.49 + 0.53 P\_USEF + 0.13 SN + 0.23 PBC + 0.27 SATISF$. To summarize, the following hypotheses are supported by the regression results:

- H2:** In an ERP implementation environment Satisfaction has a positive effect on Users' Intention to continue using ERP system (*Supported*).
- H3a:** In an ERP implementation environment Subjective Norm has a positive effect on Users' Intention to continue using ERP system (*Supported*).
- H4:** In an ERP implementation environment Perceived Behavior Control has a positive effect on Users' Intention to continue using ERP system (*Supported*).
- H5a:** In an ERP implementation environment Perceived Usefulness has a positive effect on Users' Intention to continue using ERP system (*Supported*).

In the second model we test H1a and H3b. The model assumes that SN and CONF affect P_USEF. Regression results show an R^2 of 41%; meaning that both SN and CONF are able to explain 41% of the changes in P_USEF. According to the results of ANOVA the model is significant at 0.00 meaning that the changes in P_USEF are not due to chance and the entire model is significant. The coefficients table shows the following equation where all predictor variables are significant: $P\_USEF = 1.88 + 0.34 SN + 0.25 CONF$. This shows that SN and CONF are significant to P_USEF. The following hypotheses are supported by the regression results:

- H1a:** In an ERP implementation environment Confirmation of Expectation has a positive effect on Perceived Usefulness (*Supported*).
- H3b:** In an ERP implementation environment Subjective Norm has a positive effect on Perceive Usefulness (*Supported*).

The final model to test is the one testing H1b and H5b in which we assume that CONF and P_USEF affect SATISF. Regression results show an R^2 of 63% which means that CONF and P_USEF are able to explain 63% of the changes in SATISF. The ANOVA results show that the model is significant at 0.00 which means that changes in SATISF are not due to chance. The entire model is significant. The model equation is: $SATISF = -1.06 + 0.16 CONF + 1.02 P\_USEF$. And as per the coefficients table both predictor variables are significant which lead to the conclusion that hypotheses tested are both supported by the regression results:

H1b: In an ERP implementation environment Confirmation of Expectation has a positive effect on Satisfaction (*Supported*).

H5b: In an ERP implementation environment Perceived Usefulness has a positive effect on satisfaction of using ERP system (*Supported*).

6. Future research

Future research, with various sample (different industry, type of ERP) and longitudinal studies are required. In addition to, future research is needed to investigate the success of the system from the view point of IT managers and Users. Also, future research is required to discuss the success factors of ERP from the viewpoint of the companies responsible for the implementation of ERP system.

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Potential of CRM adoption on Municipalities

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Abstract: Municipalities are developing politics to modernize their services through the adoption of agile and transparent administration models, based in information and communication technologies. In those models, the relationship with citizens plays a central role and should be based in process optimization and in the elimination of procedures and routines that don't increase value to services that are provided. In this way, the creation of contact and interaction channels with the citizens ("municipal customers") is fundamental for the quality of the services provided by municipalities, constituting CRM systems (Customer Relationship Management or, in this context, "Citizen Relationship Management") efficient solutions in this context. In this paper are discussed essentials of CRM systems and its potential to operate a deep change in the way as the municipalities interact with citizens, making possible the reorganization and qualification of their services.

Keywords: CRM, public, municipalities.

1. Introduction

The dynamism of the business world is requiring more and more each day: persons and organizations need to be able to perform more tasks in shorter time, looking for excellence and quality in their performance.

A society in constant change brings constantly challenges to organizations. Information and communication technologies (ICT) are the most visible factors of that accelerated change; the computer and Internet are the two maximum exponents of it. The organizations must be able to anticipate, react quickly and even promote the changes.

Associated to this revolution we can also verify change of work habits, of leisure and even ways of thinking. The most valuable organization's resources are certainly the human resources. Although can exist sophisticated tools for analysis and forecast, this component does not substitutes the highly qualified human resources needs (Xavier, Gouveia, 2003).

Nowadays the differentiation between companies is not focused in the quality of products: this is already a consummate fact in a world where products without quality do not have room in the market. The differentiation is in the capacity of a company/organization to attend and charm his client in such a way that is going to create loyalty.

It is on this spirit of availability, interaction and fidelity, with the customers, that the public organizations need to enter. In this context the CRM systems (Customer Relationship Management) appear as capable and fundamental tools to increase the quality of the service.

As closer as a public entity could be with citizens, using and generating information in order to know and to analyze their best perspectives, the better will be the results of the work carried

out. As such, it is very important that the people who have contact with the citizens have access to applications to support and help their work.

The CRM systems enable the public organizations to obtain organized information from the citizens. The implementation of the concept of CRM in an organization requires many times a reengineering of business process, in such a way that the client becomes the central element. The information should be organized by customer and not by transaction. In this way, the customer will obtain the same information through any channel he chooses to communicate with the organization. It also should be possible for the organization to learn more about the customer in each interaction carried out by him, allowing obtaining a complete vision of their habits, what is very valuable to the decision process.

The aim of this paper is discuss the potential of the CRM systems in municipalities to increase and improve their relationship with the citizens, as well to reorganize and qualify their services.

2. Context

As all the organizations have access to the same technological base, the competitive advantages are the result of a management and creative utilization in the best possible way of the technology.

It is a fact that the complexity of the organizations is increasing, resulting from the growing diversity of new concepts and technologies. The Internet provided a widening in the scope of the application of ICT in municipalities, bringing projects that many times transcend the aspects that have to do with the re-organization and administrative modernization.

In order to optimize the relationship between municipalities and citizens it becomes urgent the adoption of technologies that allow the automation of the internal processes as well the improvement of the contact channels.

Is this context CRM could perform a very important role.

Bretzke (2000) highlights the fact that CRM enable to maintain and develop competitive advantages, by a deep knowledge of potential and current customers, by the systematization of the communication activities, and by the use of technological tools and well directed marketing. For the author, the CRM strategy is a competitive differentiator. Curry and Kkolou (2004) refer that the CRM is a strategy that is now a requirement to compete.

It is important to note that the CRM concept that appeared in a business context could be also used in the public administration in general and in the municipalities in particular, in a perspective of substitution of the meaning of C in CRM from clients to citizens (Citizens Relationship Management).

Taking of the perspective of the citizen as a customer is an excellent opportunity for the integration of the systems of CRM and GIS (Geographical Information Systems).

Even without appeal to a customers database, there are diverse means of applying the GIS to marketing. The possibility of segmenting the populations according to statistical facts collected of inquiries (by examples, censuses) is one of the most common approaches. However, such thing only happens in countries and regions where the legislation allows it.

With the integration of GIS and CRM it is possible, in the business world, to find and develop relations with the most profitable clients, evaluate the profit value of the transactions by region, analyze the areas of contact, deliver products and service more efficiently, and fulfill more easily the fiscal and local regulations.

The CRM systems integrated with SIG could permit the satisfaction of the needs of information, considering suppliers of service and respective customers. Through the utilization of ubiquitous systems of geographical location in all of the aspects of the activity of business,

marketing, planning, analysis and management, is possible to detect standards and tendencies in the data that, otherwise, would pass unnoticed (ESRI, 2000).

According to Xavier, Gouveia and Gouveia (2002) there is no reason for a municipality to not reach the same results in the relationship with their citizens, as a company has with their customers using a CRM system.

The municipal entities will have in this way more knowledge and capacity for satisfying the needs of the citizens. On the other hand, the citizens benefit from new offers and better service.

3. CRM fundamentals

Sin, Tse and Yim (2005) stand out the importance of clarifying the CRM concept. Teo, Devadoss and Pan (2006) share this idea and, like Bull (2003), alert that the CRM has different meanings for different people, representing distinct things. Bull analyzes some conceptions about CRM and affirms that CRM represents a complex combination of factors of business and technology, stressing that the strategies should be formulated accordingly with those factors.

Some companies see the CRM only as a technological tool, however other organizations understand CRM like an essential part of the business. In that last approach, the CRM is understood like a business strategy.

Mendoza et al. (2007) refer the relevance of defining the CRM as a business strategy. As a strategy, CRM is focused on the understanding and the anticipation of the needs of the current and potentials customers of an organization.

In some cases, CRM appears also as an organizational method that enables to manage the relationship with the clients in a more efficient way.

Law, Lau and Wong (2003) analyze the diverse conceptions about the CRM, commenting that divergences and paradoxes exist between the concepts. Right away, they present a definition, calling it of new conception of the CRM. They affirm that CRM represents a process of development of the relationship with the customers. For the authors, the objective is to establish an "co-creative" environment, in which all the part involved work together, involving the collaboration, the cooperation and the communication, between the organization, the customer and, including, the intermediate and/or external partners. The authors observe the extension of the CRM in the chain, considering it as the link between the organization and the suppliers, the partners and the customer. They also call the attention for the active role of the customer, participating in the organizational decisions, by means of suggestions or critical comments throughout the relationship. They reinforce that the customer will always be the initial point. The profitable customers should be identified so they can become the center of attention of the organization. These authors also emphasize the need of relationship with partners and the vision of "network" (work in net), making feasible the strategy of CRM.

We can observe the concept of management of the relationship of partnerships inserted in the conception of the CRM. In that sense, we are able to state that this concept represents a strategy for selecting and administer partnerships, aiming at optimizing the value in the long term for the organization, assuring the satisfaction of the partners and final customers (GREENBERG, 2001).

The CRM is a comprehensive strategy that has influence in many business processes. It is important to note that what today is designated by Customer Relationship Management is not something entirely innovative, since the companies always had mechanisms, more or less sophisticated, to related with the clients. However, currently the challenge is bigger due to the fact that markets have a bigger dimension, there is a growing importance of personalizing the direct relationship, and there is not only the need to conquer new clients but also of maintaining the ones that already have.

Nowadays, is fundamental to have the capacity of carry out marketing in real time, to agile the business processes, so that in the moment of the contact between the customer and the organization, it can be recognized and, in that form, can receive offerings of products and completely adequate service to its profile.

However, to have relevant information with the needed quality about each customer, it is necessary to use efficient technological tools for collecting and manage the information concerning to all the interactions of him with the company.

This enables the organization to have an unique vision of the clients and explore new business opportunities. It is necessary to take advantage of all the interactions that the organization has with the clients, in the sense of grasp facts and transform them in information that can be disseminated by the organization.

4. Purposes of a CRM System

Integrating all functions and processes involved in the activities of the organization with its customers, decrease the cost of transactions and modernize the administration, are the major objectives to be achieved with the implementation of CRM.

With the implementation of CRM, is possible for any municipality, qualify and optimize the internal operation of the municipal service, improve the provision of services to the citizens and to the companies, promote the interaction between the different public administrations and contribute for reinforcing the quality of the citizenship.

The information systems provide now a range of services that facilitate the implementation of tools for internal management processes. It is crucial for municipalities to increase the relationship and improve the interaction with citizens, providing access to information, increasing the knowledge about the people, facilitate and provide new means of service (web and call center) (e-Business Report, 2008).

The CRM systems enable organizations to give structured information to the citizens, in different areas. CRM gives to organizations the power and the flexibility to obtain the correct information, for the correct person, at the correct moment.

The future is the full integration of all the systems that can produce relevant information for the municipality and for the citizen. It is important to concentrate all the information about the citizens that commonly is found spread around the diverse services and create a more uniform access to information on the part of officials, citizens and other entities.

5. Systems' interactions

The interaction between systems of a Municipality is of extreme importance, permitting to obtain better results with the operation of the entity improving the level of internal operation and increasing the quality of the relationship with the outside.

To develop a project capable of centralizing the information, that otherwise is found scattered around the various services and departments of a municipality and many times in autonomous and divergent systems, are today's challenges and objectives of the Municipalities in order to be able to provide timely answers to their citizens.

It is fundamental have in count that elements that are bound with the facility of integration and to interoperability with others products or tools that collaborate that already exist in the Municipal systems, namely ERPs (Enterprise resource planning), should be considered. There is the need of restructure the structures of ITC in the area of the intranet and of the services, which

they are interdependent, given that the necessary information flows especially in the intranet and like this is going to improve the contact with the public. The solution to be implemented should have in count the ERP already implemented in the municipality or others existing systems and should assure the necessary interoperability, especially in what concerns the integration with the system CRM to be implemented.

For the interaction and interoperability of systems there is a clear expectation in the increase of the productivity, as well as of the quality of the service provided. It is important to highlight another kind of benefits: the optimization of internal processes, better performance of the human resources, improvement in the service to the citizens, and the capacity of future growth. All of this combined optimize the work to whom directly deals with the processes as, for example to know how they are being dealt with and how long is going to take to process them. At leadership level, permits a better supervision, management and coordination of the service. There is, like this, a bigger and more efficient control of the whole process.

6. Conclusions

The need of CRM systems is growing and will be with certainty one of the systems of more investment in the near times. This tendency, where the focus is on the client, is to be felt in several sectors and this pressure is on the public administration and in particular the local municipalities. More and more, the citizen is going to be treated as a customer. The change of the vision of the citizen, today divided between diverse services, gradually is being substituted by an integrated vision. This change is deep and requires a lot more than technological knowledge: the need of management of the change is big and that is an essential condition for the success. The central and local government already gave significant steps in the adoption of systems CRM, appealing to suppliers that already have experience and are in particular focused in the adaptation of its solutions for this kind of organizations. This experience guarantees that the normal problems can be anticipated and avoided, diminishing the risk of the project.

In this article were aimed concepts, that are of extreme importance for the qualification of the local administration and that have to do with the evolution carried out with the systems of information and more concretely of the systems CRM.

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Measuring Extent of ERP Systems Utilization in Enterprises

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Abstract: Since deployment of Enterprise Systems (ES) such as Enterprise Resource Planning (ERPs) systems within enterprises, both Large (Les) as well as small and medium-sized enterprises (SMEs), has increased and continues to increase, it becomes increasingly desirable to measure use and utilization of ERP systems in enterprises. One reason for why this is of interest is that ERPs are massive investments that need to show benefits and it can be stated that no benefits are realized if the system not are used. It is also of interest to explain ERP systems utilization and what factors that influences ERP utilization. This paper provides an explanation of factors influencing ERP utilization by testing a research model building on the four “dimensions”: Volume, Breadth, Diversity, and Depth. The contributions of the research are: Firstly it provides support for the notion of diffusion found in the theory of network externalities and that a critical mass is necessary to achieve benefits. This can be used to better understand failures in ERP projects. Secondly the use of volume, breadth and depth provide insights to use as a construct and the need to treat it more rigorously. Thirdly the result contributes to our understanding of the many aspects of use of IT and potentially contribution to value and firm performance from IT utilization.

Keywords: Diffusion; ERP systems; Measurement; Net Benefits; SMEs; Utilization.

1. Introduction

Enterprise Resource Planning (ERPs) systems constitute one of the most important developments in corporate information systems during the last decade (Davenport, 1998; Hitt, Wu and Xiaoge, 2002; Upton and McAfee, 2000). The business interest in ERP systems can be explained from descriptions of benefits associated with implementation and utilization of ERPs (Robey, Ross and Boudreau, 2002). There are several studies on inspiring success (Davenport, 2000). Meanwhile there are also considerable numbers of failures (Larsen and Myers, 1998; Scott and Vessey, 2000). Benefits of ERPs are only partly related to the technology, most of these stemming from organizational changes such as new business processes, organizational structure, work procedures, integration of administrative and operative activities, and global standardization of work practices leading to organizational improvements, which the technology supports (Hedman and Borell, 2003). It can definitely be said that implementation of ERP systems is a difficult and costly organizational experiment (Robey et al., 2002). Davenport (1996) describes the implementation of ERP systems as “perhaps the world’s largest experiment in business change” and for most organizations “the largest change project in cost and time that they have undertaken in their

history". The implementation is a necessary but insufficient prerequisite for benefits and value, and business value can only be derived from an efficient and effective utilization of information technology resources (Agarwal, Raha and Ghosh, 2000). The management of ERP system utilization is, thus, of critical importance and involves development and implementation, as well as usage of resources (Kalling, 1999).

Although many ERP systems benefits have been identified and studied (Shang and Seddon, 2002), this research has rather focused on defining success factors (Robey et al., 2002), such as top management involvement and support, rather than investigating how ERP systems utilization relates to benefits. One possible explanation for this is that in previous benefit and success research the state of go-alive in the implementation of ERPs is often equivalent to use, i.e. that benefits are directly casually related to the first day of use. The predominant view on utilization is "Use" in different forms e.g. use, intention of use, or user satisfaction (DeLone and McLean, 1992). DeLone and McLean (2003) state that there are deficiencies related to the 'Use' construct and they emphasize on that use as a construct is too simplistic and needs to be developed. A potential elaboration, which this paper takes, is that ERP systems utilization should be explored from an organizational perspective as well as from a system perspective. To this end we introduce utilization of ERP systems as a measure of use, and we develop a model of ERP utilization, which we relate to and describe as diffusion. The reason for using diffusion of ERP as a measure is the underlying hypotheses that it is not until ERP is diffused and integrated with a large part of an organization that benefits will be receive, i.e. a critical mass. This also means that before ERP utilization in an organization is a fact internal diffusion of the ERP is necessary.

The purpose of this research is to increase knowledge of the relationship between utilization of ERP system and benefits. This will be done through a theoretical and empirical investigation of ERP utilization. In addition the paper provides input into the complex matter of the dependent variable "Use". It does so by providing an alternative way of investigating the "Use" concept which goes beyond use and user satisfaction or intention to use.

This paper is structured as follows. In the next section we present previous research useful for developing a model for measurement of ERP utilization, focusing on measuring use of ERPs in small and medium-sized enterprises (SMEs). Thereafter we introduce our methodological approach and the survey context. We then present and discuss our measurement tool of ERP utilization. Finally we address the usefulness of the measurement tool both from a practical and a theoretical perspective.

2. Measuring use of ERP systems in SMEs

In order to do research on ERP utilization there is a need to define some concepts. The concepts that need to be defined are: ERPs, SMEs, Measurement, and Use. Starting with defining ERPs it can be said that relatively often is ERPs strongly connected to the system that SAP AG developed and then started to deliver labeled as SAP R/3. However, important to say is that ERPs consists of many more software packages and ERPs is not only SAP R/3. In order to explain and define ERPs it is necessary to give some kind of historical overview. According to Møller (2005) ERPs emerged in the 1950s and 1960s, when computers were introduced in organizations, however, these systems are seen as legacy systems today, and not many would describe them as ERPs. Instead, ERP as a software package were probably invented in the 1990s, with introduction of for instance SAP R/3. This type of software is often defined as standardized packaged software (Xu and Brinkkemper, 2007) designed with the aim of integrating the entire value chain in an organization (Lengnick-Hall, Lengnick-Hall and Abdinnour-Helm, 2004; Rolland and Prakash, 2000). Wier et al. (2007) argue that ERPs aim to integrate business processes and ICT into a synchronized suite of procedures, applications and metrics which goes over firms' boundaries.

Kumar and van Hillegersberg (2000) say ERPs originated in the manufacturing industry, where the first generation of ERPs was introduced. According to Kumar and van Hillegersberg, development of the first generation ERPs was an inside-out process, going from standard inventory control (IC) packages, to material requirements planning (MRP), material resources planning (MRP II) and then further on expanding it to a software package with the aim of supporting the entire organization (second generation ERPs). This evolved software package is then described as the next generation ERP labeled as ERP II (Møller, 2005). This development has increased the complexity both when it comes to usage as well as development of ERPs. The complexity comes from the fact that ERPs are systems that are supposed to integrate the organization, both inter-organizational as well as intra-organizational, and its business process in a one suite package (Koch, 2001). It can be stated from the historical overview that ERPs as well as the way how organizations use ERPs have changed a lot. The fact that the ERP market changes a lot all the time also influences how ERPs are developed and sold, which impacts what stakeholders there are in an ERP value-chain (Ifinedo and Nahar, 2007; Somers and Nelson, 2004) but also what work tasks respective stakeholders have in the value-chain. Summing up the ERP definition, it can be claimed that ERPs are standard software package that aims at coordinating and integrating the information flow in the adopting organization. ERPs also include what could be called “best practices” and therefore having a high impact on adopting organizations business processes. This last statement makes that it becomes interesting to investigate and measure utilization of ERPs in organizations. Another area of interest when it comes to diffusion of ERPs is the organizational size. It can be stated that for ERP vendors SMEs are in focus for their future sales of ERPs. This also makes it interesting to focus on ERP systems utilization in SMEs.

When discussing IS diffusion in SMEs the definition of SMEs is fundamental. In this paper we adopt the definition of SMEs delivered by the European Commission that defines an SME as: “A small enterprise is an enterprise with fewer than 50 employees and a medium-sized enterprise is an enterprise with more than 49 and fewer than 250 employees”.

There are two more concepts that needs to be defined and these are: Measurement and use. However, this is more or less the purpose of the paper and we aim at presenting a way to measure use, and we do that by describing measurement in relation to ERP systems utilization. But, first we discuss use of information systems (IS) in SMEs and existing knowledge about how to measure use of IS.

2.1. Measuring Use of Information Systems in SMEs

When it come to usage and diffusion of IS in SMEs there is a great deal of research studying e-commerce or e-business diffusion, some examples are Eriksson and Hultman (2005) as well as Zhu and Kraemer (2005). The result presented is often a discussion of usage from a maturity model such as the Gibson and Nolan’s growth model (1974). However, these studies most often do not consider internal diffusion in a specific organization or aim at measuring use and value of the adopted system. A conceptual model that aims at measuring use and value of e-business in organizations is presented by Zhu and Kraemer (2005). The claim they make for why it is necessary to develop and test a model for measuring IS use is that research on post-adoption of IS is scarce. According to Zhu and Kraemer existing research have focused on adoption decision and on measures such as intent to adopt and factors focusing on adoption versus non-adoption. The conclusion they make is that there is a need to do research also about post-adoption in the form of actual usage. There is then a clear connection to value, and Zhu and Kraemer state actual usage is an important link to IT value. In order to do research in this area they suggest a model that builds on the technology-organization-environment (TOE) framework.

The TOE framework combines three aspects on adoption, implementation, and use of technological innovations: 1) the context of the technology, focusing on existing as well as new technologies, 2) organizational context referring to descriptive measures such as scope, size etc., 3) and the arena seen as the environmental context in which the organization conducts its business.

Straub, Limayem and Karahanna-Evaristo (1995) claim that system usage has been the most frequently used measure when it comes to measure IS success. They describe it as two different forms of measurement of system usage: subjective or objective. The subjective measurement means that the users as such state to what extent they use the system – in the form of self-reporting. The objective measurement means that the system as such is used when doing the measurement – in the form of computer-recorded measures. It can be concluded that both these methods creates some problems – if self-reporting – the outcome builds on the specific users thoughts about to what extent they use the system – if computer-recoded the data are more correct, but at the same time it can be said that measuring usage in this way raise some ethical issues.

Sedera and Tan (2007) describe the problems within researching usage related to research made about information system success. One of the problems is that usage is defined in several different ways, and they state that usage is given at least three different meanings. For the first, IS usage is described as a variable deciding on benefits from use of IS. This is exemplified by Sedera and Tan as IS for decision making. The second definition emphasizes on usage as a dependent variable which influence future IS usage, and are described as IS acceptance or successful implementation of IS. The third and final meaning is that usage is seen as a process which leads to impact on individuals as well as organizations. In this case usage is exemplified by IS success. Our model presented in Figure 1 aims at combining these three different definitions on IS usage.

2.2. Measuring Usage of ERPs in SMEs

Burton-Jones and Gallivan (2007) state that a lot of statements about use of IT/IS exists and these statements often are describing a collective use. What they ask is if it really is possible to use IT/IS collective and the claim they make is that there is a need to increase the understanding of use from a multi perspective level. We agree with Burton-Jones and Gallivan that there is a need for a multi perspective in general. But, we also emphasizes on that in the specific ERP case there is an increasing need to do research on use also from an individual level. The reason for this could be found in the basic definition of ERPs and that ERPs are software that aims at integrating the entire organizations business processes into a standard software package. This makes that if the implementation should be successful it demands that more or less all employees adapts the system. From this it can be stated that it is not whether an organization adopts an ERP that makes it come into usage, instead, it could be claimed that it is whether the individuals in the organization start to use the ERP that decides whether the ERP comes into usage or not.

Bernroider and Lesuere (2005) used the definition on SMEs that we described above when they investigated differences between SMEs and large enterprises (LEs) regarding diffusion of ERPs. They state from an investigation of one thousand enterprises in Austria that 67,6 % of all LEs have implemented ERPs while only 15,5 % of SMEs have done the same. However, what they also found was that SMEs had implemented other specific software applications such as customer relationship management (CRM) and supply chain management (SCM) in higher extent than LEs. One possible reason for this finding could be that SMEs are more specialized than LEs. Another reason could be lack of resources available in SMEs for implementing a full-size ERP.

Morabito, Pace and Previtali (2005) state that ERPs have raised high attention both in practice, academic, and media and that research around ERPs primarily focus on two aspects: 1) organizational and economic impact of ERP adoption, and 2) how to best manage adoption.

However, it could be asked what unit of analysis that should be used when researching diffusion of ERPs. It could be that there is a need to combine different units of analysis to be able to deliver deep and interesting answers to ERP research questions. In this article we look into the diffusion of ERPs in SMEs. When doing that one obvious unit is the organization, as such, and whether they adopted an ERP or not, however, it is probably more interesting and necessary to say something about individuals' adoption of the ERP. But, even if doing so it can be stated that it only gives a partial explanation of to what extent the ERP are diffused and adopted. To be able to give the full explanation we need also to consider to what extent a specific user uses the specific ERP in a specific business process. This then means that we have at least three different unit of analysis: organizations, individuals, and business processes (or work tasks). This is then in line with what Sedera and Tan (2007) suggest as necessary to have if getting "very rich" measure of usage. However, they also suggest that the IS as such should be measured, and that differs from what we would suggest. What we suggest is that there is a need to further define the construct usage. This is in line with statement from Burton-Jones and Gallivan (2004) and the claim that usage is not well defined in the IS literature. They state that there are four reasons for why researchers have called for a renewed focus on the usage construct. First, there is a lack of studies that see usage as an independent variable for systems consequences, and in these studies usage is assumed as being unproblematic. Second, in the studies of consequences of systems usage the results have been mixed, and the result of increased usage could be either increased, decreased, or have no effect on performance. Third, the appropriate way of measuring usage have not been questioned to the extent it need to be, or in other words as described by Delone and McLean (2003) the problem is that usage as a complex variable have not been defined in the way it has to be defined. Fourth, the studies of usage have been made from either an individual level or an organizational level and there has been little integration between these levels.

However, the question is then how to measure extent of ERP systems utilization. In the next section we suggest a model for doing that based on four dimensions suggested by Massetti and Zmud (1996).

3. Research Model

The vast functionality and organizational coverage of an ERP requires a comprehensive way to measure utilization. In our literature survey no operationalization of measurement on ERP systems utilization was found. The closest was Grover et al's. (1998) and Teng et al's. (2002) models, but, they both measured diffusion through a single measurement. Another model is presented in the work by Massetti and Zmud (1996) in which they have developed an instrument of measuring extent of EDI usage. Their measurement instrument includes the following four dimensions: volume, breadth, diversity, and depth. From Massetti and Zmud's description we transform: Volume, breadth, diversity, and depth from an EDI context to an ERP context. The following four paragraphs describe our interpretation of Massetti and Zmud's concepts in an ERP context.

Volume represents the extent to which a firm's business processes and users are supported through ERP. The volume of ERP in business processes is determined by mapping the extent of which the ERP supported the core and support processes. The volume of users was determined by comparing the number of employees that could benefit from the ERP with the number of current ERP users in the organization. Also, for all the information systems in the organization as a total, the percentage of IS that was defined as ERP was determined. The ERP volume shows if the organization is willing to support a large part of the users and processes with ERP. Volume is measured by four items: 1) Degree of ERP users ($\text{Number of current ERP users} / \text{Maximum number of potential ERP users}$), 2) ERP share of all computer based information system, 3) ERP

support of primary business processes (sales/marketing/production/service), and 4) ERP support of secondary business processes (procurement, R&D, HR, finance).

ERP breadth represents the extent to which a firm has integrated ERP connections with each of its business processes. This shows us to what degree the ERP is used as an integrated system within the organization hereby making use of master data. The ERP breadth gives us an idea about whether the organization tries to get rid of bottlenecks in the information flow or if the ERP is thought of as an exclusive functional support for a certain type of business process such as production. ERP breadth is measured by three items: 1) Share of business processes that uses master data, 2) Degree of internal business processes integrated through the ERP, and 3) Degree of business processes integrated with external partners.

ERP diversity represents the extent to which different types of business processes are supported through ERP. The diversity of ERP in business processes was measured by mapping the number of core and support processes that were supported by ERP. This measurement is connected to the many different types of functionality that ERP should support. Diversity is measured by eight items: To the extent the following business processes are supported 1) Sales, 2) Marketing, 3) Production, 4) Service, 5) Procurement, 6) R&D, 7) HR, and 8) Finance) by ERP.

ERP depth represents the extent to which a firm's business processes are supported by ERP on different hierarchical levels. This also points to the integrated system and the use of master data. The ERP depth lets us know if the organization believes that an ERP can be useful in all hierarchical parts of the organization and for all processes. The final dimension was measured by three items: To what extent is ERP used at the following hierarchical levels 1) Strategic-, 2) Tactical-, and 3) Operational level.

In table 1 we summarize the four dimensions and the associated items. From the discussion so far a model for measuring ERP systems utilization impact on benefits is described in Figure 1.

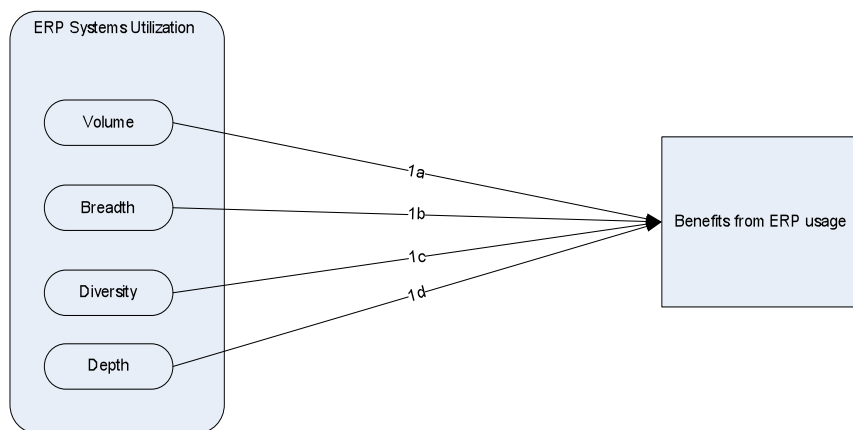


Figure 4 Research model

What the model suggests is that if organizations increase the use of ERP described as ERP systems utilization then perceived net benefits increases. ERP systems utilization is measured by four dimensions proposed by Massetti and Zmud (1996) including volume, breadth, diversity and depth. From this the following propositions could be suggested:

- Proposition 1a: Increase measured as Volume related to ERP systems utilization means an increase in "Perceived Net Benefits" from ERP usage.
- Proposition 1b: Increase measured as Breadth related to ERP systems utilization means an increase in "Perceived Net Benefits" from ERP usage.

- Proposition 1c: Increase measured as Diversity related to ERP systems utilization means an increase in “Perceived Net Benefits” from ERP usage.
- Proposition 1d: Increase measured as Depth related to ERP systems utilization means an increase in “Perceived Net Benefits” from ERP usage.

4. Methodology

To test the ERP utilization model we collected data through a survey of 77 Swedish firms using the ERP system Movex (Movex is now re-named to M3). In the data collection process we collaborated with the Swedish Movex User Association who invited Movex using firms to participate in the study, cf. see Hitt et al.’s (2002) study. The questionnaire consisted of four parts – background information, questions regarding implementation, use (17 items), and perceived ERP benefits gained from ERP usage (five items). The background information provided basic information about the company and the respondent. The implementation part explained which, when, in what way and how much of the ERP that was implemented. Use helped determine in what way and on which levels the company used the ERP, and finally the respondent answered subjectively to what extent they had received benefits from the ERP, i.e. common method bias problem. The survey contained 28 items, excluding the background information, and the items were measured based on a seven-point Likert scale and parts in percentages as indicated in Table 1. The four dimensions: volume, breadth, diversity, and depth and benefits measurements were operationalised as follows by Table 1.

Table 1. The four dimensions and items used to measure each dimension

Dimensions	Items	Type of scale
Volume (four items)	Degree of ERP users (Number of current ERP users / Maximum number of potential ERP users.	%
	ERP share of all computer based information system	%
	ERP support of primary business processes (sales/marketing/production/service)	%
	ERP support of secondary business processes (procurement, R&D, HR, finance)	%
Breadth (two items)	Share of business processes that uses master data	%
	Degree of internal business processes integrated through the ERP	%
	Degree of business processes integrated with external partners	%
Diversity (eight items)	To the extent the following processes are supported (Sales, Marketing, Production, Service, Procurement, R&D, HR, Finance) by the ERP	Likert
Depth (three items)	To what extent is ERP used at the following hierarchical levels: (Strategic-, Tactical-, Operational level)	Likert
Benefits (five items)	Operational benefits, managerial benefits, strategic benefits, IT infrastructural benefits, and organizational benefits	Likert

When it comes to perceived net benefits this was measured in relation to the following five categories of benefits: Operational benefits, managerial benefits, strategic benefits, IT infrastructural benefits, and organizational benefits (Shang et al., 2002).

The demographic data collected in the survey revealed that 32 % of the respondents were IT executives, 31 % financial executives, and 30 % ERP responsible. They had in average 15,7 years experience of ERP systems and they come from a broad spectrum of industries, but with a strong focus in manufacturing (61%). Most of the companies had finalized their ERP implementation, but were constantly adding new functionality and upgrades to the ERP they had implemented.

The number of ERP user was 72% of the total number of potential users. ERP systems are an important part (63%) of the overall information processing. The ERP systems were mainly used in primary business process (85%), but were also used to 71% in secondary business processes. 75% of business processes uses master data and 76% of business processes were integrated through the ERP system. ERP system was to a less extent used for integrating business processes residing in subsidiaries, customers, or suppliers, and dropped from further analysis. When it comes to support of business processes by ERPs, it was found that most companies had extensive support for sales, production, procurement and finance (between 4.6 and 5.9 on the Likert scale). However, the result showed that there was very little support from the ERP when it comes to marketing, R&D and HR (all below 3.0 on the Likert scale). Thus, these items were dropped in the final analysis. When it comes to more specific, who it is that uses the system, the hierarchic tactical and operational levels revealed a fairly high degree of use with means on the Likert scale of 5 and 5.88 respectively. The strategic level had a lower usage level, below 3.0, and dropped from further analysis. The benefits measurements exhibited means from 3.35 to 5.19.

The rest of the paper describes the result and conclusions from the test of the model. Before going into that there is one limitation that needs to be reflected upon and that is the organizational size. The ambition was to develop a model that aimed at measuring extent of ERPs utilization in SMEs. However, the organizational size of our sample is not coherent with our definition of SMEs, which makes that that the result from the test does not describe the situation in SMEs. But, this was a test of the model and the ambition is to do further research which then could provide additional knowledge when comparing results from the perspective of organizational size. It can also be said that this limitation makes it possible to generalize from future research results to a higher grade. Furthermore, the underlying theory might not be as promising as we hoped for. Massetti and Zmud's (1996) dimensions might not work in the context of ERP system.

5. Result

We used multivariate linear regression to measure the association of ERP utilization (Volume, Breadth, Diversity, and Depth) and perceived net benefits (operational benefits). Prior, to the linear regression analysis was performed on the scores of the items in the questionnaire; all items were standardized, since we used different scales. The four dimensions or latent constructs (Volume, Breadth, Diversity, and Depth) of ERP utilization were tested against the dependent variable (net benefits, which was measured through item operational benefits). For the actual analysis we ran four separate linear regression analysis. More advanced statistical analysis could be consider, but since this research is in its early stage we explore the underlying construct prior testing the relationships among constructs. We used SPSS version 17 for our analysis

In table 2 we have summarized the result of the four regression analysis. Returning to the propositions we can conclude that Volume and Breadth received low support in this test, whereas Diversity and Depth received support.

Table 2. Diffusion indexes correlated with benefit measurement

Index	Pearson's R	Adjusted R ²	Std. Error of Estimate	F-test	Sig.	t-test*
Volume	,446	,155	,919	4,447	,003	,000
Breadth	,426	,160	,916	8,221	,001	,000
Diversity	,546	,259	,861	7,656	,000	,000
Depth	,542	,274	,852	15,357	,000	,000

6. Final Discussion and Conclusions

The purpose of this paper was to develop and test a model describing the connection between diffusion of ERP and Perceived Net Benefits. Diffusion of ERP is then measured as extent of ERP systems utilization from the four dimensions: Volume, Breadth, Diversity, and Depth. These four latent construct were measured through two to eight individual items. However, only two of the four dimensions were found to be statistically verified. One conclusion that can be made from the fact that we did not get significant result on the dimensions, volume and breadth, could be the fact that ERP systems historically are systems that are used to a higher extent at the operational level and therefore could be seen as a commodity – necessary to have but not providing any perceived benefits from the respondents view. Another potential explanation is our interpretation of the underlying model/theory, i.e. Massetti and Zmud's EDI usage measurement, which was either wrongly interpreted or it, could be so that the model is not applicable to ERP context. A third possible explanation is the operationalization of Massetti and Zmud's four dimensions. Hence, the measurement model needs to be further developed regarding this, so that it more clearly measure benefits. It can also be said that the model needs to be further developed so that it better consider the huge complexity that ERP systems covers, which means that it has to consider qualitative benefits in the form of non-monetary benefits to a higher extent. However, our model and the results presented so far is definitely a first attempt of measuring qualitative ERP systems benefits and how ERP systems are internally diffused in an organization. It can also be concluded that the result so far gives new knowledge on ERP systems diffusion and increase our knowledge of use as a concept, since it expands the usage of the construct beyond the level of use as a go-live measurement. However, more research on post-adoption when it comes to ERP systems usage is necessary to be able to fully understand how benefits gained from ERP systems can be influenced. So, here is an explicit call for theories that can explain the utilization of ERP systems and the linkage to benefits.

The four dimensions all showed different results. We had expected the dimension volume to show strong support, but received contradictory results. The idea with this dimension was to cover ERP systems ability to support the organization and its users as well as business processes. Previous research used the quota of users that could benefit from ERPs compared to current users of a specific ERP as the sole measurement for diffusion..

The dimension breadth did not provide us with the expected result. The extent the business processes had ERP support, if that support crossed the borders of the functional areas and integrated them, and to what extent that was valid for integration in the organization. In future research these three factors needs to be studied in depth, preferably using a case study technique. The performance of the breadth dimension indicates that the factors of organization and functionality are not significant to the ERP diffusion. It also states that ERP diffusion in combination with these factors have a low impact on benefits.

In comparison with the dimension volume and breadth the performance of the diversity dimension was strong. This emphasizes the idea that organizations need support for many different kinds of business processes, hence a need for versatile ERP. The need for diversity is in other words an important initial characteristic that in time should be substituted with for instance ERP ability to mirror and support the processes that can benefit from the ERP.

The performance of the depth dimension provided us with a similar result as diversity, as indicated above this could be a result of the need for that ERP systems have to be used at different hierarchical levels and a result from the fact that ERP systems supports both operational and managerial level. Further research related to the depth dimension is needed to shade light on the relation between ERP systems depth and benefits distribution in organizations.

The contributions of the paper are the following: Firstly it provides some support for the notion of diffusion found in the theory of network externalities and that a critical mass is necessary to achieve benefits. This can be used to better understand failures in ERP projects. Secondly the use of the model and its dimensions volume, breadth, diversity and depth provide insights to the use construct and the need to treat it more rigorously. Thirdly the result contributes to our understanding of the many aspects of use of IT and potentially contribution to value and firm performance from IT utilization.

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INOVA Framework: A case study of the use of web technologies for the integration of consulting techniques and procedures

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Abstract: Nowadays, the WWW is playing a vital role in the business world. Most enterprises are becoming digital. Content management systems provide an effective method to improve the development of web applications and make the maintainer's job easier. The purpose of this work is to study the benefits that the use of web technologies can suppose for a SME company when they are applied to integrate their work techniques and procedures. We have also tried to use it to provide their customers with several services, and to make easier the company expansion process. The framework developed includes a security system for the access to the contents based on the RBAC model. The use of the INOVA framework has provided a benefit as much for INOVA itself, as for its customers, by including in a centralized way document resources and toolkits that can be accessed remotely.

Keywords: framework; CMS; WCM; open source; consulting procedures.

1. Introduction

Due to the great number of consulting companies in the market, a consulting company has to offer some innovative products if it wants to stand out. To do so, INOVA specialized in the Innovation, Optimization and Valorization of the projects that their customers carry out.

The growth of the Internet, the rise of telecommunication, and advances in computer technology have provided businesses with new opportunities. At the same time, it poses new communication challenges. In order to operate efficiently, a business needs a way for its employees to share information. No matter the size of the business, an effective, easy to use information sharing solution is critical to success.

This project was created with the idea of developing a framework (Figure 1) to improve and increase the services INOVA offers to the general public, to their customers, and to their own staff. To do so, we pretended to computerize several applications and utilities that the INOVA staff had developed through time, both to the general public, and to their internal use.

INOVA staff has realized that all those applications they had developed as internal utilities for them, could be useful for their clients and general public. In the market didn't exist any

products that would give those services to the users, or at least not in the specific field they work with. Similar papers (Pastore, 2006)(Salazar, 2006)(Souer et al, 2007)(Yen et al, 2008) emphasize in specific parts of the development of a complex web portal, such as the management of roles or the use of templates to facilitate the design of web pages. In this paper we go one step further, explaining not only the different types of roles or the separation of content from design, but also some of the innovative tools we offer to companies and general public, in the fields of innovation, optimization, and valorization.

As a result, a web portal was created, so the INOVA employees and users in general could access this application from anywhere (<http://www.inovaportal.com>). We have followed the standards to develop the portal, putting a special care in maintain a clear, simple and intuitive user interface. As a result, it is accessible via different navigators, even using text navigators such as lynx.

In this paper we are describing the goals we pursued, the solution adopted to achieve them, and the problems encountered during the development of the system.

The reminder of this paper is outlined as follows: In Section 2 is described shortly the main objectives and features of the INOVA framework. The system architecture and the technologies used during the implementation are shown in Section 3. Section 4 describes some of the most relevant software deployed. Section 5 explains some of development difficulties we have encountered. Conclusions are shown in Section 6, while the future work is drawn in the last section.

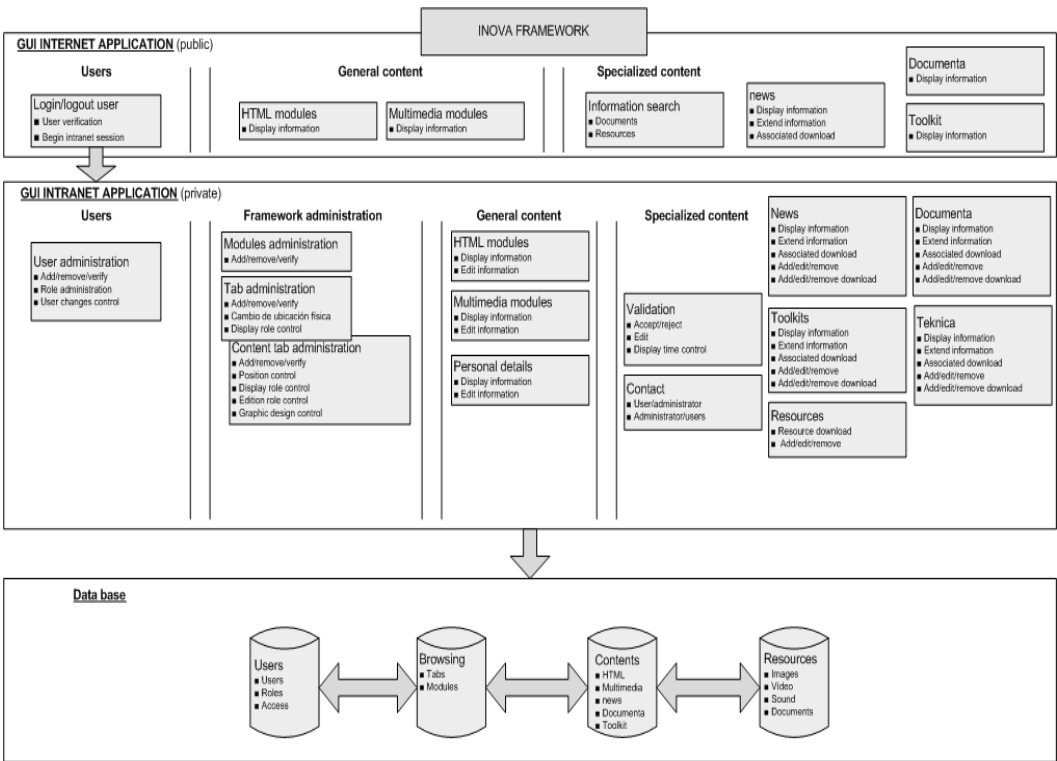


Figure 5 – INOVA Framework

2. Project Description

We can distinguish two main goals in this project, which can be explained in a brief description as:

- To offer support services to the companies to perform improvement operation processes, innovation processes, and to help them obtain fundings for their projects.
- To improve the internal processes of INOVA, allowing the INOVA staff to access a database with potential customers and to have and use standardized protocols for improvement and innovation processes.

These main goals were divided in several subtasks, allowing us to see in more detail the specific objectives we had to meet in this project:

- To update the old INOVA web portal, the contents as much as the design, and to offer the general public open access to the corporative company web portal, information about relevant publications in the areas of innovation, optimization and valorization, interesting links and innovation related news and INOVA news.
- To create an internet based platform with integrated extranet & intranet systems that allows:
 - To create a database with information about potential customers, in such a way that they were able to access, previous registration, to software applications such as online forms that allow them to test in an approximated way the capacity and the needs of innovation, optimization and valorization of their companies, or information about existing fundings that the users and their businesses could apply for carrying out R&D and optimization projects.
 - To offer the current customers of INOVA, via extranet, access to applications that help in the tracking and management of their projects, give information about technological agents, and show a detailed list of techniques to implement innovation, optimization and valorization processes in their company.
 - To establish an intranet system for the INOVA staff assigned to projects that allows them to access to applications related to innovation, optimization, and valorization processes.

By completing the goals explained above, INOVA intends to achieve some milestones:

- To increase significantly the number of projects in the companies which lead to innovative products highly valued in the market.
- To integrate the management of the innovation as an additional element in the day-to-day management of the companies, guaranteeing their sustainability in the environment of high competitiveness and globalization in which we are living.
- To contribute to the development of the Information Society.
- To contribute, specifically, in the improvement of the Information Technology and Communication infrastructures involved in the business management.
- To enhance the participation level of the small to medium-sized Spanish enterprises in R&D European programs, increasing the outputs obtained from these participations.

2.1. Web Portal Requirements

- *Robustness and flexibility.* It must use and integrate existing and open source solutions and combine the modules and applications developed in the framework among them.
- *Scalability.* The web portal had to be structured by modules, so it could grow in size and capacity based on the demand.
- *Efficiency.* The web portal applications must be able to grow quickly and efficiently. This must be done with a small amount of time and at a low cost.

- *Friendliness and quality.* It must be intuitive and attractive, and integrate simple and error-free functionalities.
- *Computing power.* The framework must support data processing algorithms, and calculate complex recommendations.

3. System Architecture

The mentioned requirements must be met in an architecture based on open software. After analyzing which were our needs, we decided to use the following architecture:

- OS platform: CentOS 5.2. It is an Enterprise-class Linux Distribution, totally free, which allows us to have the functionality we need, and ensures us a certain amount of stability.
- HTTP Server: Apache 2.0. This open-source HTTP server provides HTTP services in a secure and efficient server that follows the current HTTP standards.
- Database: MySQL 5.1 (Welling & Thomson, 2005). We chose this database because of its characteristics of open source software, its reliability and its high performance. Because of the amount of data we are going to store in our database is not projected to grow to high levels, we considered MySQL was an adequate solution. Although we had started working with version 4.1, the fact that the 5.1 version allows to execute triggers and procedures decided us to upgrade to that version.
- Programming languages: HTML, PHP 5.2.5, CSS, Javascript.
- Web based Content Management System. We decided to use a CMS to help us match the efficiency requirement, develop the web portal and simplify the publication of new web content, allowing content creators to submit content without requiring technical knowledge of HTML. Besides, it helps in the implementation of a model view controller pattern (MVC) (Gamma et al, 1993), which facilitates the task of administration and management of the web portal.

3.1. Chosen CMS: Xaraya

After comparing several CMS, we finally decided to use Xaraya. Some of the reasons to do so, are the following:

- Xaraya is an open source framework based on PostNuke which gives programmers and designers considerable flexibility.
- Its modular design allows separating function from form and content from design (Yu, 2005). Because of the use of modules, the scalability of the system is extensive.
- It uses robust permissions, data management, and multilingual systems to dynamically integrate and manage content.
- It follows the WWW standards.
- Its development and support community is extensive, and users are constantly creating new modules that improve the functionality of the framework.
- Xaraya integrates perfectly with Apache and makes use of the PHP functions.
- The privileges are managed in a modular way, allowing different types of access depending on the user, the page visited, or the content of that page. As a result, the interface can be simpler or more sophisticated depending on the type of user.
- It allows setting the content to approval before updating the webpage.
- It is compatible with Secure Socket Layer (SSL) among other protocols, such as LDAP. The system can be switched to SSL mode to login, or to access certain pages or sections.

- The edition of contents can be made using a WYSIWYG editor, allowing publishers to create formatted content without having knowledge of HTML, CSS or XML.
- It supports a huge amount of types of data, which makes the edition of contents even simpler.
- It has a powerful templating system, which helps to maintain a consistent design throughout the site.

4. Web Portal Software Description

The INOVA web portal was created as a modular system, where the different modules mix up with each other to produce a complex system. In the following subsections we describe some of the modules we consider that have a bigger importance in the INOVA framework.

4.1. Users Management System

Several types of users were defined in our framework. We could separate them in two main branches: common users and administrators. A scheme with the main type of users can be seen in figure 2.

Due to the amount of types of users in the web portal, we decided to use a role-based access control (RBAC) model (Al-Kahtani & Sandhu, 2002) (Chandramouli, 2001). Using this system, the security administration consists in that the roles must be correctly assigned to the different types of users, based on the capacities and the responsibilities that they have. The security administration is much more accessible, due to the roles assignment to organize access privileges.

In the common users we could distinguish four types of users:

- Anonymous users.
- Registered users.
- Customers.
- INOVA staff.

For the administrator's branch, the division is slightly more complicated. We could define the following general types of administrators:

- *Editors.* Those who can edit partially or totally the web portal, add new content, but not delete it. Besides, the modified or added data must be validated before being published in the web page.

The editors can have editing privileges over the entire web portal, or only over a small part. For instance, there are news editors (those who can add or edit news), or public web editors (those who can modify the corporate pages).

The reason to have those partial editors can be explained easily with an example. INOVA has appointed another company the task of looking for interesting news in the fields they consider of interest for their clients. Having the news editor role, they can give to them one of these accounts, so they can add or edit news. Before being published in the web page, a validator (usually a member of INOVA) will check if the information is valid, and decide if it must be shown in the web portal.

- *Validators.* As we explained in the previous point, a validator checks if the information given by an editor is valid. In addition, they can add, delete or edit data from the web portal.

As in the case of the editors, they could use their privileges over the entire web portal, or only over a part of it, depending on the type of validators they are.

- *Administrators*. They have several tasks: administering users, checking the links in the web portal are valid, managing the database, etcetera.

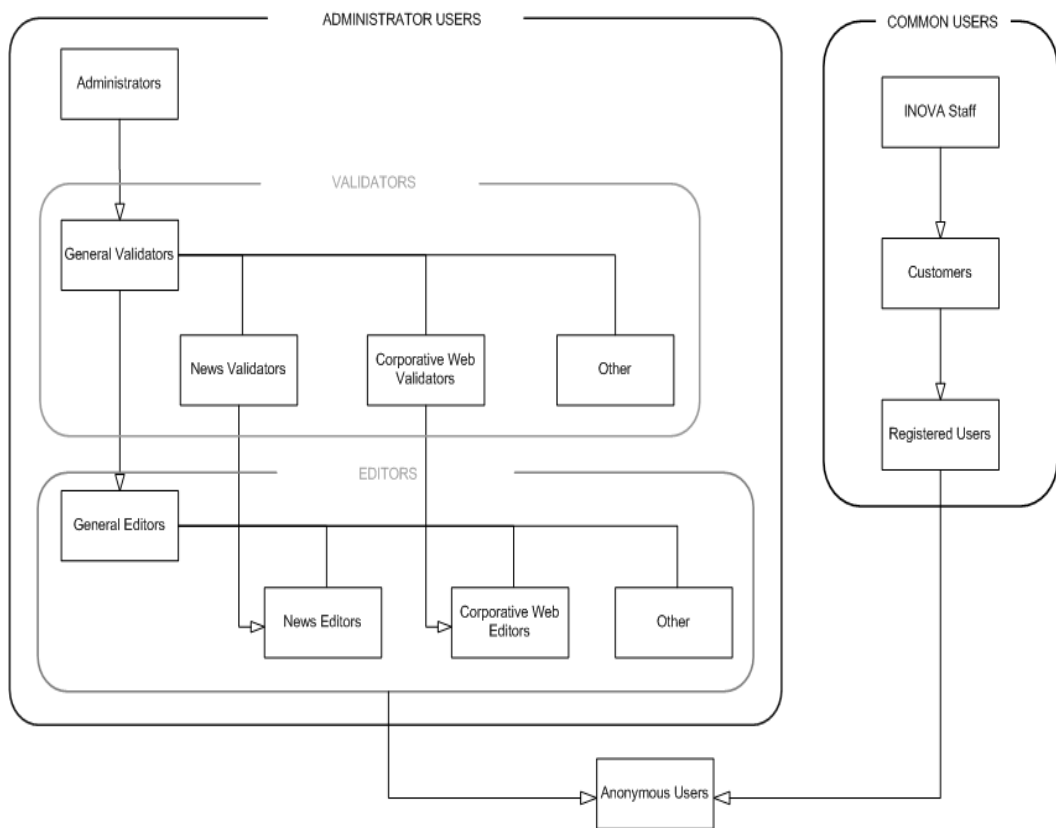


Figure 6 – INOVA Web Portal Roles

The users in a higher level inherit the privileges of the user in a lower level. For instance, a registered user, as well as their own privileges, will inherit the privileges of the anonymous users.

The reason the two branches are divided, is that administrator users could be not members of the INOVA staff, and vice versa.

One important feature is that a user can be of more than one type of role. For instance, a user could be a validator and an INOVA member.

The list of roles is open, allowing creating new roles in the future if we consider it necessary.

4.2. Information Management System

The system has several types of information management systems to treat with different type of data. In the following subsections we explain some of the more relevant systems. Joining these systems, and other applications we are developing in the future, we intend to create a web portal of reference in the fields of innovation, optimization, and valorization of private companies.

News Management System

This system allows administrators with enough privileges to add, edit or modify existing news. If these administrators have validation privileges, then they can put news publicly. Otherwise, the news must pass through a validator before being published.

Besides the usual information concerning the new, news editors have the option to put the starting date and the final date of the new. When this data is filled, the framework will automatically show or hide this new for the usual users, although editors will be able to see it.

While a typical user will see the logo of the new, the title, date of the new and description, an administrator will be also able to see the date of beginning and end of the new, its status, and a link to modify it.

With this system, INOVA intends to provide users with an easy way to access to relevant news in the fields of innovation, optimization, and valorization.

Publications Management System

INOVA wanted to store documents and links to articles published in different formats and types of publications. To do so, we created a database which stored a wide range of metadata about these articles.

The quantity of publications is quite extensive. Therefore, we have developed a search engine to look for that data, based on the type of sources of those documents, and the keywords related with them (Figure 3).

This search engine is accessible to any user, but just partially: an anonymous user can have access to the search engine, and receive a list of results, with a small amount of information. If the users are registered, they would also be able to access to more information about the specific document they are interested in, included information about the source and the original document, either linked, or downloadable in PDF format. Besides, an administrator user with edition privileges over documents, could also access to the edition page of the document directly from it.

With this system, users have access to a high quantity of data related with specific themes in a centralized way. This facilitates considerably the search of these publications, without having to look for the source of them, and saving a lot of time.

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Inicio Idioma Español

Acceso
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Olvidé mi contraseña

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Clientes
Proyectos
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Documenta innova

Seleccione **una o varias palabras claves y fuentes de interés** para localizar **publicaciones relevantes**.

La base de datos de Inova cuenta con más de 500 documentos disponibles para nuestros clientes

Palabras clave

- ☐ Todos
- ☐ Auditoría y certificación
- ☐ Benchmarking
- ☐ Casos Prácticos
- ☐ Desarrollo de productos
- ☐ Estrategia
- ☐ Gestión
- ☐ Autoevaluación
- ☐ Cadena de Valor
- ☐ Creatividad
- ☐ Emprendedores
- ☐ Formación
- ☐ Gestión de la Cadena de Suministro (SCM)
- ☐ Gestión de Innovación
- ☐ Gestión del Conocimiento
- ☐ Gestión de la Tecnología
- ☐ Gestión de Personas
- ☐ Globalización
- ☐ Herramientas
- ☐ Investigación y Desarrollo
- ☐ Mejores Prácticas
- ☐ Organización
- ☐ Políticas
- ☐ Sistemas de innovación
- ☐ Sourcing
- ☐ Tecnología de la información y Comunicaciones (TIC)
- ☐ Guías
- ☐ Innovación
- ☐ Métricas, indicadores y Cuadros de mando
- ☐ Normativa
- ☐ Patentes y Propiedad intelectual
- ☐ Productividad y competitividad
- ☐ Sostenibilidad
- ☐ Tecnología
- ☐ Vigilancia

Categorías de fuente

- ☐ Todos
- ☐ Administraciones y Organismos
- ☐ Asociaciones Empresariales
- ☐ Públicos
- ☐ Asociaciones y Colegios
- ☐ Centros Tecnológicos
- ☐ Profesionales
- ☐ Empresas de Consultoría
- ☐ Librerías
- ☐ Organismos de Normalización y Certificación
- ☐ Oficina Estadística
- ☐ Otras Empresas
- ☐ Organismos Públicos de Investigación (OPIs)
- ☐ Universidades y Escuelas de Negocios
- ☐ Portales de internet

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Figure 7 – Example of a search engine for the Publications Management System

Financing and Technological Agents Management System

As a complementary application, it was decided to create a software solution to provide their clients and users in general a way of efficiently searching for financial funding of their interest in the fields of R&D and optimization.

The software application provides a search engine to look for the exact needs of the customer's company, and provides a list of possible financing solutions. Following the same idea than the publication management system, it provides different level of access depending on the type of user using the search application. In the case of anonymous users, they could see the list of possible financing subventions. A registered user could see the detailed information of the subventions, while editors could edit this information in case they consider it necessary.

Like in the publications system, this application saves huge amounts of time, since a user just has to use the search engine to access to a list of all the possible financial funding they can apply for.

4.3. Work Procedures Standardization System

INOVA uses a set of toolkits to develop their job. Depending of the type of company they are analyzing and the type of results they are looking for, they use some toolkits or another (Figure 4).

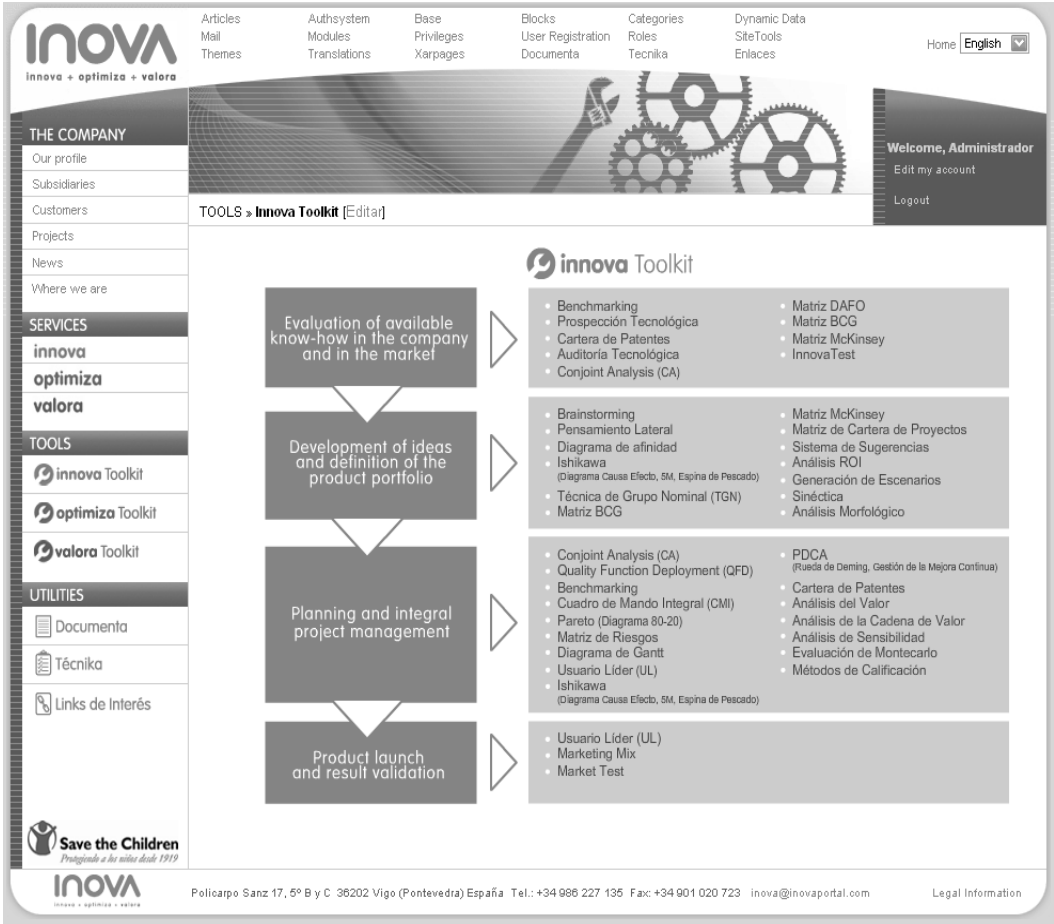


Figure 8 – Example of some of the available toolkits

Before developing this framework, they did not have these toolkits in a electronic way. When they wanted to use one of those toolkits, they couldn't access to a centralized database with the information about them, or the way they had to use them. That caused in some cases that these tools were not applied in a standard or even correct way.

To fix this problem, it was decided to develop a software application, as a part of the web portal, with information about these toolkits. It includes a description of the toolkit, when it must be applied, a guide about how to use it, recommendations, links, etc. This information is public for any member of the INOVA staff. Some information is also public for everybody, such as the description or the time estimated to obtain results.

This improves significantly the efficiency of the company, since the consult about how to proceed in each situation is available wherever they are, and they can look up the guidelines they must follow using a friendly and easy-to-use interface.

4.4. Projects Workflow Management System

This section of the system was deployed to help with the workflow of the projects the INOVA staff is working in.

This system gives the INOVA members a set of roadmaps, so they know exactly what they have to do at any time of the innovation, optimization, or valorization processes of the companies they work for, taking on account the specific characteristics they have to deal with.

This improves the efficiency of the INOVA staff, since they have a way to establish the situation of each project at any time, and the future steps they must follow.

4.5. Evaluation Toolkits

Another important part of our system consisted in the deployment of evaluation toolkits to establish the benchmarking of their customer's businesses, based on the levels of innovation, optimization and valorization.

Any user registered in the web portal, can have access to a limited section of these toolkits. With the use of this utility, they can partially establish what their needs are, just by answering a set of questions. The responses received to these questions are processed internally by the system, and a conclusion is given to the registered user, with a graphic result, and some suggestions about the points they should improve.

Of course, the obtained result is based in some general observations, and cannot be totally accepted without knowing the specific situation of the company. It is for that reason, that if the user is interested in a more extended evaluation of their needs, they have the option to contact the INOVA staff.

The goal of these toolkits it is to provide the INOVA staff a set of tools that help them give a consistent report of the needs of their customers, based on these results as much as in their own experience. Besides, it gives the customers a general idea about what their situation is, in a fast and easy way. Without this application, users wouldn't have access to that information without spending a variable amount of money.

5. Limits and problems facing during the implementation of the system.

One of the most important problems we have to face is the fact that for the modification of the web portal at the programming level, users need a considerable amount of expertise in Xaraya. It is not an easy-to-learn CMS. This is possibly due to the wide range of possibilities it allows, which makes it possible to develop new modules. This causes that it took us quite a lot of time to develop the basic functionality of the INOVA framework (the nucleus of the web portal, the design of roles and privileges, etcetera).

6. Conclusions

The purpose of this work is to study the benefits that the use of web technologies can suppose for a company when they are applied to integrate their work techniques and procedures. We have also tried to use it to provide their customers with several services, and to make easier the expansion process of the company.

The use of a CMS as a starting point has allowed:

- The quick development of prototypes.
- The fast adjustment of the users to the tasks of creation, edition and publication of contents in the framework since they don't need to have previous specialized computing knowledge.
- A secure system for the contents, because of the effective management of the roles that it makes for the access and publication to the framework.
- The access of multiple authors, editors, and customers from different locations and with a controlled access to the information.
- The modular structure of the framework has allowed evolving and improving the prototyping. The evolution process of the system has maintained its functionality and has been transparent for the users, since it didn't interfere with the previous developed modules.

The use of the INOVA framework has led the company to improve in the management of their documents, their sources of information and their customers, since they have at their disposal a centralized system with search engines and a management system, having the possibility of accessing remotely.

It has also supposed a benefit for the customers, since the framework provides them with valuable sources of information and an approach to the use of control and evaluation tools to find out the state of innovation of their companies.

Although each result obtained is not totally innovative by itself, the fact that users can have access to a wide range of tools related with the fields of innovation, optimization and valorization of private companies, is something totally new. We are constantly increasing this features, with the idea of offering more and more applications for the general public, the INOVA customers, and INOVA staff.

7. Future Works

In the future we plan to include new applications into the INOVA web portal, almost continuously, since we have a lot of ideas to develop that we think would be beneficial for users and staff, and that would contribute to improve the quality of private companies and of their projects. In the following months, we pretend to add a fundings management system based on the profile and the financing level of the customer's company. Also, we are including a private section for customers, to allow INOVA to share files and relevant information with them, and a collaborative system that allows the INOVA members to work online and together in their projects.

Another future features will be an alerts module, a contacts module, a shared agenda, a support documentation module, or a projects manager module, among others.

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Web and ICT Competencies in different types of SME

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Abstract: In this paper we investigate the correspondence between information and communication technology (ICT) competencies, web presentation and the type of their business area. We explore what are the most important criteria of web presentation in successful growing small and medium enterprises (SMEs) according their business area (some company are service oriented and the others are producers). This view brings some interesting results. We have evidence that a long-term growth can be predicted from the web presentation and types of industry or services with high accuracy. We also show which attributes of the web page are the most important for that prediction. This investigation helps to SMEs to improve their competitiveness, better communication with customers and to find a proper internet marketing strategy.

Keywords: Web presentation; small and medium enterprises; ICT competencies; internet marketing; long term growth; data mining.

1. Introduction

The current business environment is characterized as highly turbulent, influenced by modern information and communication technologies, globalization, short innovation and production cycles and employees' mobility. It is not easy for SMEs to compete in such an environment. Therefore the organizations have to utilize their corporate resources to the greatest possible extent. Using ICT and particularly the web as a dynamic tools can help companies to better communicate with their customers and partners.

This article explores the competencies needed by the entrepreneurial small firms for the effective use of the Internet in their marketing activities. We say that a company is web competent (or has web competencies) if its web presentation helps to long-term growth of this company. The research reviews a theoretical model of appropriate web competencies and presents the findings of an empirical research in thirty organizations to establish the value of this model. This article goes on to propose a marketing strategy for developing web competencies.

The thirty companies (all from the Czech Republic) have been analysed during qualitative research for 15 years. The data has been collected through interviews with the managers or the owners and also through the cooperation of students and their teachers on some real projects. During this long time period the employees in SMEs developed competencies which are connected with using of ICT and web presentations.

A number of authors see the competence as the knowledge, skills and attitudes used by employees in the performance of work (Sanchez, 1998, Post 1997, McClelland 1982). Such competencies require individuals or managers who possess capabilities in various areas. Hinckley and Perl (1996) interviewed managers and established an understanding of competencies required by managers. They identified three areas of competencies: intra personal, interpersonal and organizational competence. As a part of their organizational competence is necessity to cooperate and communicate with employees, partners and customers. Information and communication technology and also using internet for the communication and marketing play important role as tool for these competencies. Therefore the authors have been studying the employees' experience, skills and knowledge of using ICT for marketing on internet, communication between them and customers and also sharing their mutual knowledge (web competencies). As we can see from research a lot of companies quite often outsource these marketing activities (Varajo, 2009).

In the article (Antlova & Popelinsky, 2008) the authors have searched what competencies contribute to successful implementation of information systems and which competencies also help to increase their competitiveness. Next table explains shortly the examined ICT competencies. The successful and growing enterprises have had developed especially competencies connected with business and information strategy (number 1.1-2.5), competencies connected with improving knowledge and skills of employees (number 6.1-6.5) and competence connected with electronic communication (number 7). The results from this survey indicated importance of sharing knowledge inside companies, business and information strategy and electronic communication with customers.

Table 1 – ICT competencies.

Number	Area of ICT competences
1.1-1.4	Formulation of business strategy, the potential of new technologies, defining of ICT management
2.1-2.5	Formulation of information strategy, the portfolio of investment, relevant R&D into how ICT can be used
3.1-3.3	Information, application and technology architectures, organizations structures and processes to manage the resources
4.1-4.3	Identifying and planning the benefits from ICT investment, monitoring, measuring and evaluating the benefits derived from ICT investment
5.1-5.6	Implementing of information, systems and technology solutions that satisfy business needs, business continuity and security
6.1-6.5	Recruiting, training and deploying appropriate staff and ensure technical, business and personal skills meet the needs of the organization
7.	Developing and maintaining the relationship with customers

Data mining aims in extraction of interesting, i.e. non-trivial, implicit, previously unknown and potentially useful information or patterns from data (Han & Kamber, 2006) by means of statistics, visualisation or machine learning (Mitchell 1997, Witten & Frank 2005). Data mining methods have been successfully used in market analysis, management, e.g. for target marketing, customer relation management, or market segmentation but also for text and web analysis. The goal of web data mining is to discover useful knowledge from web hyperlinks, page contents, and usage logs (Liu, 2008). In this paper we apply web content mining and analysis of hyperlinks for finding dependency between long-term growth of a company, ICT competencies, web presentation and business area. The structure of paper is following. Section 2 brings an overview of web competencies (attributes of web pages). In Section 3 we describe data and methods that we used in our experiments. Section 4 describes correlation between the type of industry, ICT competencies and web competencies. Section 5 brings the conclusion.

2. Web competencies

2.1. Overview of web competencies

Web presentation is one of the marketing tools how to establish the potential relationship with the business partners, suppliers and customers. Therefore, exploring a web site design – together with information a web site offer - is one way of predicting web competencies in organizations. Some competencies have to be proved step by step by evaluators and need human assistance. Many factors determine the web presentation and we think that the most important factors are below.

- Company promotion (how the graphical design can catch the users)
- Product information (if the potential customer can find all necessary information about the product or service)
- Electronic transaction (if there is possibility of online selling and payment)
- Web-enabling marketing (if there are the advantages for the next ordering, such as loyalty program)
- Identifying of potential customers or partners (if there are the possibilities of some business cooperation)
- Communication with customers and partners
- Internal sharing of information and knowledge (if web site enables also internal communication of employees from outside)
- Other support services (such as after sale activities)
- Discussion with customers (if there is possibility to discuss with other customers their experience, ideas, problems, wishes)

2.2. Web competencies extracted from web presentations

In this work we focus especially on extracting information automatically that can be obtained without human assistance. The only exception is an attribute **Look** which contains evaluation of a web presentation set by human. Attributes extracted from web presentation and used in this work are below. They can split into four groups. First two attributes – **Look**, **Design** – concern appearance. The second group contains features that characterize contents of a presentation. The third group describes the text – in menu or in description of the profile of the company. The last group characterizes importance of the web presentation in terms of web search engines Google and Yahoo. **PageRank** (from a link analysis algorithm used by the Google) assigns a numerical weighting to each element of a hyperlinked set of documents with the purpose of measuring its relative importance within the set. **Backlinks** are equal to the number of backlinks to the web page obtained from Yahoo.

Table 2 Attributes of web presentations in companies

Name	Description
Look	Evaluation by a human (1..5, 1=best, 5=worst)
Design	A method used for building a web presentation (tables, flash, cascade styles, other)
Lan.LNG	Language (LNG=Czech, English, German, Italian, Spanish, French) (yes/no)
Workpositions	Exists a page that offer a position in a company (yes/no)
Authentication	Authenticated area exists (yes/no)
Certificates	Certificate exists (yes/no)
References	List of customers and partners (yes/no)
News	A web page that contains news exists (yes/no)
Downloads	Information to download (exists/not exist)
Sitemap	Site map exists (yes/no)
E-order	To order a product (yes/no)
Search	Web search engine offered (yes/no)
ICQ	ICQ number (yes/no)
Menu.WORD	A set of binary attributes, one for each WORD that appeared in the menu
Text	Text that describes the profile of the company
Lemma	The same text extended with lemmata
PageRank	Google PageRank (numeric)
IndexedPages	Number of pages indexed by Google (numeric)
Backlinks	Number of backlinks to the web page (numeric)

3. Data and methods

From 30 companies explored in the previous work we removed two companies that have no web pages. For each company all the attributes from Table 2. have been automatically extracted. We also added information about ICT competencies and the attribute that classified a company as growing or not growing. Companies were uniformly distributed to 14 companies with long-term growth and to 14 without long-term growth.

We employed two classes of methods – classification/prediction and association mining. All experiments have been performed with Weka package (Witten and Frank 2005). For finding associations we used Apriori algorithm. For classification we employed several learning algorithms – Naïve Bayes, Support Vector Machines, the instance-based learner kNN (N=3) and decision tree learner J48. As evaluation criterion we have chosen overall accuracy, i.e. the ratio of correctly classified companies to the number of all companies. We used leave-one-out method for testing (27 instances used for learning, 1 for testing, for all permutations, an overall accuracy has been computed as an average of those 28 experiments). We also checked various pre-processing techniques, namely for finding a small subset of important attributes, for ranking important words.

4. Results

4.1. Prediction of a long –term growth from web pages

To predict long-term growth from web pages we performed several experiments. In the first experiment, when ignoring any text information, the decision tree learner J48 returned the best results and reached accuracy 82%. It contained only two attributes, Backlinks (a number of

backlinks of yahoo) and Workpositions (X = there is a page that informs about job positions in the company). In the next experiment we added words that appear in menu and ignored the rest of the text. Accuracy did not increased (the highest accuracy was 75%). The most significant attribute was again Baclinks and reference and profil were the most significant words. In the last experiments we used only text (words that appear on the web page) or text plus lemmatized text (a lemma of nouns, adjectives etc. is a nominative in singular, a lemma of a verb is its infinitive form). The best result has been reached with Naïve Bayes classifier and Support Vector Machines (SMO). The highest accuracy augmented to 82.1%. When combining text with other attributes of web pages accuracy has been decreasing. Besides Backlinks and Workpositions mentioned above, among the most relevant attributes for long-term growing companies the principal role plays web design. Successful companies mostly used cascade styles (attribute Design). They also frequently offer information about product to download and the site map. Strong positive correlation between PageRank and long-term growth has been observed - the higher PageRank, the higher probability for the long-term growth.

4.2. Correlation between a type of a company and its ICT competencies

All companies have been classified into three classes: services (13 instances); ICT services (9 instances); production (9 instances). Baseline (an accuracy if classifying all companies into the most frequent class) was 44.8%. The highest accuracy was 72.4%. It implies that there is no strong correlation between ICT competencies and a type of a company. Moreover, no correspondence has been observed between long-term growth and a type of a company. From the ICT competencies it is competence 2.5 that has the highest impact to a type of a company. From the rest of ICT competencies we observed an influence of competence 5.3 but it was much weaker. A good insight into correlation of a company type and its ICT competencies bring association rules. In the table below, 1.2=- 11 means that absence of 1.2 competence holds for 11 companies. 2.5=X Typ=production 9 says that presence of 2.5 competence together with the type production hold for 9 companies. Confidence measures finding the right-hand side of the association rule under the condition that left-hand side holds.

1.2=- 11	==> Typ=services 11	conf:(1)
1.2=- Typ=services 11	==> 2.5=- 11	conf:(1)
1.2=- 2.5=- 11	==> Typ=services 11	conf:(1)
1.2=- 11	==> 2.5=- Typ=services 11	conf:(1)
Typ=production 10	==> 1.2=X 10	conf:(1)
2.5=X Typ=production 9	==> 1.2=X 9	conf:(1)
2.5=- 15	==> Typ=services 14	conf:(0.93)
Typ=production 10	==> 2.5=X 9	conf:(0.9)

We also decided to join classes services and ICT services. However, for the two-class problem - production vs. services - we received the same accuracy. It supports our exploration that there is no significant correspondence between ICT competencies and a type of a company.

4.3. Dependence between web presentation and a type of a company

The goal now was to learn whether there exists dependency between web presentation and a type of a company. The best accuracy was not very high and reached 67.9% (all information including text of a web page was used). F1 measure was high for classes services (0.727) and production

(0.8) but very low for ICT services (0.25).A decision tree (obtained with j48 algorithm, leave-one-out) is below.

```
not production (it means that in text is no word "production")
| not suppliers
| | not big
| | | not new
| | | | Backlinks <= 2: ICTservices (2.0)
| | | | Backlinks > 2: services (13.0)
| | | new: ICTservices (3.0)
| | big: ICTservices (2.0/1.0)
| suppliers: production (2.0)
production: production (6.0)
```

We then analyzed results for particular classes in terms of other measures used in classification - true positive rate, precision, recall. In a classification task, the Precision for a class is the number of true positives (i.e. the number of items correctly labeled as belonging to the class) divided by the total number of elements labeled as belonging to the class (i.e. the sum of true positives and false positives, which are items incorrectly labeled as belonging to the class). Recall in this context is defined as the number of true positives divided by the total number of elements that actually belong to the class (i.e. the sum of true positives and false negatives, which are items which were not labeled as belonging to that class but should have been). TP Rate (true positive rate) a number of correctly classified instances of a class divided by a number of all instances in this class. F-measure is the harmonic mean of precision and recall. A decision tree (obtained with j48 algorithm, leave-one-out) is below. F1 measure was high for classes services (0.727) and production (0.8) but very low for ICT services (0.25). Summary is below.

TP Rate	FP Rate	Precision	Recall	F-Measure	Class
0.923	0.533	0.6	0.923	0.727	services
0.167	0.045	0.5	0.167	0.25	ICT services
0.667	0	1	0.667	0.8	production

We also performed experiments for two-class problem. We took one class, e.g. production, as positive examples and the rest, ICT services and ICT services, as negative examples. For the class production accuracy significantly increased to 78.6% even without using the text contents. After adding the text (all words that appeared at least 4x in the collection of all web pages) accuracy augmented to 89.3%. The most significant words for this class are the nouns producer, production which appear only here and never appear in the other classes. The other important words is provider. The same accuracy has been obtained for ICT services vs. services + production even without the text on a web page. The most significant attribute was Backlinks and the most important words were the words new and information. For the class services the accuracy was very low - 75% (Naive Bayes - compare this value with classification to the most frequent class 71,4%).

4.4. Association rules

For finding associations between a type for company and a web presentation we employed Predictive Apriori (Scheffer, 2001) program which looks for the 'n' best rules. A rule is added if the expected predictive accuracy of this rule is among the 'n' best and it is not subsumed by a rule with at least the same expected predictive accuracy. The most interesting rules **concerned companies** other than ICT services providers. Class association rules, i.e. rules that have a class in the conclusion, are in table below. A condition consists of words that appeared (Word=1) or not appeared (Word=0) on a web page. Support is a number of instances for which a condition (or a conclusion) holds. The first table contains rules that describe associations between text and the type of a company.

Table 3 Associations rules between text and type of company

Condition	Support	Conclusion==>	Support	Accuracy
information=0 following=0 IT=0	23	Typ is not ICTservices	22	0.97975
information=0 range=0 IT=0	23	Typ is not ICTservices	22	0.97975
implementation=0 information=0 range=0	24	Typ is not ICTservices	22	0.94438

From the rules that combine words with other information extracted from web pages and have a support greater than 5, the most significant words are: English, German, already.

Table 4 Association rules between words and other information

Condition	Support	Conclusion	Support	Accuracy
already=1	8	Typ is not ICTservices	8	0.99226
German=X	7	Typ is not ICTservices	7	0.99157
Backlinks='(22-70.5]'	6	Typ is not ICTservices	6	0.99062
Backlinks='(70.5-186.5]'	5	Typ is not ICTservices	5	0.98929
Backlinks='(186.5-757.5]'	5	Typ is not ICTservices	5	0.98929
English mutation=0				
Backlinks='(186.5-757.5] ' new=0	5	Typ is not ICTservices	5	0.98929

5. Conclusion

We proved that a long-term growth can be predicted from the web presentation with accuracy higher than 80%. We also showed which attributes extracted from web presentation are the most important for that prediction. We also showed which information and communication technology competencies can be learned from the web presentation. As a result, this investigation can help SMEs to improve their competitiveness, communication with customers and internet marketing strategy. Some actual web pages of those companies are now designed with regards to the results of this study.

The findings of this study show that the company's web presentation is not just commercial information on the internet but if it is well designed, it can improve communication with customers and marketing strategy and support long term growth. From web presentation it is also possible to predict whether the company puts strength on proper business strategy and is using the possibilities of ICT. All these mentioned activities need employees who are educated, trained and able to use ICT tools for marketing and communication with customers (what means they

have proper competencies – web competencies). Therefore the managers or owners of SMEs should support educational activities in this areas and also it is the challenge for the universities how to help SMEs to increase their competitiveness with the educational trainee. Also the importance of language mutations has been proved.

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IT/IS Management

Information Systems Outsourcing – Risks and Benefits for Organizations

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Abstract: Information Systems (IS) Outsourcing has emerged as a strategic option to be considered and has been increasingly adopted by managers. However, many contracts still fail during their initial years, meaning that Outsourcing has also been subject to strong criticism. There are advantages to Outsourcing but also significant risks associated to it, and the assessment of both is therefore of great relevance for informed decision-making. The objective of this paper is to determine to what extent a common view about risks and benefits associated to IS Outsourcing is shared by the Portuguese market players – Service Providers, Customers and Opinion Makers. In order to accomplish this, an on-line Delphi study was conducted, combined with the Q-sort technique, which allowed to obtain the perspective of each player on the risks and benefits IS Outsourcing. Comparing these perspectives it was possible to understand that the market players don't share the same point of view.

Keywords: Information Systems Outsourcing; Risks; Benefits; Delphi; Q-sort.

1. Introduction

Driven by profit organizations are impelled to stay competitive or they risk losing market share. Presented with an ever-changing business environment, today's organizations continuously look for more agile ways of working, capable of increasing their ability to respond to market demands. Therefore, Information Systems (IS) Outsourcing has emerged as a strategic option to be considered and has been increasingly adopted by managers

The Outsourcing is "considered as one of the effectiveness ways that organizations meet to balance the equation of technology evolution, costs reduction and service quality" (Maculuv & Rodrigues, 2002). Organizations are transferring a large amount of their IS functions to external providers, from logistics to human resources, so they can focus on their core competences (Varajão, 2002).

The increase in organizations' Outsourcing-related expenditure in recent years shows that Outsourcing has grown – not only in Europe but also in Portugal. IDC (2005) reveals a growth rate of 10% in Portugal, slightly lower than the 11% average in Europe. In addition it predicts a growth of 40% of Outsourcing in Portugal for the period between 2005 and 2009.

According to Gartner, quoted by Ramos (2006), 50% of Outsourcing contracts fail, being renegotiated and in 25% of the cases the contract cancellation eventually occurs. Dun & Bradstreet, also mentioned by Ramos (2006), refers that 20% to 25% of Outsourcing contracts do not succeed during their two initial years and this rate increases to 50% after five years of

contract. Also, in 70% of the cases "the Service Provider did not understand adequately what was supposed to do".

There are advantages to Outsourcing but also significant risks associated to it and the assessment of both is therefore of great relevance for informed decision-making.

The objective of this study is to contribute to the understanding of the risks and the benefits associated to IS Outsourcing and also to determine to what extent a common view about them is shared by the Portuguese market players – Service Providers, Customers and Opinion Makers.

2. Theoretical background

2.1. Information Systems Outsourcing

Several authors present numerous definitions for Outsourcing, which seem to converge to the perception that is the act of contracting out services, which the organization can perform inside, to an external Service Provider by option and to focus on their core business.

Faulhaber (2005) describes Outsourcing as "the strategic use of external resources to carry out tasks that usually are internally executed. Griffiths (1999) enhance this concept defining Outsourcing as "the strategic use of outside resources to perform activities traditionally handled by internal staff and resources". Outsourcing could engage a significant restructuring of certain activities, often including human resources transfer from a main corporation to a specialized one, usually smaller but with the necessary skills to do those activities. Outsourcing is the act of delegating or transferring some or all of the IT related decision, business processes, internal activities and services to an external provider who develop and manage those activities according to predetermined deliverables, conditions and results as established on contract (Dhar & Balakrishnan, 2006).

Outsourcing covers a wide range of options, from the strategic option of delegating total IT management to the execution of a simple function, as an answer to specific organization's needs (IDC, 2005). Rocha (2006) states that "the Outsourcing market confers different names to different kind of deals, but the boundary between them it is difficult to define". The Outsourcing degree and the way this type of arrangements are established contribute to the multiplicity of existent relationships. The IS function can be handled internally, by a subsidiary or shared with the Service Provider; or developed externally either totally or for a selection of its components. On the other hand different Provider-Client sourcing arrangements are possible from single Provider - single Client to complex relations as multiple Providers - multiple Clients (Dibbern et al., 2004).

The Outsourcing process involves the Client and its Provider and describes the phases they go through when evaluating and implementing an Outsourcing solution. Figure 1 illustrates this process, combining suggestions from previous studies as Deloitte (2003) and Dibbern et al.(2004).

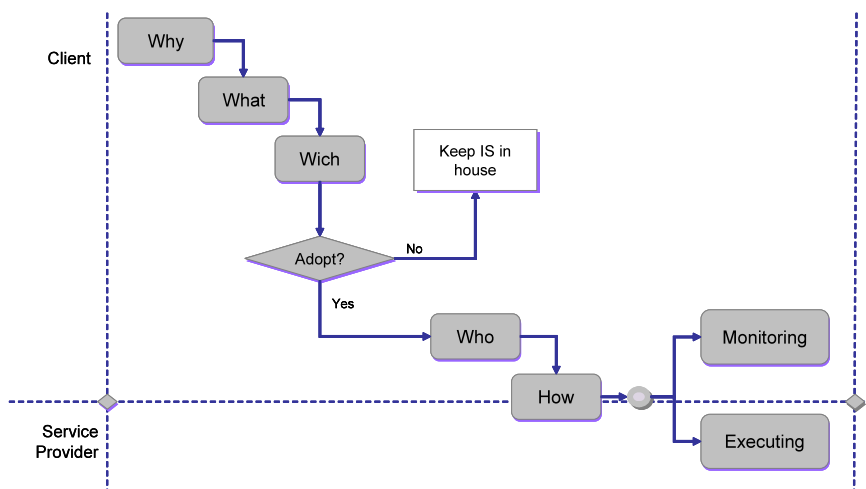


Figure 1 – Outsourcing process between the Client and the Service Provider

The process is divided into two major phases: the adopting Outsourcing decision and the solution implementation. During the first phase the organization weighs the advantages and disadvantages associated to Outsourcing ("why"), seeks to determine "what" to outsource and "which" is the adequate arrangement for its specific needs. Once the organization finds the answer to these questions it should undertake a careful evaluation of which way to proceed. If the decision is to go forward and adopt Outsourcing, the second phase of the process will begin, which means a provider must be selected ("who").

Both Client and Service Provider should agree on "how" to implement the chosen Outsourcing solution, negotiating a contract and implementing tools which will help them to manage the relationship. Finally as the provider delivers the service (execution), the Client should monitor the results attained for the specific outsourced function (monitoring).

During and after Outsourcing implementation organizations evaluate the results, which reflect the consequences of the Outsourcing decision, that is to say the success or failure of the arrangement and the lessons learned.

2.2. Outsourcing Risks and Benefits

Outsourcing Risks

Risk involves uncertainty hence, for the present study, the definition adopted is the probability of an event loss leading to occur.

In previous studies authors like Dhar & Balakrishnan (2006), Gewald & Hinz (2004), Bhattacharyaa et al. (2003), adopted different definitions of risk according to their line of investigation. For Dhar & Balakrishnan (2006) "risk can be interpreted as the occurrence of undesirable events". On the other hand Gewald & Hinz (2004) consider a more accurate definition of risk as a measurable probability of the negative deviation of a target value in relation to a reference value. Bhattacharyaa et al. (2003) adopt a theoretical perspective of IS Outsourcing risk, defining it as "the possibility of an unsatisfactory outcome".

Outsourcing Benefits

A benefit represents the gain attained based on an established goal. An organization adopts Outsourcing with the perspective of gaining something.

The common drivers for the organizations to outsource are to reduce and control operating costs, to improve the organization performance on its core competences, to gain access to capabilities they don't have in-house, to free internal resources for other purposes or even as a way of sharing risks with a partner company (Griffiths, 1999).

2.3. Delphi method with Q-sort

The Delphi method allows the analysis of qualitative data and involves a series of iterative questionnaires presented to a number of experts in a subject matter to obtain information about emerging themes and ideas, through consensus among the group of participants (Brown, 2007).

The Delphi method was devised at RAND Corporation in the 1950's (Santos & Amaral, 2004) and it was applied by the USA defense to improve the investigation based on experts forecasting (Okoli & Pawlowski, 2004).

This method was adopted in this study because the analysis of risks and benefits of Outsourcing has a strong qualitative nature and the Delphi has been the dominant approach to key IS issues research (Campos, 1998; Gottschalk et al., 2000; Gottschalk, 2001; Gonzalez et al., 2006).

It is rather usual to combine the Delphi method with sorting techniques as the Likert or the Q-sort scales. In this case the Delphi study was conducted with the Q-sort technique because it would serve the purpose of obtaining risks and benefits of Outsourcing ranked according to their importance (Okoli & Pawlowski, 2004). With this technique participants are asked to rank instead to rate and to take in consideration all issues simultaneously (Amaral et al., 2003) which prevents equal positions among listed issues.

The Delphi should be conducted through as many rounds as the necessary to achieve a reasonable level of consensus. When consensus is reached one can say the listed issues ranking is reliable (Amaral et al., 2003). The concept of a group consensus is the opinion homogeneity or consistency among the participants. In previous studies the Delphi round process has been stopped by the lack of time to proceed or the decrease of answer rates between a round to another (Santos, 2004). In this study the Kendall coefficient of agreement W was adopted as a way to evaluate the level of consensus among the experts, since it has been widely applied with the Delphi method in different knowledge areas to identify and prioritize key issues (Miguel, 2000). This Kendall's W verify the agreement among the experts, measuring the correlation of the ranked issues (Miguel, 2000). The coefficient value increase with the level of consensus, varying from 0 (without consensus) to 1 (perfect consensus) (Schmidt, 1997). This coefficient cannot be negative because when several experts are involved they can completely agree but they will not entirely disagree (Miguel, 2000).

When Kendall's coefficient is small the decision is trivial but when consensus is moderate it is difficult to come to a decision (Schmidt, 1997). Schmidt (1997) points out two criteria that can be used to stop the round process of a Delphi study:

- In case of strong consensus ($W \geq 0.7$) or
- In case of absence of strong consensus among the experts, a leveling off of Kendall's W from one round to the next, which indicates a lack of progress between rounds.

Schmidt (1997) refers that for a group of more than 10 experts, even very small values of W can be significant.

3. Empirical Study Methodology

The study methodology was a qualitative survey carried out in Portugal, using the Delphi method with Q-sort, to obtain the IS market players perspective about which risks and which benefits are considered to be of most importance. Comparing these perspectives it was possible to evaluate to what extent a common view is shared by the market players.

In this research the practical application of the method followed the steps described in the next sections.

3.1. Identification of experts

The Delphi method does not depend on a statistical and representative sample of a certain population, but on a group of qualified experts that detain a deep understanding of a specific issue (Okoli & Pawlowski, 2004). More important than the size of the experts group are their capabilities and knowledge about the issue under analysis (Saizarbitoria et al., 2006).

The participants are divided into three panels which represent the IS market players - Service Providers, Clients and Opinion Makers (Table 1). The selection of the participants followed the recommendations of the Delphi method. The experts' selection for the Service Providers and Clients panels was supported by IDC Portugal (International Data Corporation), which by the nature of its activity has a collection of organizations that regularly participate on its Outsourcing studies. For the Opinion Makers panel the experts invited were authors with work published in magazines, journals, private institutions studies or conferences within this field.

Table 1 – Panels of experts

Panel	Description
<i>Service Providers</i>	11 top managers from organizations that provides IS Outsourcing services. In general, these organizations have a business volume higher than 40 millions of Euros and more than 500 workers.
<i>Clients</i>	12 top managers from organizations that adopted IS Outsourcing services. The organizations are mainly from Bank, Post and Communications, Insurance and Electricity business sectors; and they have a business volume higher than 100 millions of Euros and more than 1000 workers.
<i>Opinion Makers</i>	9 elements with work published in magazines, journals, private institutions studies or conferences within this field

3.2. Structure of questions

The lists of risks and benefits presented to the experts were constructed based on a literature review about IS Outsourcing where risks feared by organizations and benefits they aim were identified.

In addition, the Transaction Costs Theory contributed to build the list of Outsourcing risks (Table 2). Trough this theory it was possible to identify risk factors associated both to the transaction (the activity outsourced) and the human behavior of the intervenient in that transaction (Service Providers and Clients)

Table 2 – List of Outsourcing risks

Risks	Literature references
<i>Existence of deficiencies on the contract</i>	<i>Aubert et al., 2005; Bahli & Rivard, 2003a; Bahli & Rivard, 2003b; Dhar & Balakrishnan, 2006; Gonzalez et al., 2005a; IDC, 2005; Kakumanu & Portanova, 2006</i>
<i>Unexpected costs and other hidden costs</i>	<i>Aubert et al., 2005; Bahli & Rivard, 2003a; Bahli & Rivard, 2003b; Deloitte, 2005; Dhar & Balakrishnan, 2006; a, 2005; Kakumanu & Portanova, 2006; Varajão, 2002</i>
<i>Organizations perform a poor cost-benefit analysis</i>	<i>Gonzalez et al., 2005a; Varajão, 2002</i>
<i>Organization gets in the hands of the service provider organization (lock-in)</i>	<i>Aubert et al., 2005; Bahli & Rivard, 2003a; Bahli & Rivard, 2003b; Deloitte, 2005; Dhar & Balakrishnan, 2006; IDC, 2005; Kakumanu & Portanova, 2006; Varajão, 2002; Wright, 2004</i>
<i>Organization has a lack of its needs fulfilled</i>	<i>Aubert et al., 2005; Dhar & Balakrishnan, 2006; Gonzalez et al., 2005a; Kakumanu & Portanova, 2006; Varajão, 2002</i>
<i>Providers don't comply with the contract</i>	<i>Aubert et al., 2005; Deloitte, 2005; Dhar & Balakrishnan, 2006; Gonzalez et al., 2005a; Kakumanu & Portanova, 2006; Varajão, 2002; Wright, 2004</i>
<i>Dispute and/or litigation</i>	<i>Aubert et al., 2005; Bahli & Rivard, 2003b; Dhar & Balakrishnan, 2006; Varajão, 2002; Wright, 2004</i>
<i>Irreversible outsourcing decision</i>	<i>IDC, 2005; Gonzalez et al., 2005a; Gonzalez et al., 2006</i>
<i>IS/IT logical security failure.</i>	<i>Aubert et al., 2005; Dhar & Balakrishnan, 2006; Gonzalez et al., 2005a; IDC, 2004; IDC, 2005; Kakumanu & Portanova, 2006; Varajão, 2002; Wright, 2004</i>
<i>Threat from opportunism by the Service Provider</i>	<i>Aubert et al., 2005; Dhar & Balakrishnan, 2006; Varajão, 2002</i>
<i>Occurrence of disasters</i>	<i>Aubert et al., 2005; Dhar & Balakrishnan, 2006</i>
<i>A lower IS/IT physical security</i>	<i>Kakumanu & Portanova, 2006; Varajão, 2002; Wright, 2004</i>
<i>Increasing problems on human resources management (IS staffing)</i>	<i>Deloitte, 2005; IDC, 2004; IDC, 2005; Varajão, 2002; Wright, 2004</i>

For the list of Outsourcing benefits (Table 3) was added information published by the Service Providers on their internet sites.

Table 3 – List of Outsourcing benefits

Benefits	Literature references
<i>Focus on core business functions.</i>	<i>Accenture; Capgemini; Deloitte, 2005; Gonzalez et al., 2005c; Gonzalez et al., 2006; Griffiths,1999; HP; IBM; IDC, 2004; IDC, 2005; Kakumanu & Portanova, 2006; Novabase; Prisma; PT SI; Silva, 2002; Varajão, 2002</i>
<i>IS/IT service levels assurance.</i>	<i>Accenture; Capgemini; Deloitte, 2005; Gonzalez et al., 2005c; IDC, 2004; IDC, 2005; Silva, 2002</i>
<i>IS/IT risks sharing</i>	<i>Deloitte, 2005; Edinfor; Griffiths, 1999; IDC, 2005; Kakumanu & Portanova, 2006; PT SI; SAP Portugal; Silva, 2002; Varajão, 2002</i>
<i>Access to highly skilled resources</i>	<i>Accenture; Deloitte, 2005; Griffiths, 1999; HP; IDC, 2004; IDC, 2005; Kakumanu & Portanova, 2006; Prisma; Silva, 2002; Varajão, 2002</i>
<i>Costs reduction</i>	<i>Accenture; Capgemini; Deloitte, 2005; Gonzalez et al., 2005c; Gonzalez et al., 2006; Griffiths,1999; IBM; Kakumanu & Portanova, 2006; Novabase; Prisma; PT SI; Silva, 2002; Unisys; Varajão, 2002</i>
<i>A higher control and accuracy over the IS/IT performance and costs</i>	<i>Accenture; Griffiths, 1999; IDC, 2004; IDC, 2005; Prisma; Varajão, 2002</i>
<i>Improvement on Return on IS/IT Investment</i>	<i>HP; SAP Portugal; NextiraOne</i>
<i>Higher organization productivity</i>	<i>Accenture; Capgemini; SAP Portugal</i>
<i>Improvement on IS/IT management efficiency</i>	<i>HP; Varajão, 2002</i>
<i>Increase in organization flexibility</i>	<i>Deloitte, 2005; Edinfor; IDC, 2005; Gonzalez et al., 2005c; Varajão, 2002</i>
<i>A better adjustment of human resources needs</i>	<i>Kakumanu & Portanova, 2006; Varajão, 2002</i>
<i>Higher IS/IT security and reliability</i>	<i>IDC, 2004; Unisys</i>
<i>Simplification of the organic matrix</i>	<i>Deloitte, 2005; IDC, 2004; IDC, 2005; Varajão, 2002</i>
<i>Achievement of a standard and even organizational structure</i>	<i>Accenture; Capgemini; Deloitte, 2005; IDC, 2005</i>
<i>Permanent access to up to date technology.</i>	<i>HP; IDC, 2004; Gonzalez et al., 2005c; Gonzalez et al., 2006; Kakumanu & Portanova, 2006; Prisma; Silva, 2002; Varajão, 2002</i>
<i>Cash flow improvement.</i>	<i>HP; IDC, 2004; Varajão, 2002</i>

3.3. Web-based instrument

The Delphi study was conducted on-line, developed and turned available on the University of Minho's server, with instructions to guide participants through the Q-sort technique.

The expert is presented to a list of issues that should be organized into three groups according to “most important”, “neutral” and “less important”. Within these groups the expert should choose the most and the less important issue in comparison to others until all the issues of the group are evaluated. At the end of this procedure one obtain a ranked list of issues sorted by their importance. A peculiar feature of this technique is that the certainties about the issues are at the top and at the bottom of the list since the experts have the greatest convictions about what it is “most important” and “less important” (Santos, 2004).

3.4. Number of rounds

The common number of rounds to collect data found in previous studies is from two to four (Campos, 1998), depending on the participation rate, the time available to collect data or the structure of the Delphi study. The many the rounds the less is the participation rate (Santos & Amaral, 2004).

For the present Delphi study two rounds were conducted. For the first round the level of consensus attained for the ordered lists was low or not significant, so a second round was undertaken to attempt a consensus improvement. This second round allowed experts to review their answers and it was possible to consolidate the sorted lists from the previous round.

Table 4 – Delphi rounds for Service Providers panel

Rounds	Risks	Benefits
# 1	Kendall's W = 0,44	Kendall's W = 0,33
	Weak agreement among experts	Weak agreement among experts
# 2	Kendall's W = 0,39	Kendall's W = 0,42
	Weak agreement among experts	Weak agreement among experts

As shown in Table 4 there is a lack of progress from round one to round two which indicates the Delphi process can be stopped. According to Schmidt (1997) for a panel of this size even very small values of W can be significant so the panel achieved a satisfactory consensus.

Table 5 – Delphi rounds for Clients panel

Rounds	Risks	Benefits
# 1	Kendall's W = 0,15	Kendall's W = 0,20
	Very weak agreement among experts	Very weak agreement among experts
# 2	Kendall's W = 0,23	Kendall's W = 0,17
	Very weak agreement among experts	Very weak agreement among experts

There is a leveling off of W (Table 5) between rounds which is a criteria pointed out by Schmidt (1997) to stop Delphi process. This group has low convergence for both lists.

A deeper research on previous literature has found possible causes/explanations for this result. A study carried out among the largest Spanish firms (Gonzalez et al., 2005a) shows a certain dependency between the degree of Outsourcing, the size of the organization and the risks they fear most. Gonzalez et al., 2005a found that risks are identical for different organizations

independently of the activity sector they belong to. However, the significance given to risks is close related to the degree of Outsourcing and the size of the organization (measured by number of workers and business volume). These authors discovered that small organizations fear mainly the dependence on the provider while large firms show more concern about the possible opposition to Outsourcing of their IS department staff. Although the business volume of the participant organizations in the present study is the same, they have different amount of workers, which may have been an influence over the findings. Also, the degree of Outsourcing, which is another factor that contribute for this effect, is probably different among the organizations.

The findings of Gonzalez et al. (2005c) show that the size of the organization and the activity sector can influence the importance given to benefits. These authors say that smaller organizations often view Outsourcing as a way to facilitate access to new technologies and less as way of focusing on their core competences. In addition they found that the main reason for Service Firms to outsource is to have access to new technologies which is less important for Insurance and Financial Institutions; on the other hand Industrial Firms outsource to improve IS quality service.

For the reasons pointed out above it is possible to predict that even conducting another Delphi round it is difficult to achieve reasonable consensus among this panel, which strengthens the decision of stopping the Delphi process.

Table 6 – Delphi rounds for Opinion Makers panel

Rounds	Risks	Benefits
# 1	Kendall's W = 0,33	Kendall's W = 0,35
	Weak agreement among experts	Weak agreement among experts
# 2	Kendall's W = 0,43	Kendall's W = 0,32
	Weak agreement among experts	Weak agreement among experts

The level of consensus does not change between rounds (Table 6) as it happens with the other panels so the Delphi process can be stopped. For a panel of this size even very small values of W can be significant so the panel achieved a satisfactory consensus (Schmidt, 1997).

3.5. Participation rate and non-response

To invite the experts it was sent an e-mail describing the study scope and giving access to the eDelphi, assuring to the participants confidentiality over answers and their personal and their organizational data. Santos (2004) states that to obtain a good participation rate it should be sent a personalized message to all participants with relevant information, namely the questionnaire web address and its access.

Among those who did not answered it is possible to find individuals which ignored the invitation to participate, refused to participate due to the organization policy or did not accessed the mailbox during the questionnaire period. At the end of the Delphi round process were achieved the participation rates shown in Table 7.

Table 7 – Participation rates on the Delphi process

	Service Providers	Clients	Opinion Makers
<i>Population</i>	N = 20	N = 48	N = 12
<i>Participation rate</i>	55%	25%	82%

4. Empirical Study Results and Discussion

On this section the study results, risks and benefits, are presented for each participant group: Service Providers, Clients and Opinion Makers. The comparison of their perspectives allowed to evaluate to what extent a common view is shared by the market players.

4.1. Results

Service Providers

For Service Providers group the most important risks an organization should take under consideration when adopting IS Outsourcing are: the existence of deficiencies on the contract, a poor cost-benefit analysis performed by the organization and the lack of compliance with the contract by the providers.

This panel also considers that the most important benefits to attain with IS Outsourcing are: focus on core business functions, increase in organization flexibility and access to highly skilled resources.

Clients

The Clients group consider the existence of deficiencies on the contract as the most concerning risk when it comes to outsource. This study shows that more than costs, the risk Clients fear most is the possibility of contract deficiencies. On the contrary, the IDC (2004) study among Portuguese organizations describe that 50% of participants are concerned about costs and just 40% consider the contractual issue as a barrier to outsource. Another conclusion is pointed out by the Deloitte (2005) study that state the Service Provider performance is the greatest distress for organizations.

This panel believes that the most important benefit to achieve by Outsourcing is the organizations focus on their core business functions. This result is coincident with Gonzalez et al. (2005c) conclusions from an investigation conducted among the largest Spanish firms and it is also confirmed by 50% of the participants of an IDC (2005) study carried out among Portuguese organizations. On the contrary on a study carried out by Deloitte (2005) cost reduction is indicated by 70% of participants as the main reason to outsource; and only 35% specify focus on core business as a reason.

Opinion Makers

The Opinion Makers group think that the risks of most importance are: the existence of deficiencies on the contract, a poor cost-benefit analysis performed by organizations and the possibility of an organization getting in the hands of the service provider (lock-in).

Results demonstrate that this panel considers the greatest benefits: focus on core business functions, access to highly skilled resources and a higher control and accuracy over the IS/IT performance and costs.

4.2. Discussion

Outsourcing risks

This study shows that the Portuguese market players share a common view about the most feared risk associated to Outsourcing (Table 8). They consider the existence of deficiencies on contract as the risk of most importance. This apprehension about contract is also shown on Gonzalez et al. (2005b) investigation where bigger organizations see a proper contract structuring as the Outsourcing relationship success key. However they don't share the same opinion about the other listed risks.

Table 8 – Risks rankings for the three panels

Risks	Rank		
	Clients	Service Providers	Opinion Makers
<i>Existence of deficiencies on the contract</i>	1st	1st	1st
<i>Unexpected costs and other hidden costs</i>	2nd	4th	4th
<i>Organizations perform a poor cost-benefit analysis</i>	3rd	2nd	2nd

For the Clients group *unexpected costs and other hidden costs* was the second top risk compared with Service Providers and Opinion Makers where it was ranked fourth. The risk of an organization performing a poor cost-benefit analysis was the third top risk for Clients and was ranked second for Service Providers and Opinion Makers.

This classification of the second risk seems to indicate a certain consciousness of Client organizations about their "lack of experience with Outsourcing or lack of expertise with the IT operation that is intended to outsource".

On the other hand the Service Providers and Opinion Makers second risk infers they have a better perception that "on an Outsourcing decision process there are costs that organizations don't consider on the cost-benefit analysis".

Outsourcing benefits

The Portuguese market players also share a common view about the most important benefit associated to Outsourcing (Table 9). They consider the focus on core business functions as the benefit of most importance.

Table 9 – Benefits rankings for the three panels

Benefits	Rank		
	Clients	Service Providers	Opinion Makers
<i>Focus on core business functions</i>	1st	1st	1st
<i>IS/IT service levels assurance</i>	2nd	6th	5th
<i>IS/IT risks sharing</i>	3rd	9th	12th

On different web sites of some Service Providers as Accenture, Capgemini, IBM or Novabase the slogan to outsource is "Outsourcing allows organizations to focus on their core competences", which in a way may have had a strong influence on the present study findings.

Besides the first top benefit the Portuguese market players don't share the same opinion about the other listed benefits.

5. Conclusions and research avenues

The objective of this paper was to determine to what extent a common view about risks and benefits associated to IS Outsourcing is shared by the Portuguese market players – Service Providers, Customers and Opinion Makers. In order to accomplish this, an on-line Delphi study was conducted, combined with the Q-sort technique, which allowed to obtain each players perspective on IS Outsourcing risks and benefits.

Comparing these perspectives it was possible to understand that the market players do not share the same view. Beyond the top risk and benefit associated to Outsourcing the market players do not agree on the other listed risks and benefits ranking. They agree that the risk to fear most is the existence of deficiencies on contract and that the most important benefit is to focus on core competences.

This study also contributed to the understanding of the risks and benefits associated to IS Outsourcing and to obtain each player own perspective on IS Outsourcing risks and benefits.

Finally both the findings and some limitations of the study are referred, pointing out opportunities to future investigations. Since the existence of deficiencies on the contract is the most feared risk it would be useful to carry out case studies about IS Outsourcing contracts which failed and its lessons learned. Likewise as the organization focus on core business functions was considered to be the benefit of most importance it would be valuable to exploit ways of evaluating its accomplishment. In view of the fact that the present study involved bigger organizations it would be interesting to broaden the scope to smaller firms. In addition it is relevant to undertake a deeper analysis to understand to what extent the risks and benefits associated to Outsourcing depend on the organizations business sector or on the Outsourcing level.

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Analysis of IT Governance on Spanish organizations

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Abstract: Corporate governance is a key element today in organizations and companies. IT Governance, as a part of corporate governance, plays its role in aligning IT with the business and obtaining the maximum value, minimizing the risks. This paper represent the research so far to identify the state of the art of IT governance in the Spanish small and medium organizations (SMOs). The goal is to identify best practices in Spanish SMOs.

Keywords: IT Governance, corporate governance, framework, best practices, SMOs, SMEs.

1. Introduction

Corporate governance is not an old issue that has already been solved. The recent credit crunch has its origins in a failure of corporate governance in the companies (Moxey & Berendt, 2008). Thus, corporate governance is now, more than ever, on top of the agenda of executives and governs all over the world. Just as an example, regarding the banking industry in the UK, the Chancellor of the Exchequer said that “it is clear that corporate governance should have been far more effective in holding bank executives to account” (HM Treasury, 2009).

Corporate governance has gone through different stages, from defining a framework to implement specific controls (COSO, 1992) to the definition of code of conducts such as the Cadbury Report (Cadbury, 1992) and the Turnbull Report (Turnbull, 1998). Moreover, in some countries, and taking into account scandals such as Enron and Worldcom, a specific legislation has been developed to identify and establish legal responsibilities for those managers and directors who are not committing with the legal obligations (Sarbanes-Oxley, 2002). But the definitively commitment with corporate governance was due to the publication of the OECD Principles of Corporate Governance in 1.999, updated in 2.004 (OCDE, 1999), (OCDE, 2004).

IT governance is the discipline of corporate governance that covers information and IT assets on the organization (Weill & Ross, 2003). IT governance is focusing on the way these assets are managed, organized and controlled to provide the maximum value to the organization. And this process of governing IT should be done by integrating IT into the business strategy, with an efficient management of the IT resources, and minimizing the risks; complemented by constantly monitoring the business and IT goals.

Researchers and practitioners have been working on IT governance, and different frameworks have been defined to implement and manage IT governance on companies and organizations: COBIT version 4.1 (ITGI, 2007), the framework defined by the CISR (Weill &

Ross, 2003), the structures, processes and relational mechanisms (Van Grembergen, 2004). However, the different frameworks have been more focused on big organizations, and there is no research that deals with the specific particularities of the medium and small companies. Also, there is no research so far that covers the status of IT Governance on the Spanish organizations.

Our aim is to analyze the status of IT Governance in the Spanish organizations, particularly on SMOs, identify the status of IT governance mechanisms SMOs and set the basis to define best practices for this type of organizations. This paper describes the work done so far by the authors, which consists basically on two different research projects, which are based on questionnaires and interviews with managers of Spanish SMOs.

2. From Corporate governance to IT governance

The conception of IT governance as a discipline of IT governance was done, basically, in two steps. On the report of CIMA (CIMA, 2003) corporate governance was divided in two different areas: corporate governance itself (that covers the conformance issues and the relationship between shareholders and managers) and business governance, focused on managing the business, more on a strategic and tactical view, and less oriented to handle the relationship with the shareholders.

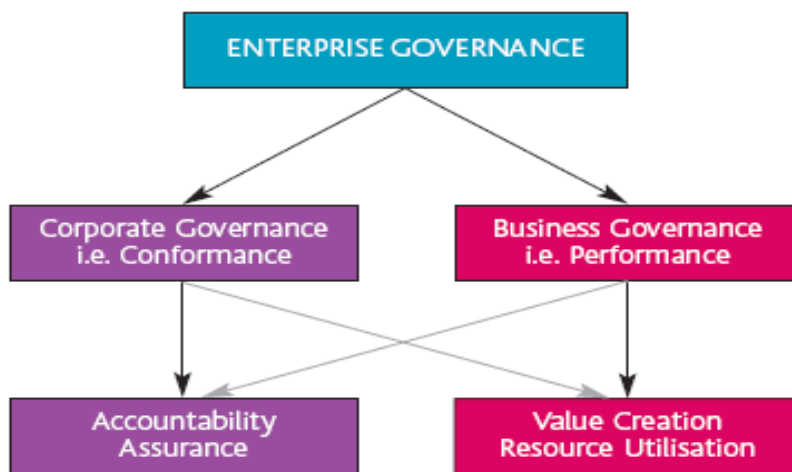


Figure 1 – Enterprise governance framework.

The next step was to identify IT and information as an asset, inside the company, that needs to be managed and governed. This is established by Weill and Ross (Weill & Ross, 2003), who identified information and IT as one of the six key assets that are managed by corporate governance.

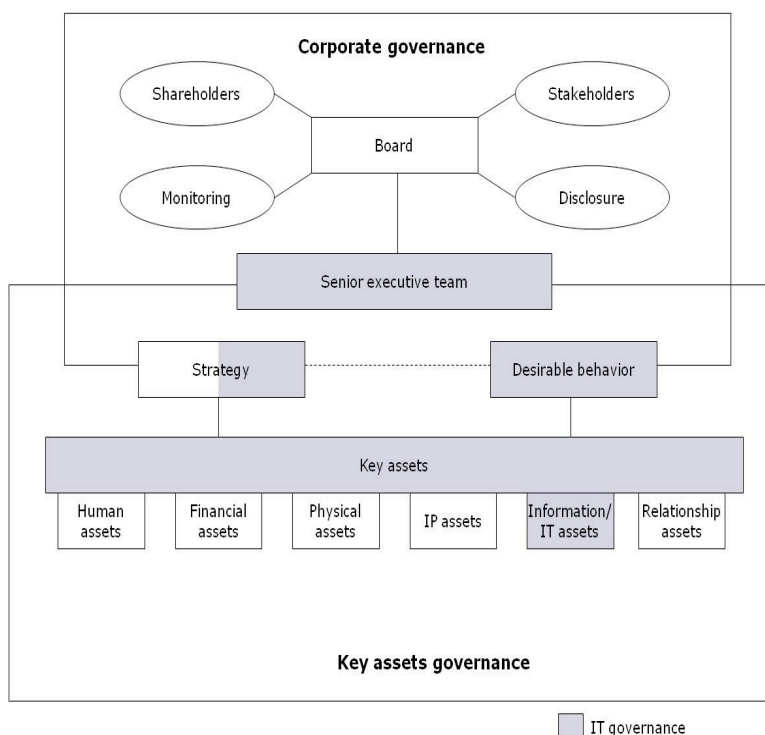


Figure 2 – IT Governance as a discipline of corporate governance.

3. IT governance key elements.

IT governance has been analyzed by researches and practitioners in different ways. From a theoretical point of view, IT Governance has released COBIT version 4.1 (ITGI, 2007), that covers IT governance from the performance management perspective. This perspective is complemented by the Val IT framework (ITGI, 2008), which is more focused on the value adding of IT to the business. And also, more recently, the IT Governance Institute has released the draft for managing Risk IT framework (ITGI, 2009), that will cover the risk dimension of IT governance.

The approach of Weill and Ross (Weill & Ross, 2003), is different, and is more in the opposite way: from the reality, from what is done in the companies and organizations, the authors conceived a framework to implement IT Governance, taking into account the best practices that were implemented or developed in organizations with superior results on its IT management. This framework considers three different aspects: the decision making mechanisms and structures, the alignment processes, and communication tools and approaches.

Van Grembergen (Van Grembergen, 2004), proposed another different (but similar) framework based on three pillars: structures, processes and relational mechanisms. And other institutions such as Forrester (Symons, Oliver Young & Lambert, 2005) also approached this subject by suggesting best practices to implement IT Governance. And, most recently, there are two milestones to be considered. First is the publication of the ISO/IEC 38.500:2:008 (ISO, 2008) that is related to IT Governance and is based on the Australian standard and the Calder-Moir IT

Governance Framework (Calder, 2007), which covers this discipline in its whole lifecycle and in the entire organization, from the board to the management, from strategic planning to operations.

With this basis, the IT governance key elements are:

- Strategic alignment of IT and linking with the business strategy, as analyzed by Venkatraman and Henderson (Henderson & Venkatraman, 1999), Luftman and Brier (Luftman & Brier, 1999) and Weill and Broadbent (Weill & Broadbent, 1998).
- Value delivery of IT to the business, as seen by Weill and Broadbent (Weill & Broadbent, 1998) and the framework Val IT of the IT Governance Institute (ITGI, 2008).
- Risk management, as described, for example, by Elieson (Elieson, B. D. 2.006) and CIMA (CIMA, 2003), and recently covered by the Risk IT framework (ITGI, 2009)
- Resource management, described and analyzed on COBIT version 4.1 (ITGI, 2007).
- Organizational structures, including decision making mechanisms, accountability settings and communication approaches (Weill & Ross, 2003).
- Processes of IT Governance, that can include chargeback mechanisms, service level agreements or SLAs, etc. ((Weill & Ross, 2003), (Van Grembergen, 2.004)).
- Performance management, as, for example, described on COBIT (ITGI, 2007). Other authors identify and describe the IT Balanced Scorecard (Van Grembergen & De Haes, 2004) as one complete tool that enables to control and monitor IT performance.

4. The research

The research done by the authors is divided in two phases. In the first phase, the authors analyzed the status of IT governance from the management point of view, trying to identify links between the state of the organization (and its structure, organization and mechanisms) and some of the elements of IT governance. The second phase was differently conceived: the aim is to identify the status of IT governance on the organizations, and the degree of awareness of IT governance.

The methodology used in both phases is described below:

- The definition of a questionnaire to present to managing directors/owners and IT managers (if existing) of Spanish SMOs.
- The selection and/or capturing of companies or organizations that can participate on this research.
- Questionnaire pre-test, on a small group of SMOs.
- Modification of the questionnaire, in order to incorporate the conclusions of this pre-test.
- Interviews with MDOs of companies/organizations, in order to obtain the information of the questionnaire.
- Analysis of the information gathered.
- Identification of preliminary conclusions for IT Governance in SMOs.

5. The first phase

The first phase finished last year, and did not considered the recent publications mentioned before: the standard ISO/IEC 38500:2000 (ISO, 2008) and the Calder-Moir framework (Calder, 2007). The elements of IT governance were analyzed from a practical perspective. The focus was to identify best practices on organizations and the relationship with the key elements of IT governance considered:

- Strategic alignment of IT.
- Value delivery of IT.
- Organizational structures.
- Processes of IT Governance.
- Performance management.

In order to identify this, the questionnaire was focusing on obtaining information about the degree of definition and implementation of:

- The organization, in terms of departments, responsibilities, coordination mechanisms, etc.
- The business processes.
- The business strategy and reporting/monitoring mechanisms.
- The organization, processes and strategy of IT.
- The location and attributes of IT within the organization.
- IT decision making mechanisms.
- IT and the relationship with other departments/business units.

5.1. Strategy

To analyze the degree of strategic alignment on the organizations, the authors analyzed the existence of a business strategy and, eventually, an IT strategy. But this is not always present on the SMOs: instead, successful SMOs can have a clear statement of strategic goals and metrics (such as sales increase, production increase, cost cutting objectives), and a clear understanding of the implication of IT on the goals.

5.2. Processes and organization

One of the key elements for IT governance is the existence of organizational structures that manages and drives IT, and the related processes. In the organizations, the authors searched for a well defined organizational structure, as well as a good definition and implementation of the business processes. In general, SMOs in Spain have the ISO 9.001 certification, which identifies processes and organizational structures. But this is only a threshold level of excellence; since this certification is not seen, by the managers, as a driver for a better management of the organization, and is only considered as a “must have”.

5.3. Balanced scorecard

Finally, the authors looked for the existence of a balance scorecard, not only in itself, but also as an element that is timely and consistently reviewed and managed. Alternatively, the existence of a set of structured business objectives, monitored consistently and driving the process of taking decision

5.4. Conclusions

There were 16 organizations that participated on this phase, with different sizes and industries.

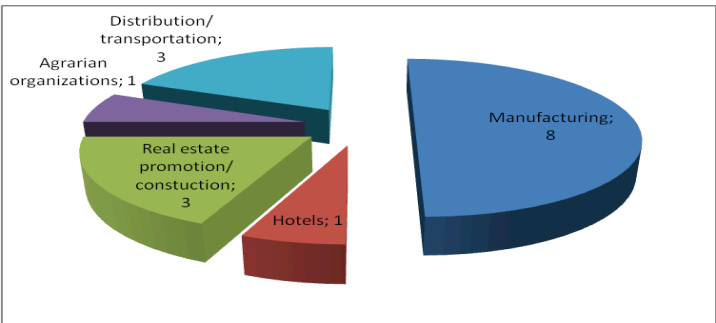


Figure 3 – Industry of the organizations that participated on the first research.

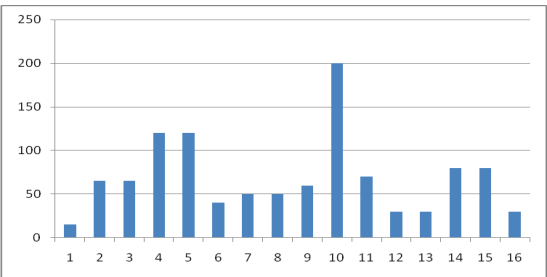


Figure 4 – Size of the organizations that participated on the first research.

Strategic alignment; business and IT goals:

Only 5 of the organizations had a well-defined business strategy, with strategic lines and business goals. The figure shows the sizes of the organizations:

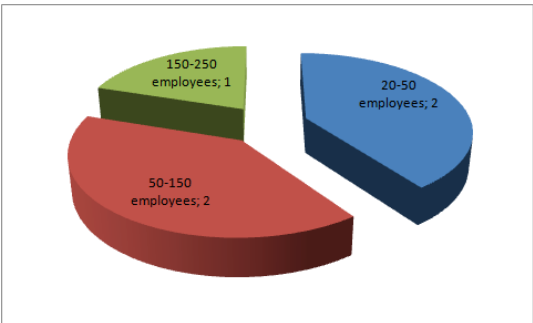


Figure 5 – Organizations with a well defined business strategy.

As a common element, the organizations have a very professional managing team, with a clear separation of functions.

But, instead of a business strategy, the existence of a set of business objectives or goals should be considered as an alternative. Regarding this, all the companies (not the agrarian organization) had a set of business goals defined. Nevertheless, the business goals are monitored yearly, which cannot be considered as a good managing practice.

There was no company or organization with an IT strategy defined. But, as an alternative, the existence of IT generic goals was considered. The goals identified (on all the companies) falls under this two types:

- Implementation of information systems (ERPs as Navision or SAP) or other IT-related systems (websites).
- Systems maintenance or new functionality.

And, finally, the last aspect was the identification of IT as a key factor that drives business strategies. There were two situations identified:

- A real estate promotion company uses IT as the only channel to sell its real estate developments (by positioning its products on search engines such as Google Adwords, and a daily follow-up, optimizing the searching criteria).
- A pharmaceutical distribution company uses IT as a way to obtain key information for the strategic decision making process, on critical aspects on its value chain: stock information, and transportation routes optimization.

Processes and organizations:

All the SMOs had their organizational structure defined, according to the ISO 9.001 standard or in an internal established way. Regarding a clear definition of roles, responsibilities and different committees (Board of directors, steering committee), only 4 companies had such definition. About business processes, the same comments apply: only 4 companies (the same companies) had the business processes clearly defined and implemented.

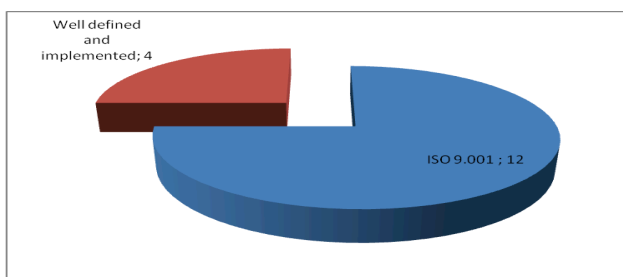


Figure 6 – Companies with well defined processes and organization.

Regarding the IT function, the research tried to identify if this was performed internally or, else, was outsourced. Only 4 companies performed this function internally. Two of them were the real estate promotion and the pharmaceutical companies described above. The other two were the biggest company and a company on the interval of 51-150 employees.

The second aspect to be discovered is the person or charge responsible of IT. In general, there is not a CIO, except on three organizations. The decisions are taking (except on the agrarian organization) at the next levels:

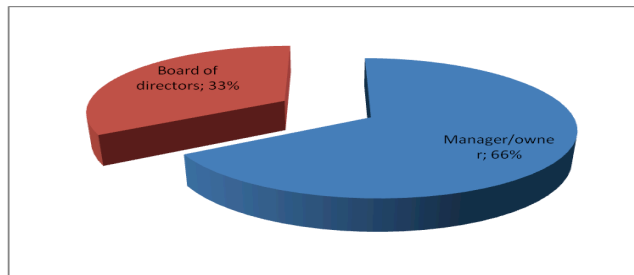


Figure 7 – Responsible for the IT function.

Regarding the follow-up of IT initiatives, this is done at the same level that takes the decision, but only on terms of budget and timing. Only in the four companies with processes and organizations well defined things such as ROI and business indicators (contacts from the website, stocks rotation, etc.) are monitored frequently.

IT Governance processes

The existence of chargeback mechanisms, and SLAs, was also analyzed. The IT function is considered as a cost center. Only on the two companies described above (real estate promotions and pharmaceutical distribution companies) the costs of IT are considered on the product pricing, and cost/benefit analysis of the IT investments are performed.

Regarding communication, there has not been identified on any of the companies communication mechanisms specifically focused on IT Governance on any company.

6. The second phase

The first phase finished last year, and did not considered the recent publications mentioned before: the standard ISO/IEC 38500:2000 (ISO, 2.008) and the Calder-Moir framework (Calder, 2007). The conclusion of the first phase led the author to consider a new research, a new phase, focused on identifying specific information about IT governance practices. The questionnaire was structure as follows:

- The status and progress of IT on the companies, in terms of issues concerning IT experimented on organizations.
- Strategic alignment and value delivery.
- Best practices on IT Governance.
- Risk management.
- Decision making mechanisms.
- Knowledge of tools and frameworks of IT Governance.

The questionnaire was defined considering the first questionnaire and the different conclusions obtained on the first phase, but also questionnaires and information associated to the different Global Status Reports of IT Governance (ITGI, 2004), (ITGI, 2006), (ITGI, 2008). This information gave the authors ideas about the structure and questions that should be included on the second questionnaire. Finally, were taken into consideration the different questionnaires included on the IT Governance Toolkit, (Calder, 2007): for both the board and the managing team.

The questionnaire has been pre-tested on 4 small and medium organizations. And the interview process is on-going, and 6 new organizations have been participated so far, including a big company.

6.1. Conclusions

As said before, currently 10 organizations participated on this phase, with different sizes and industries.

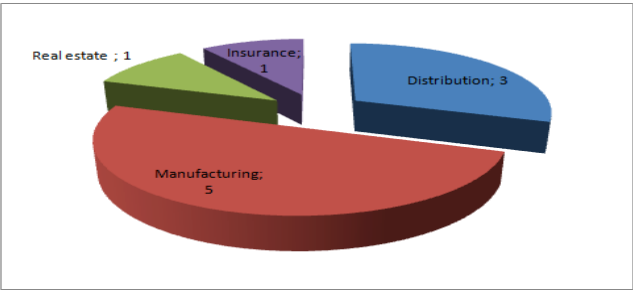


Figure 8 – Industry of the companies that participated on the second research.

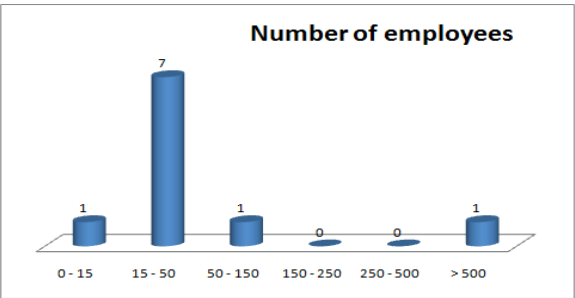


Figure 9 – Size of the companies that participated on the first research.

IT status in the organizations

The first item that is discovered is regarding the status of IT in the organizations, and the problems they have. The next picture shows that the main problem is focused on the relationship with suppliers and outsourcing, followed by agility problems (in developing new functionalities on the companies). Also, other problems to be considered are related to staff (insufficient or with a lack of IT skills), and IT service delivery problems. It is also important to remark the different problems existing with archiving/back-up.

In general, problems are remaining with the same importance that they had on the last year, and the situation has been stable

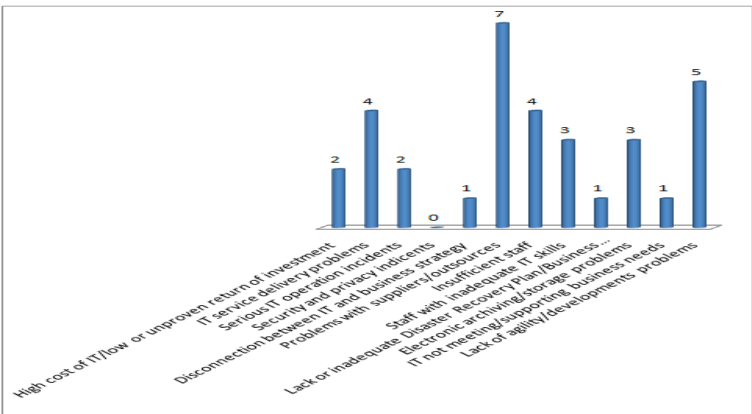


Figure 10 – Problems with IT in the organizations

The companies were asked to evaluate (in a scale of 1-5) the efficiency of high level actions that could help to solve these problems. The average of the efficiency is shown in the next figure:

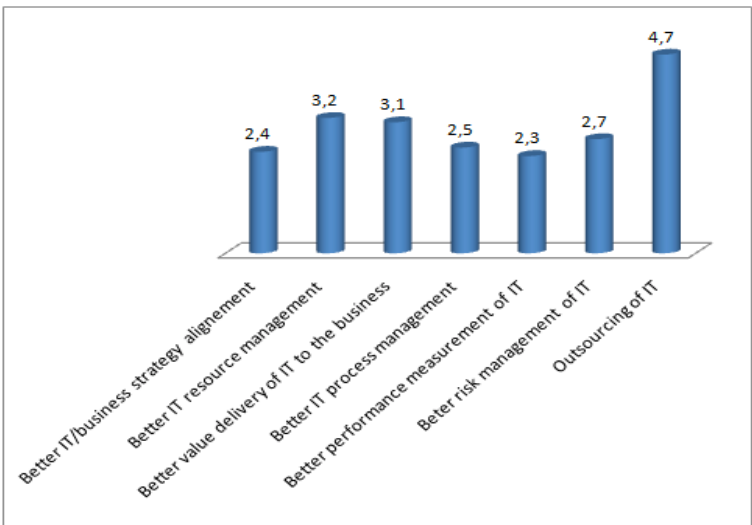


Figure 11 – Importance of high level actions

The problems the companies are facing are regarding outsourcing, but there is also important to point out the need to focus also on the management of IT resources (associated, of course, with outsourcing) but also the delivery of value of IT to the business.

Business and IT strategy

Related with the first research, on this research we analyzed if the companies have a business and an IT strategy, and its relationship. This can be seen on the next figures:



Figure 12 – Business strategy in the organizations Figure 13 – IT strategy in the organizations

The conclusion is clear: while organizations are concerned about managing its business with a business strategy or vision, with IT the situation is completely different. However, overall, the perception of the companies with regard the degree of alignment between IT and the business is good:

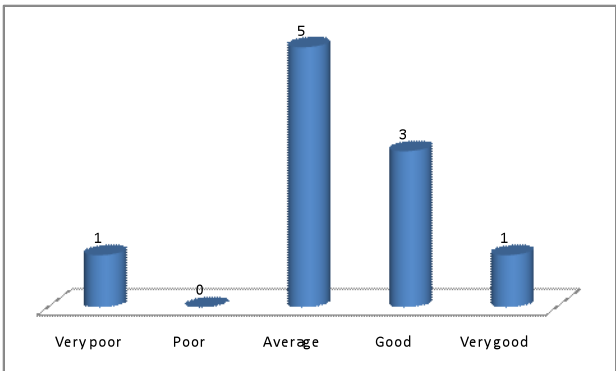


Figure 14 – Degree of alignment between IT and the business

Decision making mechanisms

The next thing was trying to identify where the IT function in the organization is, and also to understand the different decision making mechanisms that are present on the companies. In general, there is no IT department on the organization (only the big company has its own IT department), and the IT function depends of the manager. But there has been identified that the IT function depends, hierarchically, of other managing position different of the manager, in almost half of the companies. This position should be the vice-manager, or the second in charge that takes care of IT.

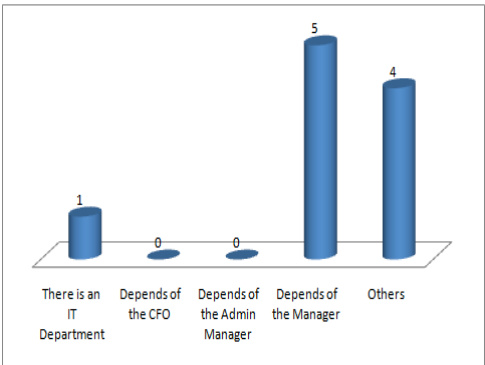


Figure 15 – The dependency of the IT department

Considering this information, it is clear that the sponsorships falls under the person that is in charge of the IT function: the manager/MDO, the CIO (that exists only on the big company), and the vice-manager or the second person in charge in the organization. Regarding decision making mechanisms, the results are showing that the decision is taking at the manager/MDO level, and also on the vice-manager. It is important to notice that here appears the board of directors, who makes the decision in two SMEs.

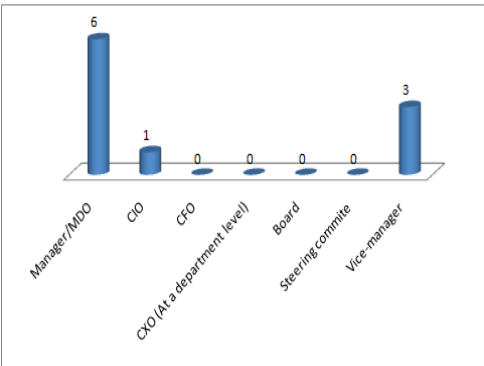


Figure 16 – IT sponsorship

Interestingly, regarding accountability of the decisions, there is a slight difference and now the board is accountable of the decision taken in one small company.

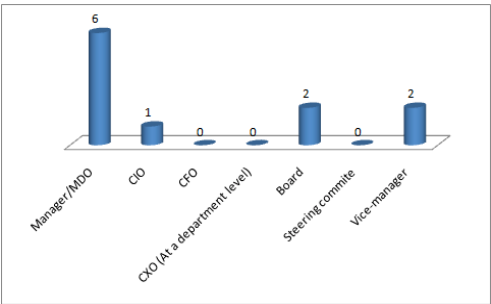


Figure 17 – Who makes decision regarding IT

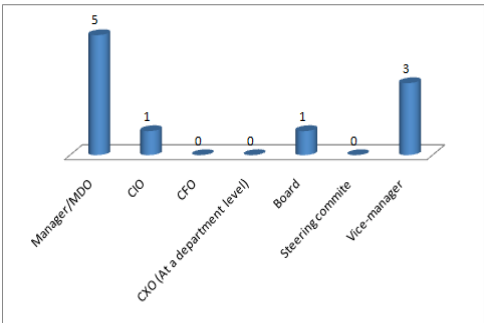


Figure 18 – Accountability.

Managing practices

In terms of managing the different initiatives of IT, the research distinguished between the tools that the companies have implemented for project approval, and the status of some project management practices on the organizations.

The figure indicates that companies used to identify costs and benefits (both tangible and intangible) when analyzing the approval of IT initiatives. And regarding management practices, the companies have knowledge of schedule, costs and problems in on-going IT projects or initiatives.

Tools for approving projects	TOTAL
Business case: economic and quantitative analysis	1
Business case: economic analysis	1
Business case: only costs and qualitative benefits	1
Costs, tangible and intangible benefits	7
Cost and tangible benefits	0
Cost	0
None	0

Figure 19 – Project approval on IT

Project management practices	TOTAL
The status of any IT initiative is know in terms of schedule	8
The status of any IT initiative is know in terms of costs	10
The status of any IT initiative is know in terms of problems	10
The status of any IT initiative is know in terms of possible risks	5
There is a committee that reviews the status of any IT initiative	4
The different departments involved on IT initiatives are identified	6

Figure 20 – Other management practices in the organizations

And, lastly, the authors wanted to know if the company is managing somehow the IT risks, and what type of risks. The risk managed is regarding business continuity (back-up and recovery, mainly) and also security. Legal and compliance aspects are important, where also important in terms of compliance with legislation about the information stored.

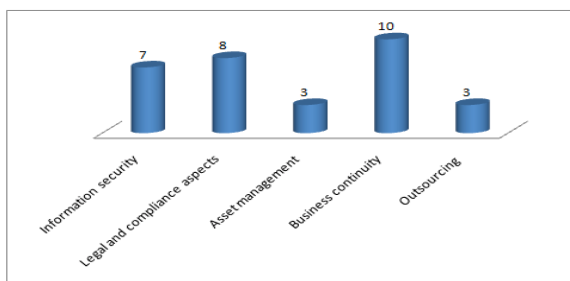


Figure 21 – IT risk management areas

7. Conclusions

Although the research, in terms of incorporating more organizations and refining the information, will continue, the information gathered gives a good perception of the IT governance in SMOs in Spain. The absence of an IT strategy other than supporting the operation, and the problems with outsourcing makes indispensable to establish some type of committee to manage IT from an

organization-wide perspective (somehow strategically) and to handle the different problems the companies are facing. This will allow separating, in the organizations, decision from accountability. There is also a need to define a risk management schema that will ensure business continuity and, also, legal and compliance aspects.

The implementation of these practices needs to bring a win-win scenario to the companies, in which the benefits of better controlling and managing IT (and thus the business) should compensate the effort and cost to implement the structures mentioned.

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A Process for Estimating the Value of ITIL Implementations

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Abstract: As World economy lingers it is increasingly more important to justify any investment so that available corporate funds are spent wisely. However, estimating the value of ITIL investments is not an easy task, which means that most CIOs do not invest in large-scale ITIL projects as much as it would be desirable. Instead, CIOs prefer to embark on quick win implementations (e.g. solely implement the incident management process). For this reason, it is necessary to create an ITIL Value Estimator. This estimator is based on an estimation process that quantifies the project's total cost, along with each process' benefits. The outcome of the ITIL Value Estimator is a Monte Carlo simulation whose result provides CIOs with a justification of the value of large-scale ITIL implementations, which can be used to gain the upper hand during the decision-making process.

Keywords: ITIL, estimator, metrics, risk analyses, cost-benefit analysis, KPIs.

1. Introduction

Today's competitive and turbulent economy forces organizations to struggle in order to remain competitive. Organizations can only grow by cutting costs as well as optimizing resources. Having this in mind, a growing number of organizations has become increasingly dependent on Information Technology (IT) to manage and grow their businesses.

A five-leg wheel chair is a good analogy to understand how organizations are structured these days. Each leg symbolizes a business function within the organization – for example: sales, marketing, manufacturing, product development and human resources; and, representing the chair's spinal column is the IT department which links and integrates the information that drives the business (Harvard Business Review, 1999).

If all the wheels (business functions) are aligned, as a result of having a common direction (strategy), then all of them will roll towards the same pathway (business goal). However, this wheel synchrony is only possible because the chair's column (IT department) supports the chair (organization) by connecting all the wheels. This simple analogy pictures the fact that organizations are intrinsically dependent on IT.

In the past, this IT dependency meant a growing IT budget, despite the fact that there was no evidence if IT investments would bring benefits to the organization (Ross & Weill, 2002). However, disproportionate budgets are no longer allowed by the executive board, as Chief

Information Officers (CIO) must justify their IT budget, and must prove that IT projects are indeed necessary for the organization to maintain its competitive level.

CIOs who have negotiation skills are able to understand the power division in the board, pinpoint who has decision rights and who is accountable in the decision-making process, and then successfully use relationships with key stakeholders to influence their stance (Broadbent & Kitzis, 2004).

Another essential skill CIOs should have is a broader understanding of the organizations' structure. Organizations are gradually becoming flat instead of having a vertical structure. This transition leads to the establishment of horizontal processes in detriment of vertical silos, which made it possible to align IT and business. And, CIOs should be able to effectively manage the link between the two of them (O'Leary, 2002).

However, without a coherent framework to manage business processes, organizations are not well prepared to avoid or solve problems related to this transition. Hence, organizations that manage their IT correctly generate returns at least 40% higher than their competitors and, for that reason, it is very important that organizations adopt an IT management framework (Ross & Weill, 2002).

In the present day, ITIL v3 consists of a set of guidelines that specify what an IT organization should do based on industry best practices. These guidelines offer advice on the definition, plan, implementation, execution, monitoring and continual improvement of the IT service management. Therefore, it is crucial not to regard ITIL as a technological project but as organizational change process (Silva & Martins, 2008).

To sum up, ITIL investment justification is a non-trivial subject and only by analysing the investment are CIOs able to justify the value of ITIL investments. In this way, the analysis of the investment ends up being the main justification support because it produces numbers that help justifying the ITIL investment, by calculating the benefits and costs. Thus, calculating the value of the investment is part of the investment analysis, and this analysis is absolutely necessary in order to justify the investment.

2. Problem

Nowadays there are multiple research case studies which support the statement that ITIL brings value (Gartner, 2006). However, CIOs are going through great difficulties so as to justify the value of ITIL implementations to their peers, as there is no pragmatic methodology in their grasp to prove the business value of ITIL implementations.

In a recent survey, 50,5% of the executives interviewed claimed that they did not approve ITIL implementations for their organizations because the business value of these implementations cannot be proven as it is depicted in figure 1 (Evergreen, 2006).

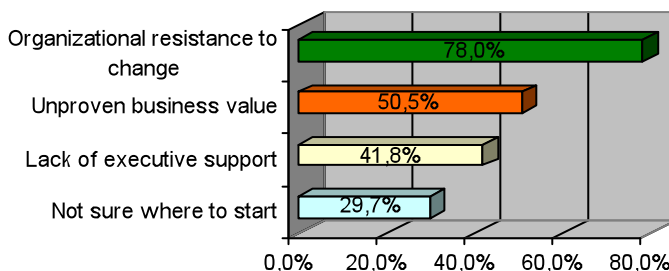


Figure 1 – Most significant barriers to ITIL adoption (Evergreen, 2006).

Indeed, estimating the value of ITIL implementations is not an easy task because many variables have to be considered (Seddon, Graesser & Willcocks, 2002). Maturity level, tangible and intangible benefits and costs, organizational complexity, and cultural context are just some of the variables that can be considered. The time factor is also another important aspect to be considered in the investment evaluation process (Repenning & Sterman, 2001).

Since the value of these variables diverges greatly from organization to organization, adding up to the fact that ITIL v3 has 26 different processes, makes it is very difficult to cluster these values and, consequently, derive patterns and re-use estimations.

Thus, CIOs need a method that quantifies the intangible benefits and costs by selecting the metrics that are indispensable for computing the value of ITIL implementations. However, questions like the following one exemplify this difficulty: how measurable is customer satisfaction and increased process effectiveness? (Dos Santos, 1991; Silva & Gama, 2006). Besides, these benefits and costs take time to be realized, and if they are measured by business financial metrics, any connection with the original ITIL investment may seem tenuous, which might result in the questioning of the CIO's position as a leader. Therefore, CIOs tend to be short/mid-term thinkers as they want immediate returns, and usually do not like to take risks when it is not clear what the benefits are (Broadbent & Kitzis, 2004).

Consequently, ITIL projects that immediately fix problematic areas (e.g. incident management systems), commonly known as *quick wins*, are usually chosen instead of large scale ITIL implementations (University of St. Gallen, 2005). This happens because large-scale projects are more complex which originates confusion and increases costs (Denker, 2005). Also, *quick wins* comprise an easier way of showing employees that ITIL works and, therefore, facilitates change that is naturally implicated in ITIL implementation projects (Silva & Martins, 2008; University of St. Gallen, 2005).

However, even if organizations observe a swift performance improvement after the *quick win* project is put into production, those improvements will not last for ever as organizations are complex adaptive systems (Santa Fe Institute, 2005). Actually, after some time the problems that were initially solved may eventually come back and new ones might emerge, making the performance decrease yet again.

So, *quick wins* have early returns associated to them but, if the organization does not continue to incrementally implement the rest of the ITIL processes, then performance may become even worse than before (University of St. Gallen, 2005). On the other hand, if *quick wins* are completed successfully and the benefits are realized, it is much easier for the CIO to ask support for subsequent larger scale ITIL implementation projects.

Alternatively, CIOs who opt for long term ITIL implementations will experience higher returns because large scale ITIL implementations involve more abstract concepts (e.g. organization design) that systematically change the investments where the organization spends its time, which ends up making the ROI proportionally larger as it is a proactive process instead of reactive.

3. Related Work

Currently, there is still limited academic research on appraising the value from ITIL implementations (Tiong, Cater-Steel & Tan, 2008). For this reason, ITIL estimation metrics are adapted from different investment analysis approaches which use financial metrics and other non-financial approaches, which are discussed in the following sections.

3.1. Investment Analyses

The value of ITIL implementations can be estimated by using general investment analyses techniques because, likewise any investment, ITIL implementations are treated as business decisions subject to the same investment thresholds as every business investment (Harvard Business Review, 1999).

The metrics by which IS are evaluated are divided into cost and benefit analyses and risk analyses. The metrics for cost and benefit analyses include: pay back period, ROI, net present value, internal rate of return et cetera. And the risk analyses metrics include: sensitivity analysis, brainstorming, scenario planning, Monte Carlo simulation et cetera (Ballantine & Stray, 1999).

Cost and benefit analyses

It is important to analyse several financial metrics in terms of their main advantages and disadvantages, so as to identify which situations are more favourable to one financial metric in detriment of the others. Table 1 corresponds to the outcome of this comparison.

Table 1 – Comparison between financial metrics.

Metrics	Advantages	Disadvantages
Net Present Value (NPV) (McCready, 2005; Harvard Business School, 2002; Gama, 2006; Dos Santos, 1991; Silvius, 2006)	- Takes under consideration the discount rate.	- Does not give any indication about the project's magnitude and risk. - Discount rate can be hard to calculate.
Return On Investment (ROI) (McCready, 2005; Harvard Business School, 2002; Silvius, 2006)	- Perfect for one-to-one project comparison. - Commonly used. - Takes under consideration the cost of capital.	- Does not give any indication about the project's magnitude. - Requires vendors to share "sensible" information. - Can only compare project with the same level of risk. - Does not recognize when the cash flows take place.
Internal Rate of Return (IRR) (McCready, 2005; Harvard Business School, 2002)	- Identifies investments with irregular profits. - Takes under consideration the discount rate.	- Not easy to compute and understand. - Does not give any indication about the project's magnitude. - Assumes that the cash inflow from an investment is reinvested at the same discount rate. - Hurdle rate varies from company to company.
PayBack Period (PBP) (McCready, 2005; Harvard Business School, 2002; Gama, 2006; Silvius, 2006)	- Expresses the time it takes for an investment to reach the 'break even' point. - Separates, in terms of risk, long-term from short-term investments.	- Does not take under consideration the discount rate. - Does not give any indication about the project's magnitude. - No information about the investment performance after the 'break even' point.

		- Does not identify when the cash flows take place.
<i>Economic Value Added (EVA)</i> (McCready, 2005; Harvard Business School, 2002; Symons, 2005)	- CIOs analyze investment with shareholder's lens. - Easy to understand. - Simple methodology. - Calculation includes cost of capital charges.	- Cannot be used by organizations that are not publicly traded. - EVA is uncertain. - Cost of capital varies from organization to organization.

Risk analyses

In terms of sensitivity analysis, the gross sensitivity analysis reveals how sensitive the estimated ROI is to given changes in the considered variable.

In addition, stress testing consists of making an analysis of the extremes by calculating the worst/best case scenarios, and the baseline ROI is calculated by using expected values for all the variables used. Then, the ROI is recalculated by using, respectively, the smallest and the largest value for each of the variables (Stæhr, 2006; Ross, 2004).

The Monte Carlo simulation calculates the chances of success of the investment by using a normal distribution shape with a 95% confidence interval, which means that the probability that a value falls within 2σ (standard deviation) of the mean is 95%, so as to generate several scenarios through a random distribution of values, which belong to the area defined by the normal distribution curve (Hubbard, 2007; Ross, 2004).

To conclude, performing risk analyses by using a Monte Carlo simulation is less limitative than using stress testing or gross sensitivity analysis, because gross sensitivity analysis only changes the values of one variable at a time and stress testing places excessive weight on very unlikely outcomes (Ross, 2004; Rodger, Jason, 1999).

3.2. IT Investment Comprehensive Approaches

Since both IS and ITIL regard organizations/systems as people, processes and technology (a slight difference comparing to the Management Information System mantra: "organization, management and technology"), an ITIL implementation can be considered an IS project. Another reason why ITIL and IS are akin is the organizational change that is associated to them, as both of them transform the organizations where they are implemented (Laudon & Laudon, 2005).

As a result, the value of ITIL implementations can be estimated by using IT investment analysis comprehensive approaches because, similarly to any IS investment, ITIL investments can be controlled and measured (Ward & Daniel, 2005). And, for this reason, new methodologies that go beyond the traditional investment analysis focus on analysing the intangible benefits/costs (Violino, 1997).

It is important to analyse two well-know approaches: the benefits management approach and the Val IT framework, in terms of their main advantages and disadvantages so as to identify which situations are more favourable to one approach in detriment of the other. corresponds to the outcome of this comparison.

Table 2 – Comparison between IT investment comprehensive approaches.

Approach	Advantages	Disadvantages
Benefits Management (Ward & Daniel, 2005)	- CIOs are able to realize the benefits of IS investments. - Decision-making will be well-informed after the benefits management approach is accepted extensively. - IT and business become aligned. - Very detailed business cases.	- Creates organizational resistance. - Takes a long time to be effective. - Requires specialists to help with the change management process. - It is ineffective if not used in its full extension. - Not all benefits will be perceived.
Val IT (Symons, 2007)	- Active value management. - Very detailed business cases. - IT and business become aligned. - It is an extension of COBIT.	- Requires a mature IT governance framework to be in operation. - Not widely adopted so far. - Difficult to implement.

3.3. Comparison

These two approaches bring more long-term added value to the organization when compared to cost-benefit and risk analyses (Silva & Martins, 2008; Harvard Business Review, 1999). On the other hand, IT investment analyses have a longer learning curve and might provoke organizational resistance as they require an organizational mind-set change.

In conclusion, the type of analyses do not constitute a satisfactory solution for the problem, because they are not prepared to make an accurate estimative of the value of ITIL implementations as multiple complex variables specific to ITIL have to be considered. Nonetheless, these approaches provide background for the conception of an estimation process.

4. Proposal

In order to perform a cost benefit analysis, three actions should be included in the estimation process: determine the tangible and intangible benefits in addition to the project's costs, which embody the tangibility return of an investment, and determine the NPV (Silvius, 2008). Subsequently, an additional sensitivity analysis should be included as the previous variables are not deterministic and, therefore, are subjected to risks and uncertainty (Stæhr, 2006).

4.1. Estimation Process Description

The estimation process is represented by figure 2 and the following points explain each activity and sub-process in more detail.

- **Choose the processes:** the start event leads to the first activity of the process which is performed by the consultant. In this activity, the consultant determines which ITIL processes will be implemented. If a maturity survey occurs beforehand, the opportunities selection will be a lot more accurate because the consultant has more precise information about each ITIL process's maturity. Nevertheless, the ITIL maturity survey artefact is an optional input.

- **Choose the project's risk level:** the consultant chooses the project's risk level based on a risk analysis, which impacts greatly the benefits quantification process and investment analysis further ahead. The higher the risk is, the lower the benefits will be, and the investment is influenced as well, i.e. the higher the risk is, the higher the value of the investment will be. So, there is a downward revision of the benefits and an upward revision of the investment value, which is done on ad-hoc basis, for instance: by decreasing 10% of the benefits and increasing 10% of the value of the investment (Stæhr, 2006).
- **Input general client data:** the consultant inputs general client data, for example: the organisation's revenue, number of employees and working hours per year.
- **Quantify benefits:** "prior to implementing any process improvement initiative, processes should be measured and if possible assigned a monetary value" (Tiong, Cater-Steel & Tan, 2008). Therefore, in this sub-process the benefits are quantified by analyzing the general client data gathered in the previous activity, as well as KPIs specific to each process which can be found in official literature (Brooks, 2006; Steinberg, 2006), for example: the total number of incidents, estimated average time lost in an incident per employee, etc.
- **Compute total benefits:** the benefits are automatically quantified by the ITIL Value Estimator through the analysis of the data that is inserted in the "quantify benefits" sub-process.
- **More processes?:** this gateway consists of a decision-making point. If at least one process, from the ones that were chosen in the first activity of the estimation process, has not been processed yet, then the next phase is to analyze the next process on the waiting list. Otherwise, the next phase is to quantify the project's costs.
- **Quantify costs:** the consultant defines the discount rate and the percentage of operating costs that come from the investment over the years and the value of the investment, so as to determine the project's costs.
- **Perform investment analysis:** using the data gathered in the previous two activities, a financial analysis is made in order to assess the NPV, PBP and IRR of the investment. These values constitute the investment analysis report depicted as the output artefact of this activity.
- **Select number of trials to run:** in this activity the consultant selects how many scenarios will be used to perform a Monte Carlo simulation.
- **Correlate variables:** because some variables are correlated to others, i.e. "the state of one variable gives us the information about the likely occurrence of another" (Rodger, Jason, 1999), it is important not to ignore the correlations that exist between variables. Therefore, the consultant has to define the correlation coefficients between all the variables that enter the sensitivity analysis.

Perform Monte Carlo simulation: to finalize the estimation process, a Monte Carlo simulation on the project's ROI is performed. However, discovering the estimated ROI by using the expected values for the project's benefits and costs is generally incorrect because of non-linearity between the variables (i.e. they are correlated). In order for the ITIL Value Estimator to be more precise and, therefore, more reliable, it is important to perform a Monte Carlo simulation since it is mathematically correct if the chosen distributions for the variables are correct. According to the "central limit theorem", since the ROI results from the sum of several variables, there are strong arguments for choosing a normal distribution. The chance that the investment will compensate is calculated by counting the number of scenarios in which the user-defined breakeven line is reached. This activity is comparable to the certainty revenue which is one of the characteristics of an investment (Silvius, 2008).

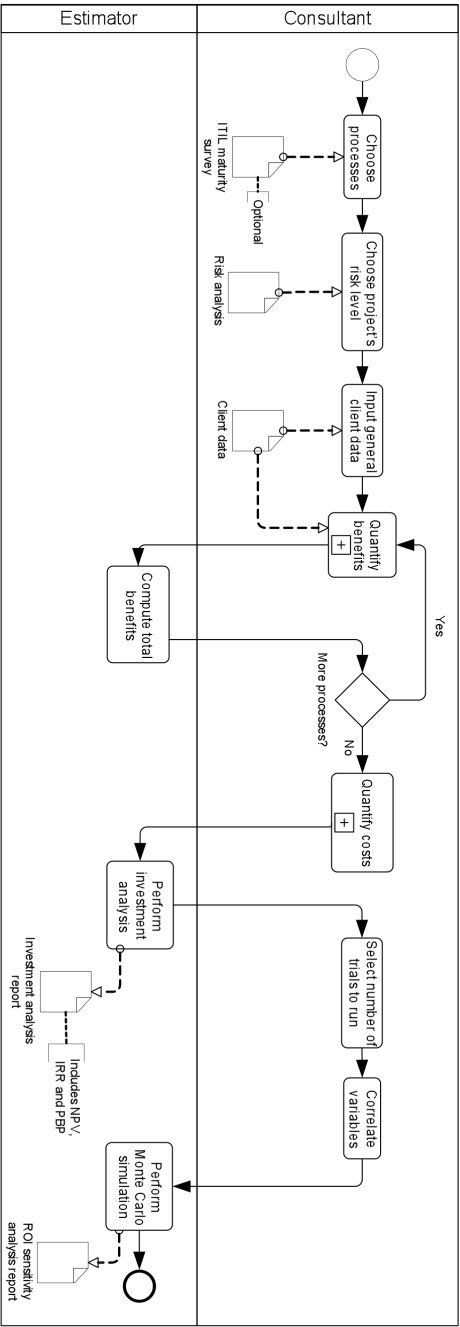


Figure 2 – ITIL value estimation process

5. Implementation

In order to realize the estimation process described in the previous section, a prototype was built with Microsoft Excel 2003 technology. Excel proved to be effective as it allows the prototype to be fully configurable, provides essential built-in functions that confer implementation flexibility as well as implementation speed, and allows powerful addIns to be incorporated into the ITIL Value Estimator.

5.1. Development process

The prototype's construction evolved at the same time as the development of the estimation process did, which was the result of several interactions (i.e. meetings) with practitioners, insights from ITIL experts, and contributions that were introduced as a consequence of further scientific investigation. Therefore, the development process was agile.

5.2. Benefits Quantification Synopsis

The quantification of the value of each KPI is the result of human reasoning, which means that the estimation process must be prepared to accept modifications to the benefits quantification sub-process, in order to be easily adapted to the user's *raison d'être*.

Finally, the logic of the benefits quantification sub-process can always be challenged because it is hard to give each KPI a monetary value, despite the fact that they still can bring value to the process under analysis, as ITIL can be a business need, for instance: clients can demand suppliers to have ITIL best practices embedded into their organization, which supports the statement that an improvement in the maturity of one or more processes or the savings gained from improved KPI values, which are typically hard to quantify, bring value to the bottom-line of the organization.

5.3. Evaluation Methodology

The evaluation methodology varies according to two distinct situations: when only one process is considered for the estimation process or when multiple processes are considered.

Several questions have to be answered in order to evaluate one process:

- Which metrics are the most relevant during the benefits quantification sub-process?
- Is the logic of the KPIs challenged by the practitioner or ITIL experts?
- Until what point is risk consequential?
- Do the correlations between variables affect the result? How?

On the other hand, the evaluation methodology for several processes is focused on the consequences that derive from the dependencies that exist between processes and, consequently, the benefits adjacent to the correlation coefficients attached to these dependencies.

5.4. Action

Incident management process simulation

A simulation using real KPIs' data was performed in a Portuguese state/public organization which implemented one ITIL process, the incident management process, for a period of one year.

In order to determine the real value of the incident management process it is necessary to retrieve reliable data directly from historical data and introduce it into the prototype, in order to perform the investment analysis as well as the Monte Carlo simulation. The estimated value of one or more processes is then calculated by introducing input data regarding the forecast values of the KPIs and other data, which were determined by the practitioner.

So, in this way it is possible to compare the estimator's effectiveness in a past project by comparing that project's real value and estimated value.

Simulation with multiple processes

A theoretical simulation with several processes was performed so as to evaluate the value of the correlations that exist between processes. The following tests were performed:

- With correlations that exist between the processes and between processes and investment costs.
- Without any correlations.

Four processes were considered and each one creates € 100.000 of benefits and the project's overall investment is € 500.000, which means that the ROI mean value is -20%. The purpose of this simulation is to realize if the correlations that exist between processes pay off the superior project's investment costs or not.

5.5. Results

Incident management process simulation

The KPI "number of incidents" has a devastating influence over the benefits quantification outcome in the simulation with estimated data with 93,31% of the monetary benefits. In contrast, the simulation with real data confirmed the existence of two high-impact KPIs, "percentage of incidents resolved without breaching one SLA" and "percentage of calls 1st line support bypassed", with 49,07% and 40,22%, respectively.

Therefore, some of the other KPIs proved to be irrelevant, but those KPIs whose percentages are linearly dependent on the "percentage of time that impacts employee productivity" could have more impact on the final result, if this percentage was set to a higher value.

So, the KPI "number of incidents" unleveraged the results of both simulations. In fact, the estimated value for this KPI is the outcome of a meeting with ITIL experts and the target organization's practitioner which challenged the benefits quantification. Hence, this KPI is included only in the benefits quantification of the simulation with estimated data because no real data was available at the time.

Taking a look at the risk, it influenced greatly the financial metrics included in the financial analysis. Thus, when the risk increases, the NPV and IRR decrease and the PBP increases.

Lastly, a higher level of a negative correlation between variables is associated to higher values of variance, standard deviation and skewness, which means that the Monte Carlo

simulation trials tend to be more dispersed if there are negative correlations between the variables considered.

Simulation with multiple processes

Even though the correlations might not pay off the superior project's investment costs, there were more positive ROI scenarios in the Monte Carlo simulation with correlations than in the one without correlations, which is caused by the fact that the standard deviation, variance and skewness are higher in the simulation with correlations than in the one without, and this causes the trials to be more dispersed in the simulation with correlations.

6. Evaluation

6.1. Incident management process simulation

The simple fact that different KPIs were utilized in the two simulations influenced greatly the effectiveness of the estimator itself.

As a consequence, different quantification logics were applied in both simulations, for instance: some KPIs are based on the employee productivity whilst others are based on the cost per incident, which is calculated by dividing the IT total costs by the total number of incidents in a period of one year. On the other hand, the employee productivity is the result of the division of the revenue by the total number of employees.

Using different forms of quantification isn't necessarily incorrect. On the contrary, it makes the estimator more correct as both forms are valid and should be taken under consideration, since the cost per incident is focused on cost reduction and the employee productivity is driven towards productivity gains.

Also, in view of the fact that the risk's influence over the investment analyses is enormous, it is important that the risk analysis is performed carefully and with the help of risk experts.

6.2. Simulation with multiple processes

When the correlations amongst processes are considered in order to perform a Monte Carlo simulation, there are higher chances of more positive ROI outputs being generated as a consequence.

It is important to consider the correlations that exist between processes as some potential generated outputs and, therefore, the client can be elucidated about the potential of large scale ITIL investments. Therefore, the benefits generated by a single process are considerably less due to the fact that the positive correlations between processes are not included in the Monte Carlo simulation.

To conclude, the estimation process can be re-factorized by making the following changes:

- Due to the fact that multiple interactions with the client must occur so as to improve the benefits quantification logic, the "benefits quantification" sub-process becomes cyclical.
- In case of a project with multiple processes, the dependencies between these should be checked in order to correlate the processes and, therefore, a gateway should be placed after the "select number of trials" activity.

7. Conclusion

The value of ITIL is a much discussed subject these days as reducing IT costs, increasing IT performance and, at the same time, improving business performance through IT-business alignment are vital for any organization.

The related work provided enough insight to create an estimation process for assessing the value of ITIL implementations. An important acumen to be added is that ITIL investments impact dramatically the business processes' efficiency as well as the business goals' effectiveness. For this reason, the estimation process incorporates into its logic the investments' impact, plus the tangible and intangible benefits quantification as well as project's investment costs and, lastly, the risk assessment of the investment which is the ultimate outcome of the estimation process.

The estimation process was tested with data retrieved from a project that consisted of implementing the incidents management process in a state organization. The main results were that only a few KPIs have a great impact on the final benefits quantification and the project's risk has a great influence over the investment analysis and the ROI Monte Carlo simulation.

Furthermore, a theoretical exercise was performed so as to evaluate how the interconnections between processes affect the overall project's ROI. The results were revealing as the project's mean ROI can be negative but, given the fact that those processes are interconnected and interdependent, the benefits are heightened, which ends up making the investment more attractive.

7.1. Future Work

Knowing that ITIL processes depend on each others, specifying the correlation coefficients between two processes is a way to include those dependencies into the estimation process, and these correlation coefficients can be derived from statistical analyses of past data or be suggested by experts. In fact, those correlations can be defined by comparing two experimental data sets, which are derived from the level of dependency that exist between processes, by using several mathematical methodologies such as the Pearson's correlation coefficient, or by associating the Pearson's correlation coefficient with the rank order coefficient (Rodger, Jason, 1999).

Another topic that needs further research is when a major operational change takes place in the IT function, for instance, when the IT department adopts a charge-back methodology for the incident management process, meaning that the IT department charges a certain amount of money per incident according to the incident's complexity and urgency. This change implies that a new KPI has to be created and quantified, but there is no way to compare the as-is with the to-be situation because the KPI is not considered in the benefits quantification before the charge-back adoption takes place. So, it is necessary to further study how these changes, whatever their range is, impact the value of ITIL implementations and, specially, what is the best way to compare the as-is with the to-be situation.

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Improving ITIL processes using a Lean Methodology

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Abstract: Many companies around the world have already implemented ITIL as a way to manage and control their IT Departments more effectively. These companies are now willing to improve their ITIL processes in order to become even more efficient. Lean is a methodology that can be used to conduct these improvements and its application in the IT Services area is becoming increasingly popular. The initiatives taken to improve ITIL processes using Lean have some limitations as they do not address all Lean's principles and goals. In this paper we propose a framework that addresses all the principles and goals and that can be used to improve ITIL processes. The framework is being applied in a Portuguese Public Organization and the results are presented and discussed in this paper.

Keywords: Lean; ITIL; IT Services; improvement; framework; costumer; value; waste; quality; quickness

1. Introduction

ITIL is a framework of best practices for delivering IT Services. It was developed by the British Government during the 1980s trying to increase efficiency, value and success in the delivery of programs and projects in the public sector. Over the years, ITIL became popular and, nowadays, its credibility is highly recognized. Its practices are aligned and have contributed to the ISO 20000 Service Management standard, the first international standard for IT service management (Reiner, 2007).

In order to guarantee a better quality of service, lower costs or to achieve a better alignment between business and IT, organizations have been implementing ITIL processes in their IT Departments (Greenever Systems, 2006). When the implementations are successful, the results are usually positive, but that must not be the end of the road. As ITIL v3 states, after implementing the processes, they must be continuously improved to steadily increase efficiency. Furthermore, business itself is not static, and IT processes must evolve at the same pace in order to effectively support it and remain aligned with it. However, conducting improvements isn't easy (Van Bon & Pieper & Veen, 2006) and ITIL literature just suggests some methodologies that can be used to do so.

In this paper we suggest and evaluate a framework, based on the Lean methodology, which can be used to guide ITIL processes optimization.

Lean is a methodology to organize, manage, develop and improve business processes with the aim of doing more with fewer resources. It emerged after the World War II in Toyota's

manufacturing environment, however, in the last few years, it has been applied in the services industry (Fillingham, 2008).

Lean is based on the principles of specifying value, mapping the value stream, enabling continuous flow, pull strategies and pursuing perfection. Following these principles enables quicker and more flexible processes allowing the delivery of services with higher quality and more value to the costumer (Sayer & Williams, 2008). In this paper, the expression *value* is used to describe any feature or service for which the customers would be willing to pay for.

The framework is being applied in a Public Portuguese Organization and the achieved results are presented and discussed at the end of this paper.

2. Problem

Many companies have already implemented ITIL processes in order to enhance better results from their IT departments. The benefits are usually high but as ITIL v3 states, it is important to keep improving the processes, always aiming to provide IT Services with higher quality and efficiency. On the other hand, IT Departments can no longer be isolated silos in the organizations. They must be completely aligned with business in order not only to support it, but also to improve it (Peynot, 2007). Still, business is not static, and it needs to be adapted as a response to market needs or to exploit a business opportunity that has arised. As business is not static, IT Services can't be static either.

The problem is that often managers do not know how to improve their IT Department's processes (Peters, 2008). ITIL books define which processes should exist, how they should interact with each other and which metrics can be used. They also define which steps are relevant for the Continual Service Improvement process (OGC, 2007):

- Define what you should measure
- Define what you can measure
- Gather the data
- Process the data
- Analyze the data
- Present and use the information
- Implement corrective actions

However, these steps are no more than a very high level strategy for process improvement. There are no references to tools and procedures that can be used.

Understanding what can be improved is not simple and conducting the improvements is even harder. In fact, the amount of changes to introduce can be extremely high and according to Laudon's framework they can be organized as following (Laudon, 2007):

- Organizational changes
 - New organizational structure for IT departments
 - New skills demanded for IT employees
 - New activities and processes
 - Different ways to perform old activities
 - New perspectives of how IT supports and enables business
- Managing changes
 - New metrics and indicators to analyze
 - New SLAs
 - Higher expectations for IT Departments and services
- Technological changes
 - New software

- New hardware

Implementing technological changes should not be too hard as IT staff is usually highly skilled in this area, however, organizational and managing changes represent a big challenge due to people's intrinsic resistance to change (Peynot, 2006). It is important to understand how this resistance can be mitigated, assuring that a process can effectively be improved and that once it was, there is no coming back. But once again, ITIL does not address these topics, providing little guidance to IT managers. In the current panorama, only experienced consulting firms can effectively assist organizations in ITIL deployment and process improvement (Peynot, 2006).

3. Related work

Some efforts have previously been taken in order to improve IT processes using a Lean methodology.

3.1. Fujitsu – Sense and Response

Fujitsu is a multinational company, providing IT services to more than four hundred clients in the areas of financial services, telecommunications, utilities and government markets. They were facing some problems, being the following the most relevant (Parry, 2004):

- Clients were not satisfied with the provided services and were looking for another service supplier.
- There was a constant need to acquire new clients to replace the ones that were being lost
- The Call Center Service was performing at a low level

In order to solve these issues, Fujitsu decided to develop a Lean based methodology which should firstly be applied to their Call Center Service. The objectives were simple: to provide a better service, increasing their direct and indirect customer's satisfaction level. The methodology consisted in four distinct phases:

- Phase 1 – Learning to Sense
 - See the organization from customer's perspective
 - Evaluate the value chain
 - Understand front-line roles and responsibilities
- Phase 2 – Learning to Respond
 - Re-educate management
 - Replace Push system by Pull system
 - Replace mass production systems by lean production
- Phase 3 – Leading Change
 - Use transformation leadership theories
 - Employ cognitive behavior methodology
 - Operate within leadership and coaching frameworks
 - Award staff with accreditations
- Phase 4 – Mobilizing
 - Provide detailed change programs to transform corporate infrastructure
 - Design plans for mobilization

The results of its first application were quite positive:

- First-contact fix increased 64%
- End-to-end service cycle reduced 60%
- End-to-end service costs decreased 30%

- Customer's satisfaction increased 28%
- Employee satisfaction increased 40%

Critical Analysis

Analyzing the proposed methodology, one can realize that most Lean principles and goals are addressed. In fact, just the continuous flow principle couldn't be found. Yet, this methodology has some limitations:

- When this methodology is applied to a new service, a new set of metrics must be defined. There is no reference to the usage of standard metrics, based in best practices, for the targeted service. This activity may then represent overproduction waste, while possibly not producing the best metrics.
- As there is not a base architecture to structure the organization/department where this methodology is being applied, it might take a while until the best one is found.
- This methodology can only be taken into practice by highly experienced professionals in the targeted services industry.

These issues support the fact that nowadays only experienced consulting firms can effectively assist organizations in IT processes improvement. Furthermore, as it does not take industry's best practices into consideration, there is the risk to waste time redefining metrics and organizational structures.

3.2. Infosys – Applying Lean to optimize ITIL v3 Event Management process

After implementing the ITIL v3 Event Management process, an organization was taking significant efforts towards monitoring alerts triggered by applications. Service Desk was overwhelmed as it was their responsibility to handle these alerts. Infosys was asked to analyze and solve this problem (Nand & Changanty, 2008). The main issues and goals identified are stated in the following table:

Table 1 – Main issues and associated goals

Main Issues	Goals
Significant non-value adding monitoring efforts	Reduce monitoring efforts. Automate manual activities
High probability of missing critical alerts	Improve ability to detect and address critical alerts
Crowded alert interface	Cleaner alert interface

Several alerts were no more than waste and they should be eliminated. In order to do so, a Lean approach was taken, consisting in three phases:

- Phase 1 – Analysis
 - Map the Value Stream
 - Collect data
 - Identify waste
 - Validate waste identification with application groups
- Phase 2 – Business Case
 - Develop a business case (effort/savings)

- Determine the implementation requirements
- Phase 3 – Implementation
 - Setup implementation team
 - Implement changes
 - Validate the achieved results

With this approach, Event Management efforts were reduced by 44%. Classifying the eliminated waste accordingly to the 7 kinds of waste:

- 32% inventory
- 24% processing time (redundant alerts)
- 13% waiting time (alerts performing reminder service)
- 11% product defects
- 10% overproduction
- 5% motion
- 5% transport

Critical Analysis

Once again, this approach takes into consideration most Lean principles and achieves quite positive results. There is, however, one aspect that is important to address: the non identification of end users and their expectations. It would be important to understand how each alert influences or contributes to the productivity or satisfaction of end users. IT staff may think that some alerts are crucial while the actions triggered by those alerts may not represent value to the final customer. As a result, some waste may have not been identified and removed. On the other hand, this may represent an opportunity to further employ a customer-pull strategy, where end users can actually ask for the kind of actions they consider valuable.

3.3. Reflection

Through the analysis of these examples it is possible to realize that Lean may be used in the IT services area. Although the achieved results are significantly positive, these approaches still need to reach a higher level of maturity in order to fully explore Lean's potential. As a standard framework does not exist to be followed, when taking Lean initiatives it is hard to address all its principles and goals.

4. Proposal

In order to guide ITIL processes optimization, a framework is proposed in this paper. The framework is based on the Lean methodology and addresses all its principles and goals. The following diagram represents the application of the framework in practice:

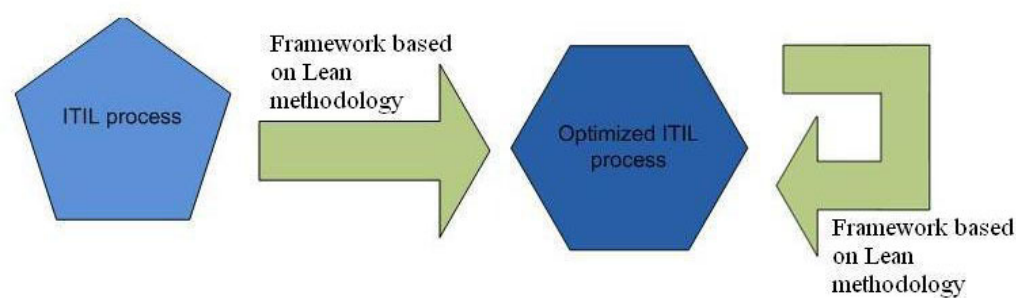


Figure 9 – Application of the framework

The framework can repeatedly be applied to an ITIL process in order to constantly improve it. As Lean states, there is always waste to eliminate. It is based on the Plan-Do-Check-Act cycle and consists in six phases, as represented in Figure 2. In the following sections the framework will be explained in detail.

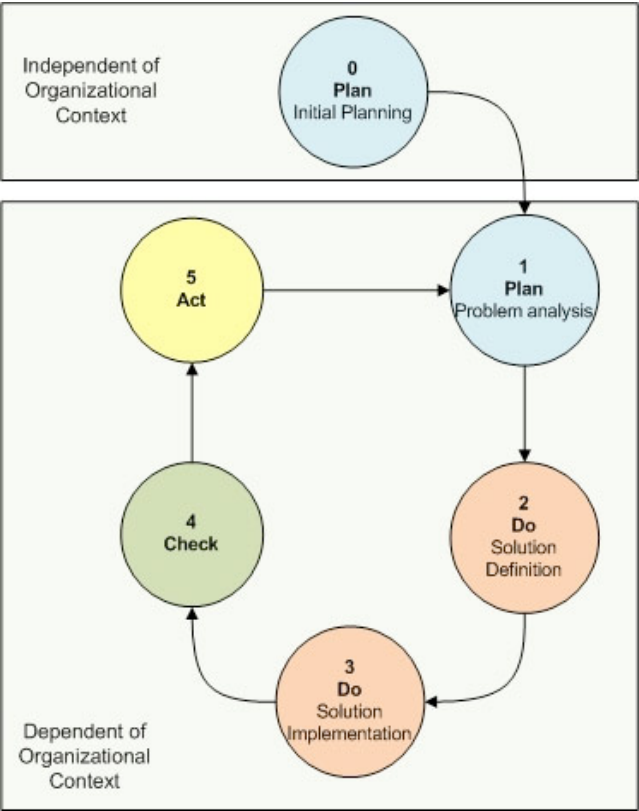


Figure 10 – Framework Phases

4.1. Plan – Initial Planning

The objective of this phase is to assess and understand ITIL best practices towards the process to be improved. It consists in three activities:

1. Define relevant metrics for the process – metrics are needed in order to quantitatively evaluate the process. They can be found in ITIL books, papers and case studies.
2. Map a desirable to-be Value Stream – Value Stream Maps are a graphical representation of the process, including the sequence of activities that compose it and quantitative information about them. This Value Stream map should represent a perfect process where Non-Value-Adding activities should only be present if they are considered essential. By reading ITIL literature it is possible to define it, as there is a detailed description of each process.
3. Define tools to capture the Voice of the Customer (VOC) – The Voice of the Customer represents the user's expectations towards the outputs of the process. In order to capture this information there is the need to develop inquiries and interviews. With these tools, it must be possible to understand the current level of user's satisfaction and which features truly represent value to them.

4.2. Plan – Problem analysis

This is the first phase that is depended of the organizational context. It is composed by eight activities, which contribute to fulfill different objectives:

- Understand the as-is state of the process
 1. Map the as-is Value Stream – Observe the process where it takes place (Gemba Walks) and create a diagram with the sequence of activities that compose it. Gather quantitative information about each activity.
 2. Quantify the previously defined metrics – Using the metrics defined in the first phase (the ones that are suggested in ITIL), try to quantify them. It may be relevant to search for data in logging tools, records or statistical information about the process. If it is possible/needed, observe the activities being performed in practice in order to measure and capture data.
- Identify process costumers and their needs
 3. Identify process costumers – They are the reason for a process to exist and it is important to understand who they are. They can be identified by observing the process outputs. Everyone who is receiving these outputs is a process customer.
 4. Capture the Voice of the Customer – By performing the inquiries and interviews, it becomes possible to capture the customer's expectations. Afterwards, using Kano's Model, they can be categorized into Basic Needs, Performance features and Excitement features, assuming different levels of importance in the process.
 5. Identify Value-Adding (VA) and Non-Value-Adding (NVA) activities in the as-is Value Stream – With the as-is Value Stream already mapped and the customer's expectations categorized, it is now possible to classify all the activities in the process as VA or NVA. For each activity answer six questions (5 Ws 1H): What, When, Why, Where, Who, How. With the answers, it becomes possible to comprehend the impact that each activity has in process outputs. If an activity enables a feature that represents value to the costumers, then it is considered as a Value-Adding activity, otherwise, it is considered Non-Value-Adding.
- Definition of a possible to-be state for the process

6. Map a possible to-be Value Stream – This Value Stream represents a state for the process that is possible to achieve on the short term. Conduct brainstorming sessions (Kaizen workshops) with process managers and collaborators. Introduce them to relevant Lean tools like the 7 kinds of waste, value stream maps or spaghetti diagrams (Schonberger, 2007). Analyze the as-is Value Stream Map searching for waste. Define a short term to-be Value Stream Map, which is an improved version of the current process. Use the desirable to-be Value Stream Map, defined in the first phase, as a reference.
- Identify the Gap between the as-is and the possible to-be state
7. Identify the Gap between the as-is and the possible to-be Value Stream – The purpose of this activity is to create charts and tables to quantitatively compare the as-is and the short term to-be state. Spider charts and Box Scores might be appropriated tools to be used.
8. Identify causes for the existing Gap – With the Gap documented, it is important to understand the reasons for its existence. Why is the process performing at this level? Which are the most relevant issues? These are the questions that is important to get answered. Fishbone diagrams may be useful for this analysis.

4.3. Do – Solution Definition

The objective of this phase is to determine how to achieve the possible to-be state. There are two activities that need to be performed:

1. Brainstorming Sessions (Kaizen workshops) – Once again, it is important to perform brainstorming sessions involving process managers and collaborators. The purpose is to define the set of actions to implement in order to achieve the possible to-be Value Stream. It may be important to turn things more visual or to automate some manual activities, however, the range of actions to implement will always depend on the kind of improvements to introduce.
2. Define a detailed plan of actions to implement – In this activity, it is created a schedule for the implementation and its scope is determined: Pilot trial or Global scale? The answer depends on how risky are the changes to introduce.

4.4. Do – Solution Implementation

The objective of this phase is to implement all the actions defined in the previous phases. It is important to explain to everyone involved why the process is changing and how it is supposed to be in the future. People may try to resist, therefore it is crucial that managers get involved in the implementation.

4.5. Check

In this phase the new state of the process is assessed. The goal is to understand if the previously defined state was actually achieved. Consequently, there are four activities that must be performed:

1. Map the new as-is value Stream – Once again, observe the process where it takes place (Gemba Walks), build a new activities diagram and gather information about them.
2. Quantify the metrics with their new values – In order to evaluate the variation in process's performance, the metrics must be quantified with their new values.

3. Perform customer satisfaction surveys – With the results of these surveys it is possible to gain some insight about customer's reaction towards the implemented changes.
4. Compare the new as-is state with the previously established possible to-be state – To understand if the possible to-be state was achieved there is the need to compare it with the new as-is state. Everything must be identical: the Value Stream Map, metric's values and user satisfaction level. Otherwise, there is the need to go back to the second phase and retake all the activities.

4.6. Act

When this phase is reached, it means that the process has improved accordingly to the plan. It is now time to define a set of standards to guarantee that the implemented changes will prevail:

1. Define new standards for the process – If new standards are not defined, the process will probably return to its previous state and it becomes harder to control it. If there is a new workflow it must be described in standards, as well as new values for the metrics or new roles and associated responsibilities.
2. Define a mechanism to periodically control the process's performance – Establish the periodicity for Gemba walks and metric's assessment.

5. Evaluation

In order to evaluate the proposed framework, it is being applied in a Portuguese Public Organization. The targeted process is the ITIL v3 Incident Management and the initial focus was the Service Desk, which is responsible for the first line of support. During the Initial Planning phase, a desirable sequence of activities for the process was defined, being represented in figure 3.

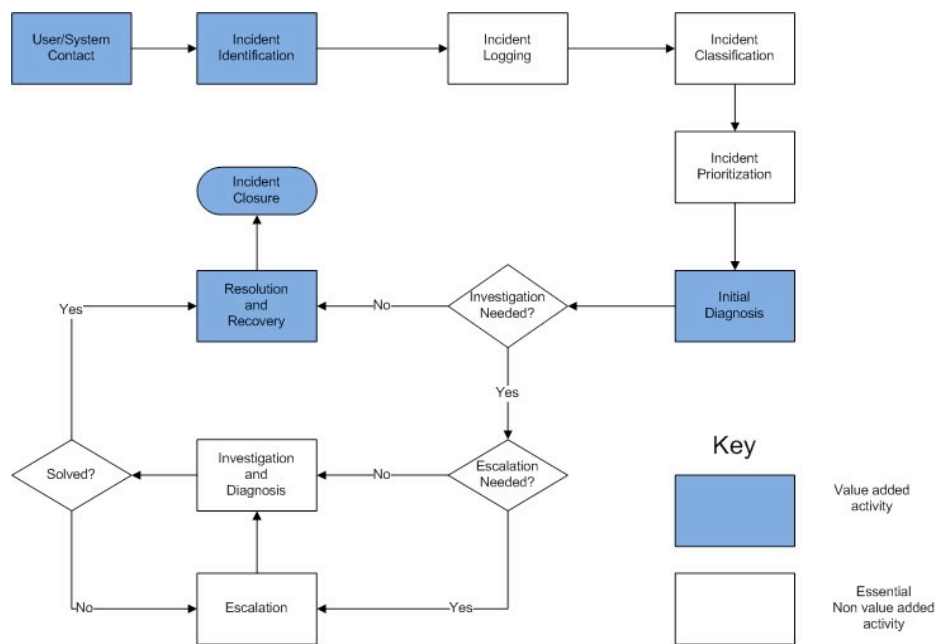


Figure 11 – ITIL v3 Incident Management Process

During the Problem Analysis phase the as-is state of the process was assessed being its sequence of activities described in figure 4.

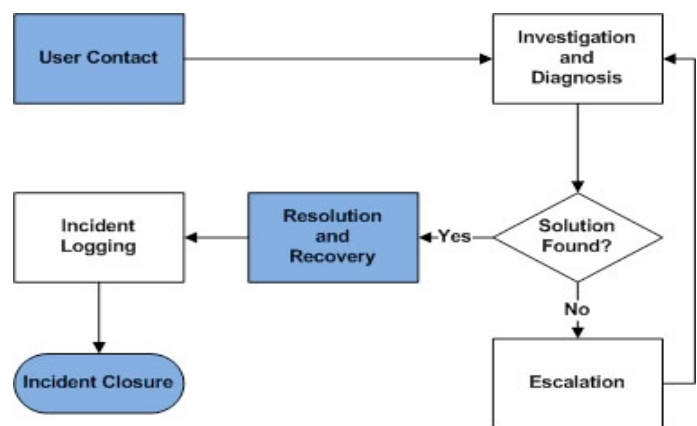


Figure 12 – Perceived Incident Management Process

The users can contact the service desk using phone, email or Windows Messenger. Additionally, there is a software application which is able to support the process as it is described in ITIL. The application is also able to automatically inform users, providing them feedback about their incidents. However, as it is possible to perceive, the process was still distant from its desirable state. The most relevant issue was the Incident Logging activity which was being performed only after incident resolution. In addition, only about 50% of the incidents were being logged. The consequences were enormous:

- 1. It was impossible to prioritize pending incidents
- 2. There was a policy of First In, First Out
- 3. Users had no feedback about their incidents
- 4. There was the risk to miss incidents

During the brainstorming sessions, it was defined that those were the first aspects to be improved. Therefore, a possible to-be Value Stream was defined, including the Incident Logging activity right after the User Contact and a 100% percentage of logged incidents. Through Gemba Walks it was possible to understand why the Gap between the as-is and the possible to-be state existed. It was a typical situation of change resistance, were the service desk elements were not performing the process as they were told to. During the following brainstorming sessions, which included Service Desk elements, it was decided that there was the need to create a new role: the Scheduler. Its responsibilities would be to answer the phone, read the email, log the incidents and assign them to a technician in order to be solved.

5.1. Results

The changes were implemented in February of 2009 and the results were immediate. The incidents started to be logged right after user contact and nowadays 100% of the incidents are logged. Moreover, the average number of emails in the inbox decreased from an average of 4 into 0. This means that users are getting a faster response to their problems. The scheduler is also able to perceive the resolution state of each incident, being capable of distribute the workload more effectively among the Service Desk elements.

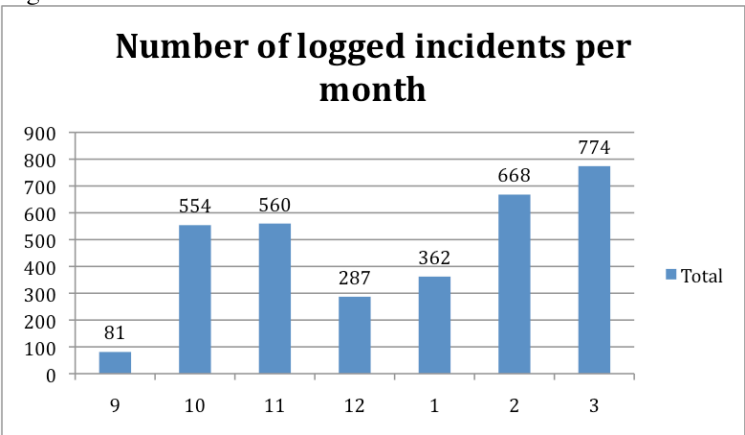


Figure 13 – Chart representing the number of logged incidents per month

Figure 5, represents the number of logged incidents since September of 2008 until March of 2009. As it can be seen, the number of logged significantly increased in February and March.

6. Conclusions

After analyzing the related work and the results obtained with this framework, it becomes clear that Lean can effectively be used to improve IT processes. Several iterations of this framework should be performed in order to introduce small changes in each one. If one tries to improve everything at once, it is more likely to fail, as the risk and the people’s resistance to change will

be higher. Performing the purposed brainstorming sessions contributes to reduce the resistance to change as everyone has the opportunity to contribute to the definition of the solutions to implement. Moreover, it is a way to improve IT processes in a way that meets costumer's needs and expectations.

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INMATE– Innovation Management Technique: an Innovation Management tool with emphasis on IT–Information Technology

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Abstract: The main objective of this paper is to present an innovative tool for innovation management with emphasis to the information technology-IT management called **INMATE–Innovation Management Technique**. In order to arrive at this tool an analysis on the current market tools was conducted. This analysis observed that none of the existent tools gives the due importance to the role of information technology-IT for the innovation process. In this way, the paper presents a brief discussion of two of these market tools: an international, called TEMAGUIDE, and a Brazilian, called NUGIN. Then the paper introduces the INMATE tool with its main dimensions. Next, the paper gives detailed account on how the IT management is dealt inside INMATE, which is done via the concept of *Enterprise Architecture*, a concept from the Computing Science and Engineering. From this concept the paper presents a methodology, in an analogy to the *Structure-Conduct-Performance* Paradigm (that is traditionally used on the empirical market analysis), which identifies the firm according to three linear connected approaches: its *architecture*, its *governance*, and its *growth strategy*.

Keywords: JEL Classification: L23- Organization of production; L25- Firm performance: size, diversification and scope; L86- Information and Internet services; Computer software; M15- IT management; O32- Management of technological innovation and R&D.

1. Introduction

Nowadays is practically impossible not to deal with technology and innovation. Despite the vast amount of technology tools at our disposal, every day one sees the emergence of innovations turning obsoletes the tools we have been used to.

In this way, the management of *innovation* ⁽¹⁾ is becoming a business imperative. This condition was the main reason for the development of a research that could analyse an innovation management tool which could be simultaneously simple, fast e effective. Hence, some available tools have been assessed in order to benchmark one tool which could generate simplicity, speed and effectiveness, and more than that, it could fit to the current technology and innovation new environments, mainly to the Web 2.0 and Web 3.0 business environments.

Amongst the analysed innovation management tools one aspect called the attention: despite the current importance of the information and communications technologies, none of those tools pays

¹¹ Innovation of a *product* (good or service) or a *process* (technological, organizational, or marketing), as proposed by the OECD Oslo Manual, 2005.

the due attention to the role of these technologies to innovation. Therefore, it seemed reasonable the development of a new innovation management tool with a competitive differential in its emphasis on the information technology- IT management. In other words, a tool which paid attention to the impact of: the information content management, the information systems management, and the information and communications technology management, on the technological and organizational internal choices of the innovative firm, organization or institution.

This paper is divided into five sections. Section 2 briefly presents an international innovation management tool called TEMAGUIDE. Section 3 presents some aspects of a Brazilian innovation management tool called NUGIN. Section 4 introduces the INMATE - Innovation Management Technique, a tool conceptualized and developed by this author whose main competitive differential is its emphasis on the information technology - IT management. Section 5 presents how the information technology management is dealt inside the INMATE tool. This section is subdivided into two sub-sections: the first shows the concept of Architecture, and the second introduces the methodology of *Architecture-Governance-Enterprise Growth*, also developed by the author. Finally, section 6 presents the final conclusions.

2. TEMAGUIDE: an international innovation management tool

Within the arena of the international innovation tools it is worthwhile mentioning the **TEMAGUIDE** tool. TEMAGUIDE, a contraction of the words TEchnology MAagement and GUIDE, is the result of a research conducted by a group of European organizations, such as Fundación COTEC (Spain), coordinator of the project, SOCINTEC, CENTRIM (from the University of Brighton, United Kingdom), IRIM (from the University of Kiel, Germany), and the Research and Development Unit of the Manchester Business School (United Kingdom). The project was financially backed by the Innovation Programme (Directorate General XIII), of the European Commission.

The basic structure of the TEMAGUIDE project contains three components: a) a description of the Technological and Innovation Management aspects from the business perspective. Its proponents look at it as being more than a description; they see it as a model that can be used either at a practical level for managing the innovation process or at an strategic level for ensuring that the Technological Management is completely integrated to business and gets the praise it deserves; b) a set of tools for assisting in specific activities of the Technological Management and the promotion of Technological Management as an important aspect of the practice of good businesses; c) a set of study cases that illustrates problems, needs and solutions from typical enterprises. These components are shown in Figure 1.

By considering that Technology Innovation is not something only related to innovating with success once or twice, but rather about frequent innovations and improvements, in other words, about enterprise *innovativeness*, TEMAGUIDE recommends a simple conceptual framework (or model) which facilitates this *innovativeness* approach. The model is based on five elements that remind the enterprise what frequently needs to be done in different points in time, and in different kinds of situations: SCAN (indicating a scan of the environment in search of signs of needs for innovation and potential opportunities), FOCUS (expressing attention and efforts in a particular strategy for business improvements and innovation, or a particular solution for a problem), RESOURCE (showing that it must allocate resources in that strategy and prepares for what it is necessary to do to make that solution works), IMPLEMENT (pointing to the implementation of

the innovation), and LEARN (indicating learning from the success experience or failure), as it is shown in Figure 2.

These five elements of the model can be supported by tools and techniques of a diversified nature, such as: a) External Information (Market Analysis, Technological Forecast, Patent Analysis, Benchmarking), b) Internal Information (Ability Auditing and Innovation, Intellectual Property Management, Environmental Assessment), c) Joint Work (Interface Management, Networks, Team Formation), d) Ideas and Problem Solution (Creativity, Value Analysis), e) Efficiency Improvements (Flexible Learning, Continuous Improvements, Change Management), e Other Techniques.

TEMAGUIDE has been publically available since 1998 e it is well recognized in the world of technological innovation management. Further details about TEMAGUIDE can be found at <http://www.cotec.es>. Despite being comprehensive, TEMAGUIDE does not pay the due importance to the role of information technology in its conceptual design, even in the reported cases of its implementation.

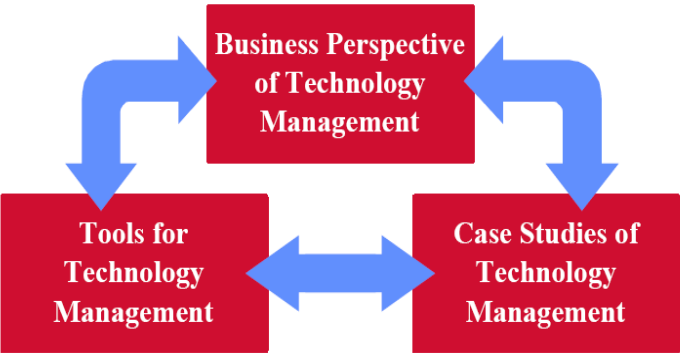


Figure 1

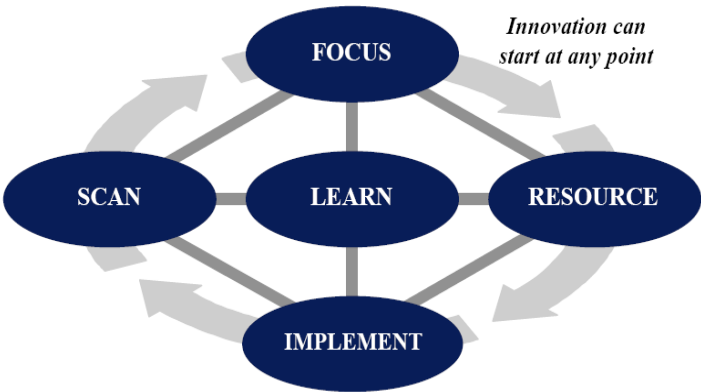


Figure 2

3. NUGIN: a Brazilian innovation management tool

This section briefly presents a Brazilian tool that has been recently developed called **NUGIN**. The word NUGIN is a contraction of “*Núcleo de apoio ao planejamento de Gestão da Inovação em empresas de pequeno e médio porte*” (Nucleos for supporting the planning of innovation management for small and medium size enterprises), a project that had been proposed by the IEL/SC (Instituto Euvaldo Lodi/Santa Catarina), which is part of FIESC/SC System (Federação das Indústrias do Estado de Santa Catarina), in partnership with the UFSC (Universidade Federal de Santa Catarina), by means of the NEDIP (Núcleo de Desenvolvimento Integrado de Produtos), from the EMC/UFSC (Departamento de Engenharia Mecânica da UFSC), the IGTI (Núcleo de Estudos em Inovação, Gestão e Tecnologia da Informação) and the EPS/UFSC (Departamento de Engenharia de Produção e Sistemas da UFSC).

The NUGIN methodology, as described by Coral *et alli*. (2008) is based on the following assumptions:

- a) Innovation must be a systematic and continuous process;
- b) Adaptable to small and medium sizes enterprise;
- c) Valuation of learning;
- d) Valuation of intellectual capital;
- e) Systemic vision;
- f) Valuation of communications and relationships;
- g) Innovation is a fundamental element for competitiveness.

This methodology, presented in a descriptive format in Figure 3, has the objective to promote innovation within the enterprise by doing systematic identification of opportunities, ranking projects, developing technologies, products and processes, and the return of this effort to the enterprise.

Its implementation starts with the *organization* for innovation, seeking to identify the enterprise capacity for innovating in products and processes. From there, one must establish an innovation management cell (*nucleous*) within the organization. The *strategic planning* of the innovation is the result of the corporate planning of the enterprise, which analyses technology and market aspects. The *product development* process comprehends several aspects since market research until the disposal or inactivation of the product, passing by the product and process design. The *competitive intelligence* involves all the other phases of the model, having its functions conducted in all the innovation process.

These aspects of NUGIN's methodology, however, are also the elements that define its limitations. The methodology is not based in a proper justification for innovation; i.e., it takes for granted the need for innovation and seeks to structure the necessary knowledge for its implementation. It does not also departure from criteria that could point to the context in which the need to innovate (and where to innovate) expresses. In this way, it is difficult to perceive, *ex ante*, when the established tool ceases to contribute for the innovator's performance. Furthermore, the methodology is essentially geared to the innovation management of goods (nothing is said for innovation issues in services products) in ongoing enterprises, and it does not provide any guidance for start ups or spin-off firms. Besides, by looking at the description on Coral *et alli* (2008), few is said in terms of intellectual property and funding concerns in dealing with innovation. Additionally, as the case of the TEMAGUIDE tool, NUGIN does not pay the due importance to the role of information technology in its conceptual design.

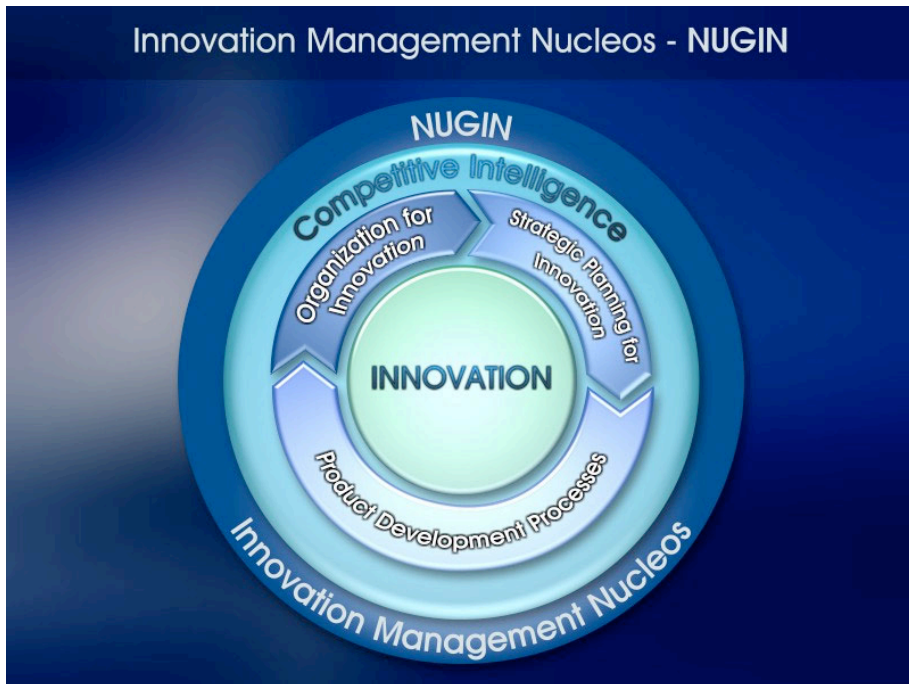


Figure 3

4. INMATE: a tool for innovation management with emphasis on IT- Information Technology

This section introduces **INMATE** – Innovation Management Technique. This tool has its roots on the experience, for more than ten years, of teaching, research e management of science, technology and innovation of the author of this paper, as well as his perception of a worldwide scenario increasingly favorable for the support of innovation within the economic environment, but, at the same time, a lack of simple innovation management tools and proper human capital formation for this management.

After a benchmark research on the current market tools, the INMATE methodology was conceptualized and developed in the form that is presented in Figure 4. Its main objective is to provide a tool in which enterprises, organizations and institutions could comprehend the diverse dimensions of the innovation process, and could, by themselves, take strategic decisions that best fit to their own interests. The INMATE methodology is based on the following assumptions:

a) Innovation is a process of perception and generation of opportunities. It is the result of a culture (entrepreneurial, organizational, or institutional) geared to the new, the disruptive, and different. It can be a systematic or a non-systematic process, depending on the context in which it reveals;

b) Innovation is an incentive sensitive process, mainly the economic ones. In the past it was believed that innovation could decline with competition, as long as more competition reduced monopoly rents that yielded successful innovators. Today it is perceived that the incentives of innovation depend not only to the innovation *ex-post* per se, but much more to the difference

between post and pre-innovation rents. Hence, competition can foster innovation and growth due to the fact that can reduce the pre-innovation rents of the firms much more than reducing its post-innovation rents. In other words, competition can enhance incremental profits of innovation, and, therefore, encourage investment geared to “*escape from competition*”;

c) Innovation does not correlate to the size of the organization. It can be processed either within the large, or the medium or the small size enterprises, being it a start up, a spin-off, or being generated from a technology transfer;

d) Innovation is a multidisciplinary process that could emerge anywhere inside the organization. In order to happen it is necessary to allow the convergence of distinct knowledge, competences and cultures, and in so doing, gathering them, in a continuous and interactive way, to the innovation development process;

c) Innovation must align *technical rationality* (which is geared towards success) to *communicative rationality* (which is related to the understanding of the parties involved) of the same process.

The implementation of the INMATE methodology starts from what is called the *design problem*, i.e., the problem of selecting (or designing) the *innovation strategy*, followed by the definition of the *organization* that could achieve the highest performance in the context where the innovation takes place. Assuming as its starting point the perception of a business opportunity, the strategy is selected to explore such an opportunity. Hence, an *organization* should be established (and *managed*) by properly specifying the Know-What (what to do), the Know-How (how to do it), and the Know-Who (with whom to do it).

Besides the innovation strategy and the organization management, INMATE incorporates four other dimensions. Due to the information overload characteristic of the Information Era, in the current economy it is vital to any innovation process to devise a competent management of several information and communication technologies - ICT at disposal. The ICT management reflects a previous understanding, by the INMATE tool, about what an *Information Strategy* means. *Information Strategy* is understood as a composite of the *Information Content Strategy*, plus the *Information Systems Strategy*, plus the *Information and Communication Technology Strategy*. In this sense, within the INMATE methodology, the information and communication management is the information strategy management that is needed for the innovation process.

As a result of the Information Era, it is also possible to observe the emergence of different forms of relationships and relationship networks, such as personal and corporate blogs, tweets, videologs, photologs, discussion groups, widgets, amongst others. In this way, as those different forms of relationship have been enhancing labor productivity, the INMATE methodology incorporates different aspects of several relationship networks that have emerged in the last ten years. In doing so, INMATE defines its *relationship networks management* dimension which is essential to any innovation process, particularly with the recent changes in the way new knowledge is produced via *collaborative networks* for research and development.

The development of new products, processes and services comprises a vast array of aspects, starting from market research, then the phase of product (process or service) design and project, up to its obsolescence, in a dynamics movement that is known as *creative destruction*, as defined by the Austrian economist Joseph Schumpeter in the beginning of the 20th Century. This whole cycle demands a competent *product development management* in order to arrive at the established goals in the innovative strategy. This is the INMATE *product (or service) development management* dimension.

Last, but not least, there is the *marketing management* dimension. To understand the importance of this dimension to the innovation management process, and to the consequent innovative product sales, it is necessary to understand that there is a crucial difference between the current media (of the Information Era) and the media of the previous Era: it is the difference

between *abundance* and *scarcity*. In the past we have had scarcity of access to information; today we see exactly the opposite, with the profusion of information, and associated means, as never seen before. This phenomenon was denominated by Prof. Barry Schwartz (¹²) as the *Paradox of Choice*, according to it the infinity of options available to humans is paralyzing and exhausting the human psyche. Therefore, in the context of information abundance it is necessary to admit the existence of an *Advertising Economics*, and fundamentally, of an emergent *Online Advertising Economics*, in which consumers are becoming increasingly more informed about the availability, variety, and quality of products and services at their disposal.

All these six dimensions of the INMATE methodology are covered by a conceptual apparatus of intellectual property rights which are inherent to the invention and innovation processes of products and services, particularly when technology transfer concerns are dealt with. Complementing this apparatus, the INMATE methodology defines also a parallel structure of funding models for different processes of innovation, depending on the characteristics of each innovator and the strategic trajectory established by him (or her).



Figure 4

5. The Information Technology– IT Management within INMATE

This section presents how the information technology- IT management works inside the INMATE. The main feature of this dimension of INMATE is provided by how the current business technological environment can be understood through the *Architecture-Governance-Enterprise Growth Analysis*, when dealing with enterprises, and *Architecture-Governance-Organizational Growth analysis*, when organizations or institutions are dealt with.

¹² See http://en.wikipedia.org/wiki/Barry_Schwartz.

In an analogy to the economic paradigm of *Structure- Conduct- Performance*, which is traditionally known in empirical market analysis, the *Architecture-Governance-Enterprise Growth analysis* was designed to describe how the enterprise, starting from its structure (or architecture), and followed by how it is governed, chooses its growth strategies. The next two sub-sections show how this analysis is viewed inside the INMATE tool.

5. 1. The Enterprise Architecture concept

As long as the enterprise (organization or institution) structures itself and grows in size and complexity, several factors start to inhibit its ability in solving the problem it faces. In other words, at one point in the evolution of the enterprise the factors that contributed to its structuring and business performance become numerous and complex. When one works with such complex systems, designers who face this complexity start to sub-divide it into sub-systems or domains which could be less complex than the original ones.

In the case of information systems the abstraction used to deal with this complexity is named *Architecture*. An *Architecture* (in analogy to the building sector) is a project system that specifies how all the components will operate to offer the general functionality of the system. The decomposition of the enterprise into manageable parts, the definition of those parts, and the orchestration of the interaction of those parts is what is called *Enterprise Architecture*.

Professionals of information technology field, such as Iver and Gottlieb (2004), focus their attention to the set of components that allows the flexible re-tooling and the creation of support environments fro different business environments. Hence, these authors developed an enterprise architecture, called *Four-Domain Architecture – FDA*, that reflects an integration of the business processes, engines, data sources (data bases and knowledge bases, for example), visualization tools, dialog managers, infrastructure, and organizational resources.

To present the FDA, the authors separate the business of creating an enterprise architecture (i.e., the processes to defining and building models of the enterprise and organizational resources requirements) from the business of doing the enterprise job (the construction and sale of goods and services) *per se*. To the former they named the *Architecture-in-Design – AID*, and the latter they called *Architecture-in-Operation- AIO*.

In order to offer to an enterprise a guide for decision making related to the information technology projects, the authors specified some phases. According to them there are several elements in the world of information technology that can build an enterprise architecture: networks, computers, terminals, programs, cabling, data sources, tasks, and so on. To gather these elements into domains, specific architectures of domains can be built to represent a common composite, and that could be focused in a simple and clear fashion. The authors' four domains are: Processes Domain, Information/Knowledge Domain, Infrastructure Domain, and Organizational Domain (a detailed account of these domains can be found in Iver and Gottlieb, 2004).

The *Architecture Advisory Group* (US Department of Commerce, 2004) suggests a process into seven steps to define an information technology architecture: 1- Define a Vision, Objectives and Principles (Who and what their architecture efforts will cover? What general principles the IT will guide its efforts?); 2- Characterize the state of the arts (How your office does its business, what IT is used, and how it is used?); 3- Establish a target architecture (What you wish that your IT architecture should be in the future?); 4- Determine the lags between the current and the target architecture; 5- Develop a migration plan (How would you overcome the gap between the current architecture and the target one?); 6- Implement a plan of migration and of the architecture (start to implement the plan to establish a bridge between the gaps of the IT architecture; 7- Review and update regularly (an IT architecture is a process, not a document).

5. 2. The Architecture–Governance–Enterprise Growth Analysis

The IT management methodology inside the INMATE tool is based on three approaches: a) the *Enterprise Architecture as an Strategy* approach, which was first developed by the Massachusetts Institute of Technology-MIT Sloan Center for Information Systems Research (US) and the IMD (Global Business School/Switzerland); the *Enterprise Governance* approach, based on the modern industrial (and services) organization theory; and, c) *Enterprise Growth* approach, based upon the economic theory of the contemporary firm. The three approaches can be briefly described as follows.

Amongst the approaches investigated by this paper in respect to enterprise architecture, one can be distinguished: that one from the MIT Sloan Center for Information Systems Research-CISR/MIT (Ross, Weil, e Robertson, 2008). After the development of a research of ten years about the IT impact on the performance of circa of 500 companies, researchers from the CISR/MIT arrived at some conclusions of enormous significance for the understanding of the role of IT on the enterprise performance.

According to the MIT's researchers the reason why some enterprises – and not others- reach a superior degree of execution and manage to explore what they do better to obtain agility and profitability, is because they have a better *execution foundation*. This *foundation for execution* consists of the IT infrastructure and of the digitalized business processes that automate central capacities of an enterprise. The foundation for execution depends on the proper alignment between the business objectives and the IT systems using a direct logic.

First the administration defines an strategic direction; then, the IT unit, ideally in conjunction with the business administration, designs a set of solutions provided by the IT for sustaining the initiative; and, finally, the IT unit offers the applications, data and the technological infrastructure to implement the solutions. This process re-starts always when the administration defines other strategic initiative.

In reality the researchers realized that the traditional approach for IT development inside the enterprises was related to what they called the establishment of a set of *silos*, a set of applications inside the enterprise. Individually those applications worked well. Together they impeded the enterprise efforts to coordinating the processes to customers, input suppliers and workers; in other words, they did not constitute a *foundation for execution*.

To overcome this *silos* stage, and to build an efficient *foundation for execution*, Ross, Weil e Robertson (2008) proposed three key-disciplines: 1) *Operational Model*: it is the form to integrate the information assets and to establish patterns of the business process to offer goods and services to customers; 2) *Enterprise Architecture*: it is the organizational logic of the business processes and the IT infrastructure, reflecting the requirements of integration and patterns of the operational model of the enterprise; and, 3) *Model of involvement of the IT*: it is the governance mechanism systems that assures that the business projects and the IT reach their enterprise objectives either local or in general.

The *Enterprise Architecture* and the *Model of Involvement of IT* inside the enterprises are constituted in the evolution of *Maturity Stages of the Enterprise Architecture*. According to Ross, Weil e Robertson (2008) these stages are: a) Business Silos Architecture; b) Pattern Technology; c) Optimized Nucleous Architecture; and, d) Business Modularity Architecture.

The next step in the INMATE methodology is the *Enterprise Governance*, which must be understood as the enterprise (organization or institution) behavior that articulates the complex relation between the *IT Governance* and the *Corporate Governance* having in mind the business objectives. The *IT Governance* on the one hand, as understood by solution vendors and consultancy firms, is the implementation of best practices, mainly in IT services, i.e., services and support to the IT infrastructure, Data Centers operations, and so on (further details on Fernandes, Aguiñaldo A. and Vladimir Ferraz de Abreu, 2008).

The *Corporate Governance*, on the other hand, is connected to the issues related to what in the Economic Science is called *asymmetric information*. As economic agents take decisions with asymmetric, imperfect and incomplete information, in their economic relations always emerge unbalances of power which could cause negative impacts in the performance of the involved parties, unless they are not properly treated.

Adriana Andrade and José Paschoal Rosseti (2007) list 10 (ten) issues associated to *Corporate Governance*: 1- size of enterprise; 2- property structure; 3- dominant sources of funding (internal or external); 4- typology of agency conflicts and harmonization of interests at play; 5- typology of legal regime of the enterprise; 6- typology of the enterprises according to group control; 7- ascendancy of the enterprise after mergers and acquisitions; 8- geographical coverage of the enterprise; 9- cultural traces of the nations in which the enterprise operates; 10- legal institutions and regulatory frameworks in different parts of the world. They also present and discuss the 7 P's of *Corporate Governance*: Property, Principles, Purpose; Power, Processes, Practices, and Permanence.

The last step in the IT management of the INMATE tool is the *Enterprise Growth*. The underline question of this step is: what determines the growth of an enterprise? This question has been addressed by several specialists for many years. In a series of newsletters published between 09/07/2007 to 13/08/2007 (see <http://www.creativante.com.br>), this author treated several aspects that have emerged on this subject, either from the empirical evidence side, or from the academic economics literature.

Summing up, it is possible to say that there are two types of growth models of the enterprise: a) *Stochastic Models* that point that the growth of enterprises is a pure random process (i.e., in the long-run some enterprises are lucky and tend to get a share above the average rates of growth, while other get bad luck and tend to remain at the same size or decline; b) *Non-Stochastic Models*. In this second kind of models there are: i) Optimization Models based in learning (passive and active); ii) Growth Models based in accumulation of human capital and those of quality ladders based on research and technology, and stochastic innovation; iii) Growth Models based in the development of the financial sector.

The approach developed inside the INMATE tool is one that filters the conditioning factors of growth (such as the macroeconomic environment) and focus on the growth strategy of the enterprise. A central concern in this approach is to model stages of growth of the enterprise. In this respect, the INMATE departures from some established models such as the *Greiner Model of Growth* (Greiner, 1972 and 1988).

Models like these from Greiner have direct correlation to the *Information Systems Maturity Models*, such as those of Nolan (1973), Gibson and Nolan (1974), which are based in the technology used and the budget of the *information systems – IS* as indicators of maturity of the information systems management, by applying an S curve consisting of four stages: i) Initiation; ii) Contagion; iii) Control; and, iv) Maturity. Nolan's model has been expanded in Mutsaers, Ziee and Giertz (1977). These authors described three curves in S shape as three eras of the IS management maturity: Data Processing ; Information Technology; Computer Networks.

6. Final Conclusions

As it was indicated in this paper amongst market tools for innovation management none dedicates special attention to the role of information technology – IT in its innovation processes. Such an insight catalyzed the opportunity for the development of a tool that could involve the complexity of what it is means to manage modern IT technologies in the innovation processes.

In this respect this paper showed two market innovation tools: the TEMAGUIDE and the NUGIN. Then, the INMATE- Innovation Management Technique was presented with its main assumptions and dimensions.

The central concern of this paper was to demonstrate some details (and complexity) of one dimension of INMATE: the IT management dimension. By appropriating from Computing Science and Engineering the concept of Enterprise Architecture, the paper has given special highlight to a new methodology, called *Architecture-Governance-Enterprise Growth*, which embodies an analogy to the economic paradigm of *Structure-Conduct-Performance*, which is traditionally utilized in empirical market analysis. This new methodology relies on three treatment approaches: a) the Enterprise Architecture as an Strategy approach; b) the Enterprise Governance approach; c) the Enterprise Growth approach.

Despite being presented in a brief fashion, it is hoped that this INMATE tool, with its own concepts and methodology shortly presented here, can allow a new orientation for the analysis of innovation processes, since these processes can not any more ignore the advances proportioned by new content, systems, and information technologies.

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Contact center's information systems project management framework: a focus group study

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Abstract: Over the past decade, Contact Centers have experienced phenomenal growth. In UK and USA Contact Centers employ about three percent of the working population. Contact Center's projects are complex because occur in a multidisciplinary area with multiple actors and constraints. Information systems play a decisive role in these projects. However, several studies indicate a low success level of information and communications technology projects leading to research opportunities for their improvement. In our previous research we have identified a framework with the key factors to be considered in these projects. Due to the highly dynamic reality of the Contact Centers, the framework must evolve in order to maintain it's usefulness for project managers and other center professionals. Focus groups are interactive discussion groups used for generating knowledge and hypotheses, exploring opinions, attitudes and attributes. In this way, the present study aims to verify, expand and actualize the existent framework, using a focus group with professionals in the area.

Keywords: contact center; project management; framework; key factors; focus group.

1. Introduction

Over the past decade, Contact Centers have experienced phenomenal growth in several countries around the world. Fuelled by advances in Information and Communication Technology (ICT) and the plummeting costs of data transmission, organizations have found it cost effective to provide service and sales to users (of the Contact Center) through remote technology-mediated centres (Holman, Batt, & Holtgrewe, 2007).

Contact Centers' users gain from new or lower cost services, while governments view them as a source of jobs and economic development. Organizations reduce costs, increase productivity and gather information about their users that enable either the identification of new business opportunities either the personalization of the services/products generating more business and better services.

A multi-disciplinary approach is called for in order to balance service quality, efficiency and profitability from the likely conflicting perspectives of users, service-providers, managers and

society (Gans, Koole, & Mandelbaum, 2003; Mandelbaum & Zeltyn, 2007). Research crosses a significant number of disciplines from Operational Research, Statistics, Human Resources Management, Psychology and Sociology to Marketing and Information Systems (Gans et al., 2003).

ICT plays an important role in the Contact Centers, supporting the operations and data mining user's information. However, Standish Group studies indicate low success rates in the ICT projects (Standish Group, 2006). This situation represents research opportunities in order to contribute to improve the success level of the projects.

In our research we focus on Contact Centers Information Systems (CCIS) project management. In order to increase success rate, identify best practices, create decision processes and, in the future, prepare standards, it is fundamental to identify and systematize the concepts used and the key issues to consider in CCIS project management. In this way, a framework with the key factors to be considered in a CCIS project and the characterization made by project managers specialists in this area was proposed in our previous work.

Because of its growth and development, Contact Centers' reality is dynamic leading to the evolution of the framework. To verify framework's actuality, adapt and expand it in order to keep its usefulness, the present research study was conducted.

Focus groups are an important approach to create knowledge. They permit time efficiencies and to take advantage of possible synergies that the combined effort of a group will provide.

Taking the characteristics of the reality to study and our access to it, focus group was chosen as the suitable method to gather empirical data in the present research.

The result is an expanded and actualized tool for CCIS project management.

This paper is organized as follows. Section 2 introduces key Contact Center's concepts. Section 3 presents the existent framework. Section 4 explains in detail the objectives of this work. Research design is presented and justified. Section 5 describes how empirical data was gathered and analyzed. Section 6, the main contribution of this paper, presents the resulting framework for CCIS project management. Finally, a summary of the results is given in section 7. Future research directions are also discussed.

2. Concepts

Call centres appeared in the middle of eighties (Cardoso, 2000; Cohen, 1980; Gaballa & Pearce, 1979; Hawkins, Meier, Nainis, & James, 2001) and they are the predecessors of contact centers. A call center constitutes a set of resources that enable the delivery of services via the telephone. Resources are typically people, the agents that handle calls, also known as customer service representatives (CSR), which interact with the users of the services provided by an organization.

An interaction is a contact between a user (customer or citizen) and the organization. Call centers may handle inbound and outbound interactions. Inbound interactions are those initiated by users requesting some service to the center. Outbound interactions are those initiated from within a center.

Call centers use Interactive Voice Response (IVR), Computer Telephony Integration (CTI) and Skills Based Routing (SBR).

IVR consists of computer automats that allow users to "self-serve" while communicating their needs. Users interacting with an IVR use their telephone keypads or, with speech-recognition technology, voice commands to provide information, such as account numbers or indications of the desired type of service. IVR uses synthesized voice to report information, such as bank balances or departure times of planes. IVR can also be used to provide simple services, such as the transfer of funds among bank accounts.

CTI technology is used to integrate more closely the telephone and information systems. CTI allows a binding between a telephone call and the context associated to that call, including user's personal data, desired service and the transactions done during the call (Cardoso, 2000). CTI can be used to automatically display the caller's user record on the agent's workstation screen. It eliminates the need for the agent to ask the caller personal information saving, in this way, agent's time and reducing calls' duration. It can also reduce variability among service times, thus improving the standardization of call handling procedures.

Agents' skills can be used to route calls. This routing, based on agents' skills is called skills based routing (Avramidis & L'Ecuyer, 2005; Koole & Mandelbaum, 2002). Agents can be organized upon their skills, for instance the ability to speak languages. If one call arrives and the system detects its origin, then it can be delivered to agents speaking the right language, providing a better service to the user.

CTI are IVR help to integrate a special information system into a call center's operations, the Customer Relationship Management system (CRM). CRM systems track user's records and allow them to be used in operating decisions. CRM allows an efficient and personalized relationship between the organization and each user, independently of the number of the users (Cardoso, 2000; Gans & Zhou, 2003). "Call centers" became "Contact Centers" with the use of interaction channels like e-mail, fax, sms, chat or web. With these new channels and business approaches, complexity increased and, agent's skills had to improve to do the work with new technologies and services.

3. Framework for contact centers information systems project management

In this section we present the framework for CCIS project management resulting from our previous work. Our goal was to identify the key factors in CCIS project management and the characterization of those factors. We recurred to semi-structured interviews and to a set of highly specialized individuals in the area.

The framework considers twelve key factors: flow, channels, technology, service type, integration, geography, dimensioning, way to obtain the service, user and agent focus, legislation, business sector and relevant actors.

A brief overview of the framework will be presented with the characterization of each factor. The twelve key factors are the following:

- **Flow.** The concept of flow can be applied to the interaction, to the service provided, to the agent and to the complete flow. In this last case all the relationship between user and the organization is considered. The complete flow can have inbound and outbound parts and include one or more services. From the point of view of an IS, the inbound is considered more complex, demanding a higher level of systems integration and more skilled agents. However outbound services like debt collection are an exception. The dichotomy outbound/inbound should be used to facilitate the organization of the services and not as a rigid division in the services. The use of these concepts must be done carefully in order to preserve the valuable asset of the relation among users and organizations;
- **Channels.** Interaction channels can be classified logically as self-serviced or assisted. Assisted channels demand agents to process the interaction, self-serviced ones no. Interactions have two main components, the relational component and the transactional component. It is necessary to analyze both components when deciding if an interaction

can be automatic (e.g. using a self-service channel). Pure transactional interactions tend to be supported by automatic channels. Relational transactions demand human interaction. Channel selection must take into account some factors, among others: organization strategy and image; how usually organization interacts with its user; target public profile: age, sex, culture, technological skills; product and service characteristics like service level;

- **Technology.** Contact Centers have technological solutions related with relational marketing (among others, business intelligence, customer relationship management and workflow) and operations. It is possible to distinguish two components in the operations: planning and on-line systems. Planning is related with volume estimation (forecasting), estimation of how many agents are needed based on volume estimation (staffing) and the creation of the appropriated work schedule (scheduling). Operations on-line systems like Computer Telephony Integration (CTI), Automatic Call Distributor (ACD) or quality monitoring and reporting tools are related with interactions' distribution, monitoring and reporting as well as business continuity systems. Today, with high reliability and reduced cost of dedicated lines, operations tend to be centralized in a datacenter with remote agents geographically distributed. This solution facilitates systems administration, increases system reliability, and it is not an obstacle for geographical distribution. Actually, organizations where contact centers are critical to the business are splitting their operations into just two sites. This increases security from the viewpoint of business continuity (for example, if there is a fire, operations continue) and enables load transfer when burst situations occur;
- **Service type.** Service type depends of the strategy and on the business area. It is possible to distinguish the following main inbound services types: customer service (refers to information about billing and provisioning), claims, generic information about services or products and technical support. Outbound main services types are debt collection, welcome calls (for first-time service users), churn reduction, sales and inquiries. Specialists believe that it is possible to identify best practices for each type of service;
- **Business sector.** Knowledge, best practices and experiences of CCIS projects done in a certain business sector, tend to be applied to other organizations operating in the same business sector and in similar markets. Business sectors with a large number of residential users and without an high level of market fragmentation have, naturally, contact centers. Nevertheless, many organizations have the account manager or power user function. Account managers (or power users) are persons that manage a set of customers. They do debt collection, up-selling, cross-selling, and process requests. They aren't pure contact center agents, but they use similar procedures, tools and technologies. So, whenever there are a significant number of interactions, contact center technology and expertise can be applied. Market maturity level and competition influence also the investment in a contact center;
- **Integration.** The purpose of integration is to make information available to agents and other actors. There are three main strategies: use existing back-end applications if their complexity and response capacity allow; develop a new front-end integrated with the back-end through a set of transactions; and built a new system from scratch. The evaluation of the integration complexity must consider, among others factors the number, the diversity and the integration level of existing systems; technology details of each system (proprietary systems, standard, open source, others); performance of the systems; interface complexity; decision about synchronous or asynchronous integration; number of transactions to support. Inbound services require, most of the times, a high level of integration;

- Geography. Technology, net capacity and cost have evolved in ways that allow geography to become "transparent". From the information system viewpoint, geographic dispersion is no longer a problem. Yet the design of the information system must take into account geography issues as culture, maturity of the markets, legislation and distributed project management;
- Dimensioning. Correct dimensioning is critical because the workforce represents about seventy percent of the operational cost of a contact center (Gans et al., 2003). Well-designed CCIS reduce the number of necessary agents. On the other hand, the number of agents influences technology, system architecture, processes, among other relevant aspects. Inbound dimensioning requires the estimation of expected volume (number of expected interactions), expected interaction durations, expected distribution by day/month/year, and target service level. This data allows the use of Erlang statistical distributions to calculate the number of necessary agents (Gans et al., 2003). Outbound dimensioning requires definition of target volume, forecast of average interaction duration, and a goal for the percentage of successful contacts. Either in inbound, outbound, or both, growth forecast for the contact center is important for dimensioning;
- Way to obtain the service. An organization has four main ways to set up a contact center service: fully in-house; first line outsourcing, second line in-house; first line outsourcing, second line insourcing (organization owns systems and infrastructure, workforce come from a third party); everything outsourced. The outsourcer solution transforms the initial infrastructure investment (usually high) into operational costs, reduces setup-time and avoids a long learning curve. An outsourcer adds experience but also adds the complexity of managing a third party. Confidentiality, control, and operation of internal resources are main reasons to implement in-house operations. An interesting solution is the mixed model, in-house and outsourcing at the same time. With this solution, it is possible to have the best of both worlds. The organization uses its business knowledge, experience and processes, and gets know-how from the contact center from the outsourcer. All these solutions have impact in the architectural design of the project;
- Actors. The number and the functions of the actors in a contact center vary from one organization to another. Two main functions can be distinguished: production line functions and support functions. Agents, supervisors, and service project management in production line functions are decisive to success of contact center service projects. Each supervisor works with ten or fifteen agents. A service project manager is the person that has the global vision of the project. She/he understands the needs and expectations of the customer, the organization that requires the service. At the level of support functions, there is an axis connecting marketing with operational abilities. Marketing abilities involve front-end creation, from a perspective of what message to transmit, how to relate with users, and what information to provide to the agent, among others. In turn, operational abilities include planning, forecasting, dimensioning, training, quality monitoring, among others; or, in other words, everything related to the industrial component of the project. Another function is system analysis. All the processes have to be thought concerning the way information flows and how they should interact with existent processes, demanding a global perspective of the operations. Human resources department support functions like selection, recruiting, training and administrative tasks. Finally, in-house operations may have a Contact Center Manager, responsible for the entire contact center department;
- User and agent focus. One of the guidelines in a CCIS project is users and agents focus. Usually, users' needs are the main reason for the existence of one organization. When organizations create a contact center or a new service for a contact center – in-house or outsourced – all the solution (marketing and operational components) are conceived to

satisfy users' needs to strengthen user-organization relationship. This generates continuous (and probably growing) purchases and consequently continuous profits. Agents are organizations' face to users, so keeping and increasing the relationship is one of the most important goals of the contact center. One of the most frequent approaches in contact center service design is the straightforward adoption of existing processes. The idea is to do the same things in the same way but using telephone, e-mail, or any other channel. This approach may lead to a set of independent, non-related and confusing services, damaging the relationship between the user and the organization. Thus, processes must be carefully designed to facilitate users' life and agents must have a support system with tools that allow them to efficiently satisfy present and future users' needs. These tools belong to CCIS;

- Legislation. Labour and contact center legislation varies from country to country, conditioning centers activities and consequently CCIS projects. The Global Contact Center Report 2007 (Holman et al., 2007), states substantial differences in the organization of work and human resource practices in Contact Centers across countries. In general national labour market institutions influence management strategies. Another example is the Do Not Call legislation. In some countries like US, people can register their telephone number in a Do Not Call database in order to avoid telemarketers. UK legislation is even more restricting. Labour legislation, work organization and Do Not Call laws, among others, must be considered in the process and project design.

After the framework presentation, our next step is to introduce the objectives and the methodology of the research.

4. Research objectives and design

This section introduces several research questions that triggered the present study and the research method followed.

Research questions in this work arise from literature revision, empirical experience gathered all along almost ten years of fieldwork in the area and from the observation of the diversity of CCIS projects.

In the contact center literature, Gans, Koole and Mandelbaum (Gans & Zhou, 2003) consider that processes and systems design are one of the most important and strategic decisions to make in a contact center. Aksin and Harker (Aksin & Harker, 2003) explain the importance of information systems in the capacity planning of a contact center.

Regarding project management, several studies (Demarco, 1997; Ewusi-Mensah, 2003; Standish Group, 1996, 1998; Yetton, Martin, Sharma, & Johnston, 2000) indicate misspecifications and poor requisites decomposition and vision as some of the main reasons for project failure. Chaos Reports (Standish Group, 2006) indicate a lower level of success for information system projects, despite the positive evolution in the latest years.

CCIS projects exhibit many particularities. For example, an inbound information service is totally different of an inbound emergency service like 911. Processes, agent's skills, response time, liability, are some of the main differences.

The characteristics of an in-house contact center are also different from one outsourced at a Service Bureau where, among other issues, it's necessary to negotiate project results, service levels, know-how transfer and confidentiality.

For the Service Bureau, it is substantially different whether the project needs integration with client's systems or the project doesn't need any kind of integration.

A distributed contact center communications, data infrastructure and project approaches may be substantially different from one with a centralized architecture.

Finally, contact centers vary from few agents to hundreds or thousands agents.

In short, information systems play an important role in a contact center and there are different approaches to design and manage CCIS projects leading to the following research questions: which are the relevant factors to consider in a CCIS project? How do project managers further characterize those factors?

These reasons justified our previous study in order to identify and characterize concepts and the organizational, social and technological context of the contact centers project management area.

The result was the framework presented in the previous section.

Due to contact centers' growth and changing environment, our goal in this work was to verify, expand and actualize the existent framework. Contact center is a multidisciplinary area that crosses marketing, operational research, psychology, sociology and information systems, among others, so CCIS projects are complex, involving a multiple kind of actors and interests.

All research is based on some underlying philosophical assumptions about what constitutes valid research and which research methods are appropriate (Myers, 1997). To accomplish our present goal, an interpretative approach was followed because of the multidisciplinary and complex reality of the contact centers and the relation between the observer team and the object of study.

In recent years, interpretive research has emerged as an important strand in information systems research (Walsham, 1995). Interpretive research can help information systems researchers to understand human thought and action in social and organizational contexts; it has the potential to produce deep insights into information systems phenomena including the management of information systems and information systems development (Klein & Myers, 1999).

After choosing a proper approach, next step was to choose the research method. There has been a general shift in information systems research away from technological to managerial and organizational issues, hence an increasing interest in the application of qualitative research methods (Myers, 1997). The goal of this study was to verify, actualize and expand the framework with the relevant factors to consider in the CCIS project and their characterization. It was therefore crucial to identify contact center specialists who have the necessary experience and knowledge to provide a characterization of the phenomena involved.

The need to capture such knowledge suggests looking for people with a wide experience in the area, ten years, say. The goal was to find professionals with experience as consultants and project management in CCIS and experience in the development of software for contact centers. Another issue is to have worked in several business areas and diverse geographic areas with markets of different maturities and dimensions. By last, the specialists should have skills beyond computer science.

The observer team has almost ten years of effective work in the area. Their projects cross several geographies, among others, Tokyo (Japan), São Paulo (Brazil), Hong-Kong (China), Macau (China), Kuala Lumpur (Malaysia), Madrid (Spain), Amsterdam (Holland) and Lisbon (Portugal). Projects business areas range from finance and insurance to travel agencies and retail. Frequently used in exploratory-descriptive studies, as well as in other types of research, focus groups, as data gathering technique, seemed particularly useful in this context, as explained in the next section.

5. Research objectives and design

This section presents the procedures and tools used to gather, organize and analyze data. Many qualitative researchers prefer the term "empirical material" to the word "data" since most qualitative data is non-numeric (Myers, 1997).

Focus groups are interactive discussion groups used to generate knowledge, hypothesis, explore opinions, attitudes and attributes (Fern, 1982). To MacDonald (McDonald, 1992, 1994), a focus group is seen as "...[a group] discussion of a particular topic under the direction of a moderator who promotes group participation and interaction and manages the discussion through a series of topics".

Focus groups seek to maximize search time and to take advantage of the synergies that arise from group effort.

Stewart e Shamdasani (Stewart & Shamdasani, 1990) point the advantages of focus groups over other methods like individual interviews and Delphi groups from the point of view of the researchers and participants. To participants, focus groups offer synergy, momentum, stimulus, security and spontaneity. To researchers offer collective wisdom, innovative ideas, structure, speed and specialization.

This required preparing a list of subjects to cover. This list of subjects evolved into a sequence of questions and sentences for comment. This tool was reviewed and tuned in order to reach the defined goals.

A letter requesting the participation and explaining the goals, the focus group process, and the use of data gathered was sent to the interviewees.

Focus group was realized in the physical presence of the participants, had the duration of about two hours, and was tape-recorded (with explicit concordance of the participants). Curriculum Vitae of the participants were also requested.

Focus group record was transcribed verbatim and the resulting document was sent to participants for revision and acceptance. Confidentiality was always assured.

Before analysis of content, verbatim documents and notes were organized. That material was processed through content analysis based on emergent thematic categories. Data analysis, in qualitative research, is a phase of the research process that occurs every time the researcher collects new data. In the analysis, researcher must continually use what has already emerged (Deslauriers, 1991). One of the key elements in qualitative data analysis is the systematic coding of text (Miles & Huberman, 1994; Strauss & Corbin, 1990). Codes are the building blocks for model building and the foundation on which the analyst's arguments rest. Codes embody the assumptions underlying the analysis.

The first coding step consisted of organizing all the contents in major topics. As they had been identified, these new topics were also considered in the organization of the information. The second step was to iteratively look for similarities, differences, common denominators, models and other relevant aspects. Through this process, the different categories began to emerge. Several memos and diagrams were built along the analysis based either on the verbatim descriptions either on the notes registered during the focus group. Memos and diagrams help put on paper the preliminary products of the iterative analysis (Fortin, 1999).

6. Results

This section presents the results of the research.

Figure 1 shows the identified factors and their relationship. Following we discuss the rationale of the framework.

A contact center project must be aligned and included in the strategy of the organization. Business sector, geography environment and users' needs influence strategy definition. Many organizations decide to implement a contact center to improve their performance and competitiveness. Others, having already a contact center, decide to create or reformulate services provided by the center. Any of the previous situations has a CCIS project associated. Each project may affect several or all contact centers' actors. Any affected actor is a participant in the project.

A CCIS project can consider several or all factors presented, depending on the requisites. Other factors may also be considered. The importance of each factor in a specific project may also vary and that must be decided by the project team.

In every project, organizational aspects are decisive and must be analyzed. Project management literature refers the importance to understand organizational culture and internal forces.

Taking into account strategy, objectives, organizational culture and internal forces, among other organizational issues, choices must be done regarding: the services to provide to users; the appropriated interaction channels; the flows that must exist in order to provide the best services for users; the information/actions to obtain/provide/generate from/to/into existent systems (integration); the best integration approaches; the number of agents and supervisors needed and how must be organized to support the services (dimensioning); the skills they must have; the way to obtain the service (in-house or outsourced); the suitable technology architecture; and the applicable legislation.

All the process must consider the relation between user and agents. This relation is the key link that enables a long-term relationship between user and organization. Those long-term relationships generate profits.

Another issue is the reengineering needed not only at the process level but also at the hierarchy and structure level. Finally, the project must have the top management commitment. The analysis of the results confirms, generally, the factors and the characterization of the existent framework. Still, there are some new and interesting aspects that expand the framework.

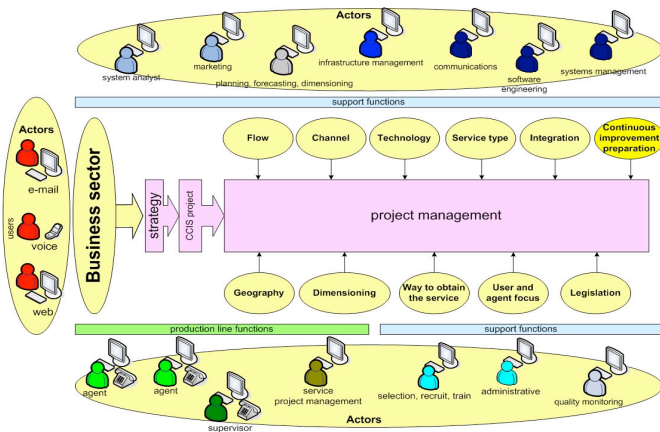


Figure 1 – Resulting framework for contact center's information systems project management

Regarding flow, participants were unanimous considering inbound projects different from outbound ones. They confirm that inbound services usually need to provide more information for the agents.

When a user calls (inbound interaction), the agent only knows the reason why she/he is calling when they start talking. There are some few exceptions, namely when there is an IVR and the user must choose one option indicating the motif of the request. Even in this situation, most users choose randomly an option just to talk to an agent. With this uncertainty, agents must have access to more information, provided by CCIS, in real-time than in the outbound interaction. In the outbound situation, the interaction is previously prepared in detail so it is possible to determine, for the majority of cases, the information needed and the flow of the interaction.

Another conclusion is that inbound projects usually are longer than outbound ones. Participants stressed that inbound design is done more carefully because inbound services, most of the times, will work for several years. On the other hand, outbound services, most of the times, are prepared to work for a few days or weeks. Examples of these situations are a customer care inbound service in a bank and a promotion outbound service. Customer care is a service designed and implemented to work for long-term because bank customers will use it over years. Some main reasons can be typified, but there is always a degree of uncertainty that must be overcome with agents' experience and capable CCIS. The outbound service, will work for some days or weeks and the target public is previously choose as well as all the details of the interaction flow.

The conclusion is that inbound CCIS services projects are longer than outbound CCIS service projects and demand more experienced analyst and careful design. Focus group confirms our previous research in the way that the dichotomy inbound/outbound represents a logically abstraction facilitating the comprehension and should be used in a proper manner. Actually, the main focus should be the user, her/his needs and the relation between user and the agent (the face of the organization). Inbound and outbound services have relations among them that must be reflected in the CCIS.

Another issue is the automatic blending between inbound and outbound. From the point of view of the CCIS it is possible to implement automatic blending, but from the operational point of view this context switch doesn't work so well. What centers usually do is to make some switch, but manually.

Regarding the channel factor, focus group participants consider that the use of web collaboration to help users to change from assisted to self channels has a moderate success. Video call is a recent new channel. Results present it is as a trend pushed by communications operators in order to create the need for this kind of service.

Concerning technology, VoIP utilization is growing. It allows just one infrastructure to voice and data and more flexibility. It allows the "anytime, anywhere" contact center. With VoIP architecture, agents just need an Internet connection and a headphone-microphone to work. This powerful flexibility however demands an elaborated communications design, considering security, quality of service, liability and load balancing.

Participants consider that service can be grouped in several types like customer service, technical support, debt collection or welcome calls. Know-how re-utilization is extremely important and can be used among service types of similar businesses areas.

Another contribute to expand the framework is related with a new factor that emerged from the focus group: continuous improvement. All participants refer it has an important issue in CCIS design. Each second improved in each interaction in a large contact center has a huge impact in the human and material resources needed for the operations. When a service starts its operation there are always details to improve, new small situations to consider and some flows to adapt. To improve is necessary to measure. Different business sectors have different measures and benchmarking indicators. It is fundamental to identify which ones the organization wants to consider and they must be integrated in the CCIS design in an earlier stage of the project development.

7. Discussion of findings

The results of the study support many of the findings of previous research. Consistent with previous research the key factors in CCIS project management are flow, channel, technology, service type, integration, improvement, geography, dimensioning, way to obtain the service, user and agent focus and legislation.

A new factor emerged: the preparation for continuous improvement. This idea expands the existent framework a step ahead. In the present research, participants indicate that the success of CCIS depend on the continuous improvement of operations after the end of the project. In order to prepare the after-project phase it is necessary to identify what to compare along the time. After the identification of useful key performance indicators, which vary from business sector to business sector, it is necessary to include them in the design of the contact center. The Global Contact Center Benchmarking Report (Merchants, 2007) presents key performance indicators for the contact centers. All of these indicators depend on the existent information system. Most of the conclusions of the resulting framework are supported by other research studies. If the flow is inbound, then the need of integration with the existing systems is usually greater with some exceptions like debt collection. Aksin and Harker (Aksin & Harker, 2003) show that in a system with a high level of integration, the increase of the number of the agents has an impact in the system performance.

Dimensioning is a major issue because of the impact in costs (Gans et al., 2003). All identified studies analyze inbound dimensioning. Almost no academic outbound studies were identified (Gans et al., 2003), the exception being Samuelson (Samuelson, 1999). Actually, the present study confirms that the division between inbound, outbound and blended useful but, in order to provide a better service to the user, the complete flow should be analyzed. Inbound projects usually are longer and demand a more careful design. Service quality, capture and retention of users should also be used when analyzing performance and dimensioning.

This study also confirms that voice is still the most important channel followed by e-mail, which is growing in use and importance. Video calls appear pushed by communication operators.

The possibilities of obtaining the service are becoming more mixed between in-house, outsource and insource solutions. Actual research considers the outsource possibilities (Aksin, Véricourt, & Karaesmen, 2004; Gans & Zhou, 2007). In either case this decision has an impact in solution design (security issues, performance and distribution, among others) and must be considered in the project.

8. Conclusions

Contact centers' economic role is significant and is growing. Technology, processes and procedures are key issues to ensure productivity in the centers, so CCIS projects assume a central role.

The present research validates, expands and actualizes the existent framework for supporting the activity of CCIS project managers, result of previous research. The framework gathers the relevant factors to consider in a CCIS project and their characterization.

This study was influenced by an interpretative approach. In order to capture specialists' knowledge, a focus group was developed. The participant's specialists have a wide experience of work in the area as consultants, project managers and product developers. They worked in contact centers projects of several businesses, in different geographies, with markets of different

maturities and dimensions. A framework with twelve key factors and their characterization was created.

Results expand the framework that was previously proposed and are generally supported by other studies. This brings aspects regarding CCIS projects like considering the complete flow of interactions and not the traditional approach dividing interactions between inbound, outbound and blended. The relation between users and agents is considered the key link for a long-term relationship between users and organizations. Thus, it is considered a critical issue in the CCIS design. A new factor was included in the framework, the continuous improvement preparation. Any smaller improve may have a huge impact in either in the user's satisfaction either in the cost of the resources. To improve is necessary to measure. Measures come from records in the information systems. Contact centers must define their own key performance indicators, and they must be include in the service's design in an early stage.

The use of an adequate framework for CCIS projects will enable: the development of a systematic and structured research in knowledge areas related with CCIS; the identification of the critical factors and the specific characteristics of the different types of projects; the identification and development of project management approaches, best practices, tools and techniques; organizations to have a framework to build decisions processes based on their needs, choose the best alternatives in order to reach their strategic goals; the creation of standards and norms; the increase of the success in CCIS projects.

This is a dynamic and growing area. Contact centers' research represents a dynamic work that must evolve with the changes in the area. In this way, much work has to be done in the future. New questions arise like: Are traditional information systems project methodologies adequate for contact center projects? How to consider these identified key factors in the project phases?

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Semantic web meets information effects planning model for information systems: planning is you

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Abstract: Information systems planning should be able to put up organization evolution and this goes far beyond strategic alignment. Strategic alignment can be translated by traditional requirements survey and define organization momentum, but not the future, leading to strongly oversized information systems in order to increase solutions functional curve. This paper presents the architecture model for integration of information system planning model using information effects with the wisdom of crowds in order to develop organization information ecosystem by creating semantic architecture of information. With this integration is possible to create dynamic patterns, based on semantic definition of information, as input for the planning model and with that create a correct definition of the ecosystem information needs in each moment in time and the needs to support the wanted effects. That's the first step for dynamic ontologies learning. The wisdom of crowds is in this architecture a fundamental parte, as been able to create conditions to obtain the how, when and for what, the architecture of information system should be done and what are the expected effects. The power of many is used to identify the needs of few. Semantic web and definition of semantic mining, translated to ontology and then to effects are possible, and information ubiquity can then be integrated.

Keywords: effects, information, planning, collaboration, information systems, wisdom of crowds, semantic web, ontology, semantic mining

1. Introduction

Known as predicate for success, organization information main goal is to be supplied to the correct user at the correct time in a reliable way. For that organization need to know information flow and needs, of each of informational ecosystem element.

Planning information system according to information effects (Sousa, 2008) shows the way to aggregate web 2.0 tools, integrating collaboration as the way to use web as platform. In this model are presented information characteristics and the way in which they can be used in the development of organization information ecosystem for producing organization empowerment.

However, the development of this ecosystem cannot be done using traditional requirements survey even if it is possible to map them to a business ontology (Z. Jin, 1998), since this kind of

work needs some elements like knowing the future that is impossible to translate from strategy, even more on this challenges time.

The presented information systems model uses effects as information characteristic in order to develop dynamic information systems architecture and create fundamental conditions for organization development. This model integrates the collaborative use of information, web 2.0 main goals, creating conditions for information context development that goes far beyond strategic alignment. This collaboration is a fundamental element for organizations development and also for information ecosystems modeling in order to create a model based on diversity.

The use of diversity is a fundamental key to promote the reliability of the relationships between the different elements in the information ecosystem. The diversity is not achieved if the planning model only waits for expertise input. This input only solve the problem of known needs, but the context needs that lead to innovation than underlie in the ecosystem information flow are now visible.

It is fundamental to get the correct information needs, information context, for the different elements, for that is used web semantic to get context related information.

Semantic web is the logical solution, according to the definition of the effects planning model that integrates web 2.0 as organization empowerment solution. The integration of semantic for context information into information systems analyses is done in order to create conditions for semantic mining.

This semantic (Tim Berners-Lee, 2001) makes possible to develop ontology learning using wisdom of crowds (Surowiecki, 2007) as input for the planning model. The wisdom of crowd's analysis has as main goal the development of information systems context patterns, making possible to discover what are the actual information systems flows and needs.

This interaction makes possible the creation of a dynamic architecture that defines the organization ecosystem and that does not depend on a project based requirements analysis.

The organization needs to be dynamic so the information ecosystem must be developed and there is nothing more dynamic.

Instead of contributing for the omniscient executive myth, organizations information systems should look for ways to collect and relate distributed organization knowledge (Hamel, 2008). In fact, the deficient strategic alignment between power and acumen is the most frequent fatal cause of strategic maladjustment.

2. Information Systems Planning Using Information Effects (*ISP^{IE}*)

Traditional information systems planning models are unable to manage the informational ecosystem and don't use information characteristics to take care of that job, beside that fact, information is considered the most valuable organization asset.

For WEB 2.0 social structure and functional development, information characteristics are fundamental elements for the sustained development of collaboration and information reliability. This new way of share, develop and improve information management and transformation into knowledge is supported in information. The correct use of information is them a fundamental element in this conquest for the most usable information(Don Tapscott, 2006).

Information is considered to have, like any other object, characteristics from which the effect is a central one(Sousa, 2009).

This information effect characteristic is achieved when over some information is done some activity in order to produce some result.

In WEB 2.0 age, information system planning should assume this activity to produces the expected result for the organization information ecosystem, and for that information systems planning using information effects shows the way(Sousa, 2008, 2009).

In order to achieve that goal information system planning promoted by the information systems analyses and conception model is oriented according to information flow doing ecosystem definition.

The architecture model of analyses and conception is presented on figure 1, where is possible to see model for the information ecosystem management in any organization.

As is possible to see organization information is no more confined to organization walls but needs to flow to promote innovation and organization development. In this 2.0 web world organization should be able to acquire any possible information evolution that occurs. And what is possible to see is information transformation that flow to the organization ecosystem to be transformed into knowledge them returns to organization to be used as input as needed.

Any information system planning for this kind of interaction must consider this flow.

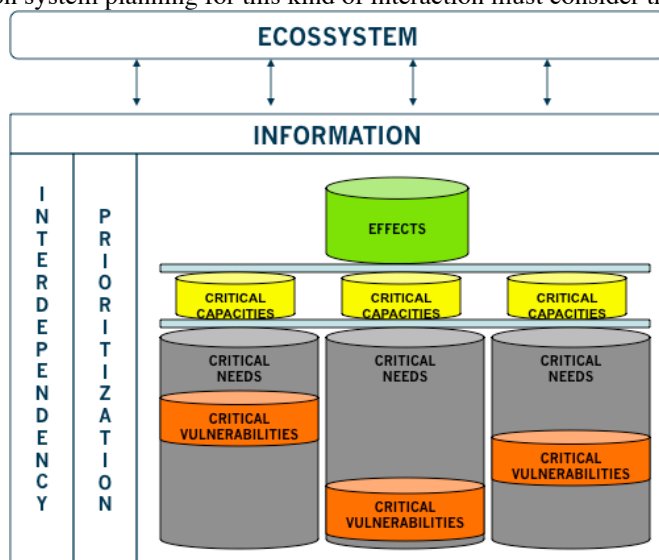


Figure 1 – Information system planning model using effects(Sousa, 2008, 2009)

As said, this model is centered on information effect and in how information systems should be developed to get the expected result.

The expected effects are supported in tree central elements that in coordination should map what is need for the right development.

So, main definitions of information effects characteristics should be done in way that focus security of information in order to guarantee information reliability and that is done by using three central elements:

- Critical capacities;
- Critical needs;
- Critical vulnerabilities;

These elements are part of information object and responsible to promote the wanted effect. This security aspect of information flow is a central element for organization innovation since is information is only valuable when is reliable.

Critical capacities define the base elements for effects realization. These base elements can be any kind of elements from hardware, software or any kind of user or organization activities.

Critical needs define needed support elements integrating critical vulnerabilities in order to translate security into effect creation.

Prioritization and interdependency, two fundamental elements of software engineering for requirements management, are integrated to map effects relationships and development sequences.

Prioritization is responsible for characterization of effects order, and depends on importance, penalties, cost, time, risk and volatility. Effects relations are managed by interdependency that can be of three types: structural, conditioned or cost/value.

Table 1 presents the variables of each interdependency type.

Table 1 - Interdependency variables

Interdependency		
Structural	Conditioned	Cost/Value
Refined to	Requires	Decrease cost of
Changed to	Conflicts with	Raises cost of
Similar to		Decrease value of
		Raises value of

With this architecture of information systems planning using information effects is possible to analyze, define, develop and manage any information system to support organization information life cycle with no need to rely on strategic alignment or standard requirements definition.

Effect, as information characteristic, is the central element and each organization can define the associated goal.

3. Semantic Web Culture of the Crowds

Information systems planning using information effects are web 2.0 and ecosystem information flow paradigms based, in order to promoting the information systems dynamic evolution.

For this dynamic ecosystem, the fundamental point is, how to collect information needs of ecosystem elements, without the need to promoting user expertise for collecting relevant up to date information. Finding where the ecosystem stores that information, how often the information is need and what kind of interactions it develops and sustains.

Standard requirement management is done by few elements with local expertise and in this ecosystem model everything is dependable and related so many should do it. It them a structural and necessary to have a meaningful representation of information for all ecosystem elements and information flow in order to create the structure for analyze, conception and development of information systems model.

A representation model of this interaction with information is necessary to find.

Semantic web can represent information that is distributed, can express meaning, can represent knowledge, and can create collections of information called ontologies (Tim Berners-Lee, 2001), them can be the starting point for this development. The ability to represent distributed information creates conditions to be used in the ecosystem where information flow trough all ecosystem elements. Express meaning is the key element to support the relevant context

of information use, and the knowledge representation is need for collection user interactions and developments supported based in the use of some information.

The use of semantic web can create condition for the use of wisdom of crowds to obtain dynamic ontologies that promote information systems ecosystem dynamic evolution.

With the wisdoms of crowds, that will be represented by all the elements of the ecosystem that interact with some information, are expectable that a dynamic pattern of ontologies can emerge. This combination of wisdom of crowds is a particular vision associating all emergent collaborative solution that promote information development and interchange, and that are considered one essential parte for the development of this model.

Semantic ecosystem can then be complementary to the web 2.0 vision of the model (Ankolekar, Kr̂ttsch, Tran, & Vrandecic, 2008).

The creation of dynamic ontology cannot only be related to business domain [(Z. Jin, 1998) but should be able to address the organization ecosystem.

Semantic ecosystem can be the foundation for this collective knowledge integration, for its ability to allow ubiquitous interactions, give structure to ecosystem information content, creating conditions for the development sophisticated information processing (Mikroyannidis, 2007).

With this vision is possible to collect a large amount of information that cans them being processed using by semantic mining. Semantic mining is this model the application of data mining techniques to ecosystem dynamic ontologies resources (Bettina Berendt, 2002). Semantic mining can be applied to content mining, structure mining and usage mining.

This structure has a main goal that is to allow information management in an automatic manner, and semantic mining can help in ontologies definition to organize information, creating the possibility for ontology learning, with the mapping and merging ontologies and instance learning (Bettina Berendt, 2002). In this form, information is ready for the wisdom of crowds finds of ecosystem information needs.

There is no proving that anyone could be considered expert in “strategy” or “decision making” but diversity is a value by itself (Surowiecki, 2007). It must be possible to achieve the balance, between the need that individual knowledge results global and collectively useful, without simultaneously lower its local specificity.

Despite the facts that crowds can be naive and simple agents, they can be coordinated to achieve a certain complex goal. As individual they don’t know where they go, but as a part of the ecosystem they are suddenly capable to reach there and fast. With this it’s possible to obtain ontologies promoted by semantic solution (Mika, 2007).

This reality leads to, if it is possible to collect semantic information, process it and integrated into information effects planning model, its possible to have dynamic ontology based on the many, and in this way information systems architecture also be dynamic.

Dynamic ontology will be the result of semantic mining integrated with information ecosystem context and this development will be the central element for identifying organization information needs and relationships.

We live in a world of contexts where each of can contribute to the information ecosystem realization. In this world semantic web tools create conditions for informational context integration in the information systems planning model using effects.

4. Development Process

Information systems planning using effects is fundamental because creates conditions for the ecosystem realization when clarifies the challenges that web 2.0 assimilation puts in information system planning.

New times demand that organizations should be able to support this integration in order to empower organization development.

For been able to achieve the ecosystem, information systems planning must know what are organization information needs, and in this architecture that is done using the semantic culture.

This semantic culture integration is promoted according to the architecture defined on figure 2.

This context acquirement is done with the integration of:

- Semantic web proxy;
- Wisdom of crowds;
- *ISP^{IE}* (Information Systems Planning using Information Effects);

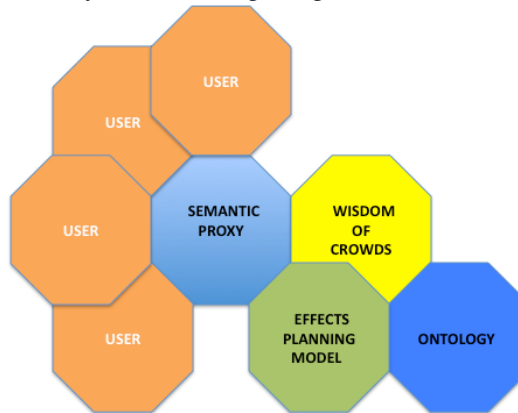


Figure 2 – Semantic information discovering model

This model architecture demands a semantic approach in order to collect information supported in the use of wisdom of crowds to map organization information effects that information systems must empower. These information effects are integrated using a structured evaluation (Sousa, 2009).

In this collect for information semantic mining, wisdom of crowds and ontology learning have fundamental papers in the inputs definition for the information effects planning model.

This architecture uses the traditional web access support done by a proxy server, but in this case uses web or internal information collected using semantic. There is a semantic vision of organization information access and use done by ecosystems elements and not only the use of business ontology. To discover semantic ontology patterns are used wisdom of crowds supported by the development of plug-in tools to support that discover.

The information will be managed using data mining and them mapped into the planning model in order to create ecosystem information flow architecture.

This model will allow the early discover of ecosystem information needs and them been able to develop the architecture that empowers information effects.

Information system planning using effects will be for the dynamic information ecosystem what machinery is for production, the evolutionary tool that promotes innovation and development.

5. Conclusions

Presented model architecture integration of semantic information context into the creation of the ontology will be the most suitable form to information ecosystem. Information system planning using effects has the support for the dynamic information ecosystem development and integration of semantic web with semantic mining allows the creation of ontology learning as input.

This model for information systems planning where information effects and information semantic are central elements is clearly a better solution than strategic alignment where requirements definition resides on defined organization strategy and in the oversize of information systems.

These times are not for oversize but for dynamic moving and there is no strategic alignment able to do that.

The dynamic ecosystem development as presented, can develop the architecture of information system giving organizations the dynamic with a sustained development that in any time of organization development cycle will be there for support.

This architecture is facing the emergent reality of information readiness and reliability, and the information ecosystem allows the exploration of the information according to each element need and after creating correlations is ready for requesting to information effects model the correct architecture.

One challenge for the future is to address a group of elements that could develop this architecture and promote its implementation.

This is the beginning of this model architecture and a demand in the research for the use of the many in behalf of few.

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Personnel Performance Appraisal in ICT. A review of governance and maturity models.

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Abstract: Due to the crucial importance of human capital in the ICT industry, the current work analyses one of the elements which underlies effective management of human assets: performance assessment. The analysis is carried out using the development of a common standard based on the tasks and processes outlined in People CMM, the standard in Human Resource Management. The said framework is evaluated in different models related to IT Governance, such as COBIT, to the management of ICT infrastructures and resources, such as ITIL, to the measurement and establishment of maturity in development, such as CMMI for Development, or related to acquisition projects such as CMMI for Acquisition, and lastly, in relation to the establishment and management of services, such as CMMi-SVC. The results indicate that exclusively COBIT presents reliable coverage in relation to personnel performance assessment.

Keywords: Performance Appraisal, People-CMM, COBIT, CMMi, ITIL.

1. Introduction

The development of intellectual capital of corporations represents one of the most significant challenges for today's managers, and one of the most fertile fields for business innovation. The advancement in techniques for personnel development has enabled the application of practices and processes which foster training and learning, improving the performance of individuals and groups. Studies of Human Capital (for example, Schultz, 1959; Becker, 1964; Mincer, 1974) indicate that this asset is sustained in knowledge, and that this element provides individuals with increases in their cognitive abilities, leading to more productive and efficient potential activity. Drucker (1998) stated that knowledge is the most significant economic resource of a post-capitalist society. This has led to the formation of definitions such as Knowledge Intensive Organizations (KIO), which, according to Starbuck (1992), are those organizations in which "knowledge plays a more important role than any other of the inputs to an organization". In this environment, KIO, in which IT-related organizations are included, according to Hurley & Green (2005) require effective measurement techniques for the development of their employees, both from the perspective of knowledge as well as competency elements (aptitudes, attitudes...). Human capital is particularly critical for competitiveness in high-tech sectors (Bartelsman et al. , 2004) and this circumstance has obliged an increase in the importance of human capital in general

and its evaluation, in particular in different environments focused on the governing and management of ICT. In order to accurately analyze such elements, the current paper proposes a structured reflection of this research field, comparing the practices proposed in the state of the art with those models implemented in the ICT field. To include a more refined analysis, the present paper outlines some recommendations for the inclusion of such practices in different models.

The remainder of the paper is organized as follows. The next section defines the state of the art about people assessment methods, as well as its components and principal implications. This is followed by the description evaluation framework. Subsequently, several ICT related initiatives are analyzed using the evaluation framework. Lastly, the paper presents the principal conclusions and future work of the study.

2. State of the art

Drucker (1954) in the "Practice of Management" first proposed the concept of human resource. Taking into account the importance of this concept, the performance appraisal of human resources has been explored both from a theoretical and applied viewpoint. Performance appraisal is a delicate issue (Myloni, Harzing, Mirza, 2004). Cole (2001, p. 798) defines performance appraisal as a formalized, systematic assessment and discussion of an employee's performance and his/her potential and desire for development and training. In plain words, according to Chilton & Hardgrave (2004) performance is a term that is often used to refer to the degree to which an employee has executed his or her assigned duties. There are three approaches a manager can take in evaluating an individual employee: (1) effectiveness and productivity; (2) evaluation of traits; and (3) evaluation of behaviors (Latham & Wexley, 1977).

According to (Curtis, Hefley & Miller, 2001), the role of performance appraisal as a part of performance management is primarily to record the results of performance for use as input to decisions about adjustments to compensation, personal development planning, staffing, promotion, and other workforce activities. In this way, performance appraisal is the central point for the collection of data which underlie decisions regarding the competency of human assets in their activities, requiring, on the one hand, the definition of the elements for comparison with established performance standards, and on the other hand, mechanisms put into place for the storage and exploitation of performance information.

Poor management of human factors can hinder the use and effectiveness of technology and Information Systems (Ives & Olsen, 1984; Willcocks & Mason, 1988). Examining this aspect even further, performance management has been cited as a common cause of IS failure (Eastman, 1991; Legge, 1989; Seilheimer, 1987). According to Ball and Harris (1982) Information Systems personnel evaluation is the second most critical issue of IS management. Perhaps for this reason, the literature has discussed the difficulty of developing software systems and evaluating IT personnel in the organization for more than 40 years (Boyd et al., 2007). The different goals of the stakeholders lead to different courses of action and conflicting perspectives of this personnel performance (Linberg, 1999), the differences between the perception of the success of IT staff and the success of the standard user being one of the principal sources of disagreement, as exhibited by the evaluation (Jiang et al., 2001).

In this study domain, in one of the earliest studies of IT personnel performance, Arvey and Hoyle (1974) developed a behavioral expectation scale to measure the performance of systems analysts and programmers. Subsequent to this work, contributions by many other authors were made for the construction of a method of performance management (for example, Igbaria & Wormley (1992); Jiang, Sobol & Klein 2000; Chilton & Hardgrave, 2004). The applications of the performance measures proposed are focused on distinct objectives, such as the comparison of

performance between contract versus permanent workers (Ang & Slauter, 2001), fit between individual characteristics and job characteristics (Ketler and Smith, 1993), assignment of personnel in software projects (Acuña & Juristo, 2004; Acuña et al., 2006), to cite some of the most significant cases. Concerning the elements which have been examined in order to achieve an effective evaluation, intensive debates have also emerged among the scientific community regarding the elements for performance evaluation. In a recent significant contribution, based upon a literature review, Boyd et al. (2007) found seven important performance dimensions for IT Professionals: (1) work quality, (2) project work, (3) general tasks, (4) interpersonal quality, (5) dependability, (6) teamwork and leadership, and (7) career related training.

Independently of the evaluation method and the items evaluated, due to the importance of performance appraisal, the authors considered it interesting to determine the level of support which is given to this management tool in the various ICT maturity and governance initiatives. The sections which follow provide a response to this research question.

3. Elements for the analysis.

Prior to realizing the analysis of the evaluation of performance of different frameworks, a reference standard for the management of human capital and a diagnostic element which permits the analysis of the distinct models from a common perspective should be established.

The reference standard in the management of human capital selected was the People Capability Maturity Model (P-CMM). P-CMM is a model of maturity and capacities based on 17 key process areas for the management of human capital in software development organizations, however, it can also be applied to organizations in other industry sectors (Curtis et al. 2001). The model is divided into 5 maturity levels (from level 1 to level 5, which represents a rather restricted view of the management of human capital), each of which represents a change in the culture of the organization. Traversing the levels, each level improves the attraction, deployment, organization, motivation and retention of human capital. Each of the 17 process areas corresponds to one of the four operating levels of the model, and is divided into the following sections: purpose, description, objectives, compromises, skills, practices, measures, verifications. From the perspective of performance management, P-CMM offers an evolution according to level with four phases; at level 2, performance is measured at individual level and is reported to the managers; at level 3, performance is measured at team level, and is reported to the management, together with performance at individual level. At level 4, performance is measured quantitatively; and at level 5, performance is aligned between the teams of the organization. Taking into account the characteristics of this model, for the present research, the model has been analyzed selecting exclusively the process areas which focus on performance management: Performance Management (level 2), Quantitative Performance Management (level 4), Organizational Performance Alignment (level 5); together with the objectives and practices of other process areas linked to this management. As a diagnostic, a checklist for the evaluation of the performance of human capital has been created. For the preparation of this checklist, the P-CMM model has been analyzed examining process areas, activities, and objectives, which cover the elements necessary to evaluate human capital performance. The evaluation, viewed as a process, has been divided into three sub-processes; establishment of measures, measurement, and evaluation of performance. Within each sub-process, generalized practices which are based on at least one P-CMM practice have been included. Each sub-process contains a series of activities with an identifier, a level (individual or group or both), a short description together with the P-CMM practices to which it is related. These practices are defined using the initials of the process area which they pertain to, and the practice number. The table below demonstrates the checklist.

Table 1 – Checklist

Process	Subprocess	ID	Activity	Mode
<i>Human Capital Performance Assessment</i>	Establishment of measures (EST)	EST1	Individual. (PM: P4, P5) (QPM: P3) (C-BP: P7)	I
		EST2	Unit (PM: P1, P2) (QPM: P2) (C-BP: P6) (WP: P6)	G
		EST3	Group (QPM: P3) (WD: P3)	G
	Performance measurement (MED)	MED1	Individual Level (PM: P7) (QPM: P5, P6) (CCI: P2)	G
		MED2	Unit Level (PM: P3) (WP: P11)	I
		MED3	Group Level (QPM: P5, P6) (WD: P13)	G
		MED4	Almacenamiento de las mediciones de rendimiento (QPM: P8)	A
	Evaluation of performance (EVA)	EVA1	Individual Level (PM: P9) (C-BP: P8, P9) (CCI: P3)	I
		EVA2	Group Level (EW: P11) (CCI: P6)	G

I= Individual; G= Group; B= Both

The section which follows presents the analysis of the evaluation of performance using various ICT models, employing as analysis tool the checklist just described. The use of the checklist may be split into three levels. At the activity level, an activity is considered covered when at least one element of the model under analysis has the same objective as the activity in the P-CMM model. At the sub-process level, three categories have been considered: performance appraisal at individual level, when the model covers individual employee activities (I); covered at group level, when the model applies measurement and evaluation at group level (G); and covered at both levels, when the model covers all activities of the P-CMM model together with those which pertain to both categories, individual and group (A), or “joint”.

4. Analysis of the models in relation to human capital evaluation practices

The models selected for the analysis are focused on the following principal areas: ICT management, project development, and outsourcing. For the selection of the models, their relevance and level of use has been taken into account, both in academic and organizational environments. Employing the diagnostic element formulated in the previous section, the results of the analysis for the following models will be presented and discussed: ITIL, COBIT, CMMi-DEV, CMMi-ACQ y CMMi-SVC. For each model, the following aspects are included: a brief description of the model, the checklist as applied to the model, and a summary of the analysis together with the considerations taken into account for performing the analysis. Upon completion

of the analysis of the models, the section includes a diagram which summarizes the conclusions of the findings.

4.1. Information Technology Infrastructure Library (ITIL)

Information Technology Infraestructura Library (ITIL) is a standard of best practices whose objective is to manage ICT infrastructure efficiently, with the objective of guaranteeing the levels of service agreed upon by the ICT organization and its clients (OGC, 2009). ITIL in version 3 consists of a set of five books published by the Office of Government Commerce (OGC), which empowers an ICT organization to improve the service it offers to its clients. Each of the books covers a specific area: Service Strategy, Service Design, Service Transition, Service Operation, Continual Service Improvement; this set has been entitled ITIL Core. For each area, ITIL defines objectives, activities, and the inputs and outputs of the processes of the ICT organization. Using these elements as a basis, it is possible to realize an analysis of the evaluation of the performance of human capital from the ITIL perspective.

The elements of ITIL utilized for the analysis of this model are processes, together with sub-processes, and their associated activities. Based on these elements, and using the checklist, the following results are obtained:

Table 2 – ITIL personnel assessment coverage

Activity (ID)	Related Elements	Covered (Yes/No)
<i>EST1</i>	Service Design: Roles & Responsibilities	Y
	Service Transition: Roles & Responsibilities	
	Service Operation: Roles & Responsibilities	
	Continual Service Improvement: Roles & Responsibilities	
<i>EST2</i>		N
<i>EST3</i>	Service Design: 4.2 Service Level Management	Y
<i>MED1</i>		N
<i>MED2</i>	Service Transition: 4.4 Release and Deployment Management	Y
<i>MED3</i>	Service Design: 4.2 Service Level Management, 4.3 Capacity Management	Y
	Service Transition: 4.1 Transition Planning and Support, 4.2 Change Management, 4.4 Release and Deployment Management	
	Service Operation: 5.1 Monitoring and Control	
	Continual Service Improvement: 4.3 Service Measurement	
<i>MED4</i>	Service Design: 4.3 Capacity Management, 4.6 Information Security Management	Y
	Service Transition: 4.7 Knowledge Management	
<i>EVA1</i>		N
<i>EVA2</i>	Service Design: 4.2 Service Level Management, 4.7 Supplier Management	Y
	Service Transition: 4.4 Release and Deployment Management, 4.6 Evaluation	
	Service Operation: 5.1 Monitoring and Control	

Taking into account the results displayed in the previous table, it can be deduced that ITIL does not cover the entire process of human capital performance evaluation, the model lacks elements for measuring and evaluating at individual level (MED1, EVA1), however, it does define roles and responsibilities for the entire service provision life cycle (EST1). At joint level, ITIL does not cover performance measurement (MED2). To carry out the current analysis, ITIL has been considered in the context of services; with the outcome that the practices for human capital performance evaluation for groups are considered uniquely for services in the context of this framework or model.

4.2. Control Objectives for Information and related Technology (COBIT)

COBIT is a set of recommended practices for the governance of Technologies and Information Systems (TIS), created by the Information Systems Audit and Control Association (ISACA), and IT Governance Institute (ITGI) (ISACA, 1996). COBIT 4.1 is organized into 34 high level control objectives for TIS processes, which are grouped into 4 activity domains for the governance of TIS: Plan and Organize (PO), Acquire and Implement (AI), Deliver and Support (DS), Monitor and Evaluate (ME). For each of the 34 objectives, COBIT provides detailed control objectives, 215 objectives in total. All of the objectives, both those at high level (34), as well as the detailed objectives (215), are correctly structured and contain explanations of their purposes and reach (ITGI, 2007). COBIT defines the relation between an ICT organization and its goals, as a set of clearly defined processes which use the skills of the employees, and the infrastructure, to use automatic business applications, adding value to the information of the organization.

The elements of COBIT used for the analysis are the detailed objectives, based on which, and using the checklist, the following results are obtained:

Table 3 – COBIT personnel assessment coverage

Activity (ID)	Related Elements	Covered (Yes/No)
<i>EST1</i>	PO4.12 , PO7.3, PO10.8	Y
<i>EST2</i>	PO10.7 (at project level)	Y
<i>EST3</i>	DS1.3, DS1.4 (at service level)	Y
<i>MED1</i>	PO7.3, DS3.5	Y
<i>MED2</i>	PO10.13 (at project level), DS3.5	Y
<i>MED3</i>	DS1.5 (at service level), DS3.5	Y
<i>MED4</i>	ME 1.2	Y
<i>EVA1</i>	PO7.7, DS3.2	Y
<i>EVA2</i>	DS3.2 (at service level)	Y

Taking into account the results of the previous table, it can be said that COBIT covers the entire performance evaluation process of human capital, which includes its sub-processes and activities. In order to realize the analysis, the researchers considered the characterization of

COBIT focusing on services and projects; this has been subsequently formulated as the conclusion that the performance appraisal of human capital practices for individual employees are considered in this model for projects only, and group evaluation for services.

4.3. Capability Maturity Model Integration for Development (CMMi-DEV)

CMMi-DEV (CMMI, 2006) provides a comprehensive integrated solution for development and maintenance activities applied to products and services. This model forms part of a set of models whose objective is to cover the necessities of specific areas. CMMi-DEV follows the structure CMMi Model Foundation, which defines, among others, the following elements: objectives, roles, measurements, and verifications. Taking into account these elements, it is possible to analyze human capital performance evaluation from the perspective of this model.

The elements of CMMi-DEV used for the analysis are the practices, both generic and specific, based on which and using the checklist, the following results are obtained:

Table 4 – CMMi-DEV personnel assessment coverage

Activity (ID)	Related Elements	Covered (Yes/No)
<i>EST1</i>	GP 2.3, 2.4, 4.1;	Y (Low coverage)
<i>EST2</i>	MA: SP 1.1, SP 1.2	Y (Low coverage)
<i>EST3</i>	SAM: SP 1.3 (Supplier)	Y
<i>MED1</i>	IPM: SP 1.4; QPM: SP 1.1, 2.1(Project);	Y (Low coverage)
<i>MED2</i>	(IPM) + IPPD: SP 3.3 (Team)	Y (Low coverage)
<i>MED3</i>	GP 2.8, 4.2;	Y
<i>MED4</i>	MA: SP 2.1	Y
<i>EVA1</i>	SAM: SP 2.2 (Supplier)	Y (Low Coverage)
<i>EVA2</i>	IPM: SP 1.5; PMC: SP 1.1; QPM: SP 1.4, 2.3 (Project);	Y

Examining the results obtained, it can be concluded that CMMi-DEV covers the entire performance appraisal process. It should be mentioned that the coverage of the practices at individual and joint level is low, given that CMMi-DEV does not include practices exclusively dedicated to evaluate performance at these two levels. To realize the analysis, the researchers considered the characterization of CMMi-DEV as focused on the development of projects; this has led to the conclusion that evaluation performance practices for groups are considered for projects in this model, and individual employees for suppliers.

4.4. Capability Maturity Model Integration for Acquisition (CMMi-ACQ)

CMMi-ACQ (CMMI, 2007) is a maturity model evolution of CMMi-DEV model focused on the acquisition process of acquirer organizations. This model follows the structure of the CMMi

Model Foundation, making it possible to utilize its elements to analyze the evaluation of the performance of human capital from the perspective of this model.

The elements of CMMi-ACQ used for the analysis are the practices, both generic and specific, based on which, and using the checklist, the following results are obtained:

Table 5 – CMMi-ACQ personnel assessment coverage

Activity (ID)	Related Elements	Covered (Yes/No)
<i>EST1</i>	GP 2.3, 2.4, 4.1;	Y (Low coverage)
<i>EST2</i>	MA: SP 1.1, 1.2	N
<i>EST3</i>		Y
<i>MED1</i>	IPM: SP 1.4; PP: SP 2.1; QPM: SP 1.1, 2.1 (Project);	Y (Low coverage)
<i>MED2</i>	IPM: SP1.6 (Team)	N
<i>MED3</i>	GP 2.8, 4.2;	Y
<i>MED4</i>	MA: SP 2.1	Y
<i>EVA1</i>		Y (Low coverage)
<i>EVA2</i>	PMC: SP 1.1, 1.2; QPM: SP 1.4, 2.3 (Project)	Y

Examining the results obtained, it can be concluded that CMMi-ACQ does not completely cover the human capital evaluation process. The model does not cover the evaluation of performance at joint level, and its coverage at individual level is scarce. The conclusion in this case is that this model exclusively covers evaluation of performance for the group framework; teams, projects, services. To realize the analysis, the characterization of CMMi-ACQ has been considered focused on the acquisition of projects; this has been translated into the conclusion that only performance evaluation practices for groups are considered in this model, as well as for work teams, projects and services.

4.5. Capability Maturity Model Integration for Services (CMMi-SVC)

CMMi-SVC is a maturity model which covers the activities necessary to manage, establish and deliver services (CMMI, 2009). Similarly to CMMi-ACQ, it is a model based on CMMi to adapt itself to the requirements of organizations which provide services. Given that its structure is based on the CMMi Model Foundation, it is possible to analyze performance evaluation of human assets in this model in the same way as in the two previous models. CMMi-ACQ contains elements in common with CMMi-DEV and CMMi-ACQ, and adds objectives and practices specific to the provision of services.

The elements of CMMi-SVC used for the analysis are practices, both generic and specific, based on which and using the checklist, the following results are obtained:

Table 6 – CMMi-SVC personnel assessment coverage

Activity (ID)	Related Elements	Covered (Yes/No)
<i>EST1</i>	GP 2.3, 2.4, 4.1;	Y (Low coverage)
<i>EST2</i>	MA: SP 1.1, 1.2;	Y (Low coverage)
<i>EST3</i>	SSD: SP 2.2	Y
<i>MED1</i>	SAM: SP 1.3 (Supplier)	Y (Low coverage)
<i>MED2</i>	IPM: SP 1.4; QPM: SP 1.1, 2.1 (Project);	Y (Low coverage)
<i>MED3</i>	IPM: SP1.6 (Team);	Y
<i>MED4</i>	CAM: SP 1.2; SD: SP 1.2 (Service)	Y
<i>EVA1</i>	GP 2.8, 4.2;	Y (Low coverage)
<i>EVA2</i>	MA: SP 2.1;	Y

Taking into account the results obtained, it can be concluded that the CMMi-SVC model covers the entire human capital performance evaluation process. The model lightly covers the evaluation of performance at joint and individual level. Therefore, the conclusion is that the model covers performance evaluation for the group model; teams, projects, and services. To realize this analysis, the characterization of CMMi-SVC has been as being centered on service provision projects; thus performance evaluation from a group perspective is considered for this model, as well as work teams, projects and services, and units for suppliers. To finalize, Figure 1 includes a graphical vision of the coverage of the elements of Personnel performance assessment in the models analyzed.

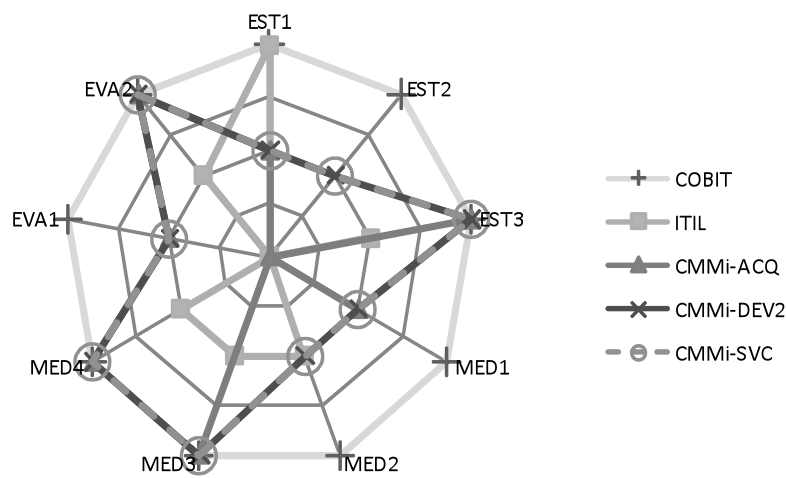


Figure 1 – People Assessment in ICT Models: a graphic vision

5. Conclusions and future work.

The current work has presented a study carried out of the coverage of diverse models of personnel performance which are relevant to the management of ICT organizations. The results obtained exhibit disparate characteristics with regard to coverage of the global process, only COBIT covers the entire evaluation process exhaustively, while the CMMi-ACQ and CMMi-DEV models cover it, but display weaknesses with regard to individual and joint levels, and lastly, ITIL does not cover the process satisfactorily. The results, in spite of the overall differences, have certain similarities. Among these are; all of the models cover the establishment of measures for individuals (EST1), the storage of the performance measures (MED4) and the evaluation of performance at group level (EVA2). Regarding the differences, not all of the models cover the establishment of measures for units (EST2) and groups (EST3), some lack elements for the measurement of performance in the three categories (MED1, MED2, MED3) and only COBIT covers the evaluation of performance at individual level (EVA1).

As future research lines, three different study areas are proposed. In the first place, it is proposed to extend the work to other models which are considered of relevant application in the ICT field, and in particular, applicable to Chief Information Officer, such as COSO, for the case of risk management, PMBoK and PRINCE2 in project management and ISO 20000, eTOM and BPM for IT services, operations and infrastructure. In the second place, a study is proposed which covers the personnel competencies cycle in the context of evaluation, focusing on fields such as compensation and the management of competencies for the alignment of the performance and job position. Lastly, and as principal future research line, the development of a standard which includes recommendations for the integrated inclusion of management measures in the context of management tools for ICT is proposed.

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Framework for Innovation-Oriented IT Management

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Abstract: Companies are in worldwide competition for innovations which are essential to ensure their competitiveness and consequently their business success. Information technology (IT) plays an important role in this context. Thus, it is expected from the IT department to provide an own value contribution to the corporate performance by delivering innovations. Due to the high importance of such IT-enabled innovations, the central task of IT management is to ensure an innovation-encouraging use of IT. Therefore, this research paper reveals how IT management should ideally be designed to encourage IT-based innovations. For this purpose, a literature review and expert interviews have been conducted. Altogether 14 experts – IT department manager, IT business unit manager and IT consultants – have been interviewed.

Keywords: IT Management; IT-based Innovation

1. Significance of IT for innovations

IT organizations are facing a changing understanding of their responsibilities and their role in companies. They are no longer just seen as IT service providers but as business-oriented drivers for innovations which have an impact on the business concept (Rohloff 2007). Thus, it is not enough that IT supports business processes only cost-efficient. It is expected from the IT organization to provide an own value contribution to the corporate performance by delivering innovations (Vollmer et al. 2008). Oftentimes IT enables innovations and is the decisive factor for the business development and the competitiveness (Müller & Neidhöfer 2008) (Baschin 2001).

In general, IT can enable three kinds of innovations in business (Hofbauer & Wennmann 2008) (Dietrich & Schirra 2006):

- product and service innovations: new products and services or the improvement of existing products and services
- process innovations: certain parts of a business process or the entire business processes are improved measurably
- strategic innovations: IT enables new businesses or new business models

2. Implications for the IT management

Due to the high importance of IT-enabled innovations, the central task of IT management is to ensure an innovation and value increasing use of IT (Holtschke et al. 2008) (Pritsch & Gushurst 2006) (Kütz 2006). This way, IT management can establish a unique selling proposition for the whole company (Müller & Neidhöfer 2008).

In order to ensure such an innovation-conducive use of IT, 'innovation' has to become a central perspective within IT management (Wintersteiger 2007). Consequently, the innovation aspect has to be considered in IT management frameworks (Vollmer et al. 2008).

Within literature and practice there are several IT management frameworks which could be used by IT department managers. Table 1 contains an overview of such known task-oriented frameworks.

Table 1 – Task-oriented IT management frameworks

References	IT management framework
<i>(Biethahn & Muksch 2004)</i>	Framework of Biethan, Muksch and Ruf
<i>(Griese 1990)</i>	Framework of Griese
<i>(Heinrich 1996)</i>	Framework of Heinrich
<i>(Krüger & Pfeiffer 1990)</i>	Framework of Krüger and Pfeiffer
<i>(Rauh 1990)</i>	Framework of Rauh
<i>(Stickel 2001)</i>	Framework of Stickel
<i>(Krcmar 2003)</i>	Framework of Krcmar
<i>(Szyperski & Winand 1989)</i>	Framework of Szyperski and Winand
<i>(Voß & Gutschwager 2001)</i>	Framework of Voß and Gutschwager
<i>(Wollnik 1988)</i>	Framework of Wollnik
<i>(Brenner 1994)</i>	Framework of Brenner
<i>(Dobschütz 2000)</i>	Framework of Dobschütz
<i>(Österle & Brenner 1992)</i>	St. Galler framework
<i>(Zarnkow & Brenner 2004)</i>	Integrated information management framework
<i>(Brombacher 1991)</i>	Framework of Brombacher
<i>(Gabriel & Beier 2001)</i>	Framework of Gabriel and Beier

Most of the existing frameworks are insufficient in the context of innovations because they provide only less or even none detailed information about possibilities for fostering innovations based on IT. Examples are (Biethahn & Muksch 2004) who consider 'innovation management' as a strategic task and (Griese 1990) who issues 'innovation' as one of five topics of his framework.

3. Research methodology

The previous chapters pointed out the relevance of IT for innovations as well as the requirements concerning the IT management. Considering those explanations, the question comes up how IT management should ideally be designed in order to encourage IT-based innovations. Therefore, the following chapter reveals the aspects which are essential for an innovation-conducive IT management.

For this purpose, we analyzed data from different sources. For one thing, we conducted a thorough literature review within information system (IS) academic journals, proceedings of the leading IS conferences as well as other publications. As there are no integrated concepts for an innovation-conducive management of IT available in literature, we used qualitative research methods. For this work several elements of the so called Grounded Theory according to Glaser and Strauss are being used (Glaser & Strauss 1967). It is rather a style how to analyze qualitative data than a specific method or technique (Strauss 1994). In contrast to other methods, the Grounded Theory does not start with a theory that should be proved. It starts with a research question and lets the theory evolve itself. For this reason, this paper starts not with a certain number of existing hypotheses but asks generally and impartial for aspects of an innovation-conducive IT management and concretizes them during this examination. In order to achieve these factors we conducted interviews in an iterative way until the theoretical saturation was achieved. Altogether 14 experts – chief information officer (CIO) / IT department manager, IT business unit manager and IT consultants – have been interviewed. For data analysis we used open coding according to Glaser (Glaser 1992).

4. Factors for an innovation-conducive management of the IT

Based on our research we identified three essential aspects for an innovation-conducive IT management. These are:

- the development and design of the IT strategy (cf. chapter 4.1),
- the design of different IT control objects which are important in order to encourage IT-based innovations (cf. chapter 4.2) and
- methods and tools that can be used for the management of the IT (cf. chapter 4.3).

In order to ensure an innovation-conducive IT management, the innovation aspect has to be considered adequately in all these aspects.

4.1. IT strategy

To ensure an innovation-conducive use of IT, this aspect has to be anchored adequately within IT strategy. For this purpose, it's seems promising to establish an own IT innovation strategy as part of the superior IT strategy. This IT innovation strategy should determine and describe all aspects concerning the generation of IT-based innovations. By this, it creates the required general conditions for innovating successfully with IT. Beside the IT innovation strategy, several other partial strategies could be derived from the IT strategy, e.g. IT personnel strategy and IT finance strategy.

Another important aspect of the IT strategy is its temporal horizon. In many IT organizations the IT strategy is determined for a period of three up to five years. But in the context of

innovation-conducive IT management, the IT strategy should not strictly be determined for such a long period. It rather should be reviewed regularly and – if necessary – adapted to the new conditions. By this, the IT management can assure that new technologies with a high potential for innovations as well as new business requirements which should be supported by IT can be considered appropriately.

Furthermore, the IT strategy should not just be derived from the business strategy (alignment). Oftentimes, new information technologies enable new products, new processes or even new business models. Therefore, there should be a feedback of IT to the business strategy (enabling). By this, the potential of information technologies for innovations can be incorporated in the business strategy.

4.2. IT control objects

Our research revealed that five IT control objects are essential in the context of an innovation-conducive IT management. These control objects are (cf. figure 1):

- * IT project portfolio
- * IT system portfolio
- * IT process and service portfolio
- * IT staff
- * IT organization

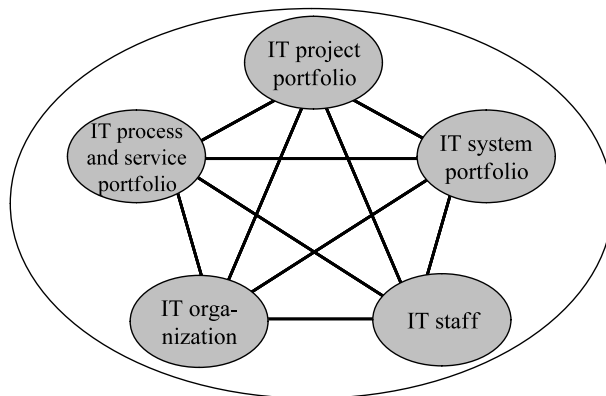


Figure 1 – Essential IT control objects for an innovation-conducive IT management

In order to ensure an innovation-encouraging use of IT, several aspects have to be considered concerning these IT control objects.

Within the IT project portfolio, sufficient resources for the implementation of business strategy as well as for realizing IT innovation projects have to be provided. Furthermore, project teams with fundamental IT and business knowledge and an extensive involvement of business departments into the IT project portfolio management process encourage IT-based innovations.

Related to the IT system portfolio, IT departments should conduct technology management systematically and continuously. Beside this, a flexible IT architecture as well as an innovation-conducive composition of the IT system portfolio foster innovations based on IT. Finally, an early provision of new systems and system components leads to a further increase of the innovation potential of information technologies.

In the context of IT process and IT service portfolio, following aspects foster the generation of IT-enabled innovations: a continuous examination and adaptation of the IT service portfolio, a continuous improvement of IT processes and services and a proactive management of innovation-conducive IT services. Beyond this, also a differential management of commodity services and strategic services as well as an innovation-conducive design of cost charging for IT services help to encourage innovations based on IT.

Additionally to the portfolios mentioned above, also an adequate management of IT staff is essential for an innovation-conducive IT management. For IT staff's innovation capability it is essential to promote freedom and creativity. Additionally the exchange of ideas and communication has to be supported. It is also important that leadership on all levels is innovation-conducive. Furthermore, to stimulate IT staff's innovative strength they need the right incentives. After all, a sufficient IT and business knowledge of the personnel is required to use the IT innovation potential successfully.

There are even several approaches for an innovation-conducive design of an IT organization itself. First, it is important to design the internal IT organization innovation-oriented. The technology management for information technologies should be anchored in the IT department organization. A regular exchange of information between the IT department and business units about the possibilities and demands of new information technologies is promising. Also the cooperation with innovative external partners contributes to the IT organization's innovation capability.

4.3. IT methods and tools

IT department manager need appropriate methods and tools for a successful management of the IT. According to our research, especially methods and tools like an IT balanced scorecard or IT key performance indicator (KPI) systems are widely used for managing IT organizations. By an appropriate consideration of the innovation aspect within these kinds of methods, IT department manager can help to establish a more innovative use of IT.

There are a lot of possibilities to incorporate innovation in those methods and tools. For one thing, IT department manager can use IT KPI systems with an adequate amount of innovation-concerning KPIs. For another thing, the innovation aspect can be considered within IT balanced scorecard at different positions, for example in the mission and the vision. Furthermore, IT department manager can anchor innovation by defining an own innovation perspective as part of the IT balanced scorecard.

5. Summary

This research paper points out how IT management ideally should be designed in order to encourage IT-based innovations. In this context, three essential aspects for an innovation-conducive IT management have been identified: an IT organization's strategy, its control objects as well as the methods and tools which are used. In order to ensure an innovation-conducive IT management, the innovation aspect has to be considered adequately in all these aspects. Regarding the IT control objects, following objects are essential: IT project portfolio, IT system portfolio, IT process and service portfolio, IT staff and IT organization. Considering these research results, IT organizations can help to establish a more innovative company and thus contribute to increase the competitiveness and consequently the business success.

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Information Systems Architectures

Governance and Management of Information Technology: Decomposing the Enterprise in Modular Building Blocks Based on Enterprise Architecture and Business Oriented Services

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Abstract: The aim of this paper is to present a proposal for a model that supports organization governance through the alignment of business with Information Technology - IT. Initially, it was observed that there are some paradigms that limit the use of enterprise architectures and ultimately hinder governance functions. Secondly, it focuses on the IT unit, where IT systems and subsystems are interrelated and the performance levels of the organization were aggregated, to create a macro-structure system capable of supporting corporate governance and IT. Finally, the IBM's Component Business Model - CBM® was applied to represent relationships of IT unit with the organization, through decomposing the organization into business components that supply and demand services to facilitate their governance and management.

Keywords: business service, component business model, enterprise architecture, governance, management.

1. Introduction

Organizations operate as large systems composed of other systems and subsystems. Considering organizations as systems raises questions about the interdependence of its systems and subsystems. This is especially relevant when dealing with issues involving human activity in social systems, including production organizations, in which the factors involved depend upon different fields of knowledge and different levels of research (Kasper, 2000).

In this context, Information Technology (IT) appeared in order to facilitate the systemic flow of information in organizations, initially serving as a support tool for routine operations. Nowadays, the existence of IT is an essential factor for maintaining a competitive advantage. For it to fulfill its current mission, two key concepts can be considered: enterprise architecture and the concept of business services.

The application of enterprise architecture in conjunction with business services is capable of generating a competitive advantage, since the resulting solution allows the attributes of interoperability, flexibility, cost-effectiveness and innovation to be better explored.

This article presents a model that applies the knowledge of enterprise architecture and business services as a way to make corporate governance and IT viable.

The objective is to promote the alignment of business with IT, decomposing the organization into business components that supply and demand services based on elements of enterprise architecture, in order to facilitate their governance and management.

Justification for this article comes from the recurring use of different paradigms of enterprise architecture to map out an organization. This vision is disaggregated, due to the application of different paradigms generating rework in enterprises, because any problem diagnosed is examined from different points of view.

The contribution here is in presenting a model that supports the dimensions of organization governance through the alignment of business with IT. It considers the three paradigms of enterprise architecture to map out an organization and the business services concept.

2. Theoretical Reference

The theoretical reference presents the main knowledge base that subsidized the proposed model. The concept of performance levels; enterprise architecture and services; paradigms of enterprise architecture; IT subsystems; and business components will be presented.

2.1. Performance Levels

According to Rummler (1994), to understand the dynamics of an organization as a system one can divide it into three levels: organization, processes and implementation.

At the organization level, the strategies, governance, structure, enterprise architecture and the use of resources are considered and evaluated, in addition to the tools that help in understanding the vision of customers, suppliers and human resources in order to improve the organization's business model.

At the process level, the business model is represented by the flow of processes and procedures.

At the implementation level there are people, technical architectures and technologies that enable the implementation of procedures. Regarding people, we refer to the profile of professionals that contribute to achieving the goals of the business and through this we can build the foundations for hiring policies, for defining responsibilities, for rewards and for training.

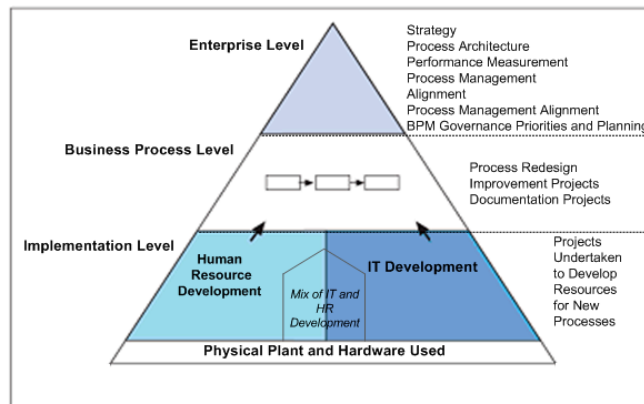


Figure 1 – Performance Levels (Source – Harmon)

2.2. Enterprise architecture and services

Comprehending the concept of enterprise architecture depends upon understanding architecture, stakeholders, and enterprise concepts. The following concepts are defined according to the IEEE 1471-2000 norm or by inference:

Architecture - is the organization that is key for a system's body considering its components, the relationships between components and the external environment, as well as the principles that guide its design and its development (Dragstra *apud* IEEE 1471-2000).

Stakeholders - an individual, a team or an organization with interests or concerns related to the system.

Enterprise - a collection of business units that has a defined set of goals or interdependent operations (Dragstra *apud* IEEE 1471-2000).

Enterprise architecture - a coherent whole of principles, methods and models that are used in the design and implementation of an enterprise structure, business process, information system and technical infrastructure (Dragstra *apud* IEEE 1471-2000).

In other words, Enterprise Architecture aims at communicating the essential elements that explain the operation of an organization, allowing its managers to have a clear idea of the issues that must be dealt with to reach the desired goals. Thus, the entire organization is represented, expressing and aligning goals, visions, strategies, principles of governance, operational processes, organizational structures and aspects of automation, such as information systems and technology infrastructure.

This representation ability of enterprise architecture allows for continually refining information technology, without jeopardizing alignment with the business organization and favors the permanent retention of knowledge to facilitate decision making.

It is necessary to understand the concept of services concurrently with the concept of enterprise architecture. A service can be defined as a functionality that some entity (system, enterprise unit, etc.) offers to its environment, which has value for certain entities in the environment (typically service users) (Lankhorst, 2005).

The importance of using the services concept in conjunction with the enterprise architecture concept arises from the fact that the services concept is widespread in different areas of an organization, allowing IT and business employees to have a common language.

Applying the services concept in conjunction with enterprise architecture can generate a competitive advantage, since the resulting solution allows a better attributes` exploitation of interoperability, flexibility, cost-effectiveness and innovation.

2.3. Enterprise architecture paradigms– IT-centric, business process-centric, governance-centric

According to Dragstra (2005), there are three approaches that aim at representing an organization based on enterprise architecture elements in order to achieve the alignment of business with IT. They are:

- • IT-centric.
- • Business process-centric.
- • Governance-centric.

The IT-centric concept is based on utilizing enterprise architectures to improve effectiveness and efficiency in the technological area. The IT-centric vision is a widely used approach that creates an architecture that shows different models of IT and resources and explains how they relate (Figure 2) (Dragstra, 2005).

Usually, this view is presented using a model of four layers made up of: business; information; application; and technical infrastructure.

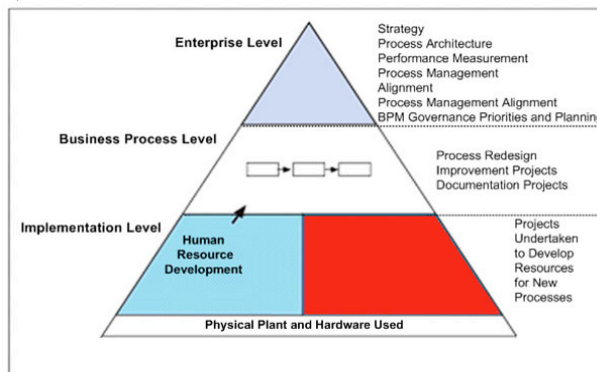


Figure 2 – IT-Centric. Source: Dragstra.

The business process-centric concept defines a sequence of activities and knowledge required to produce the desired results. In this case, enterprise architecture focuses on all the processes of an organization, seeking to optimize them and to create new opportunities for refinement (Figure 3) (Dragstra, 2005).

Application architectures and infrastructure technologies are also used in this approach in a secondary role.

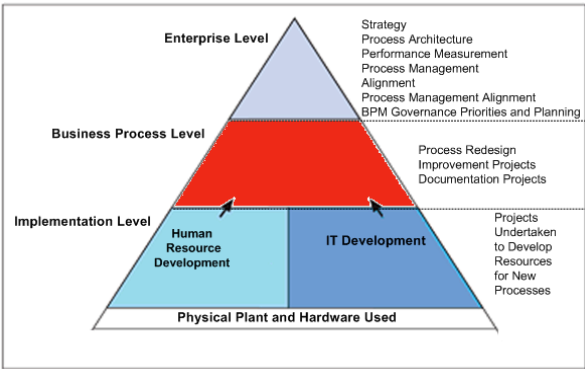


Figure 3 – Business process–centric. Source: Dragstra

The governance-centric concept is interconnected with a description of the desired functionalities of the components, which is represented by specifying the results to be achieved.

Since organizations are composed of a set of complex systems, there are two ways to govern them. The first way is to focus on improving management systems and control of the organization as a whole. The second divides the organization into a network of small manageable parts, called business domains.

The governance-centric vision uses a governing approach and emphasizes boundary demarcation on different levels (organization, processes and implementation) and between organization personnel and IT systems (Figure 4).

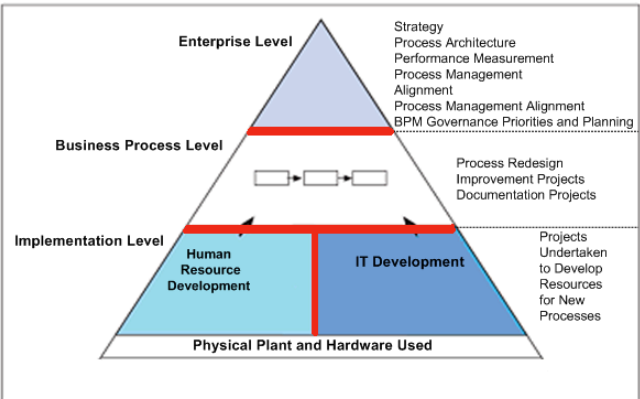


Figure 4 – Governance–centric. Source: Dragstra

2.4. IT Subsystems

One of the organization’s systems is the entity responsible for providing all IT services to other entities of the organization. This system can be considered an autonomous IT organization that has three cohesive subsystems called: Direct, Development and Delivery (Gibert, 2003).

These subsystems interact with the IT organization, enabling its alignment with the business (Figure 5) (Betz, 2007).

The direct subsystem takes care of the IT organization's strategy and its architecture. It has the function of: planning and exercising high-level control; monitoring if demands are met; defining priorities in the service portfolio and products to be developed or delivered by other subsystems.

The development subsystem has the task of designing and building solutions, typically using the project management process, ensuring quality and configuration management in order to mitigate the risk of the development subsystem.

The delivery subsystem executes the implementation of projects developed, manages the service catalog, runs all of the information systems, support and equipment for operations, as well as managing maintenance programs that support these systems and equipment, such as the operation of data storage centers, help desks, e-mail service, among others.

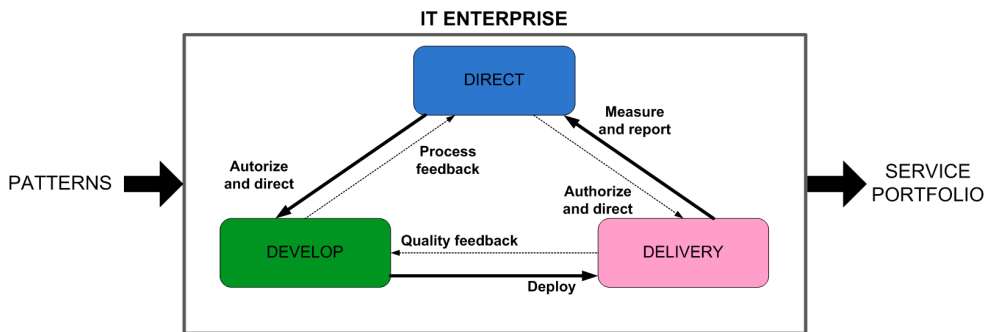


Figure 5 –Fundamental systems and subsystems of an organization and IT functionality (Source – Betz)

2.5. Business Components

The Component Business Model - CBM® is an IBM modeling technique. It is a mechanism that enables the achievement of excellence through encapsulating services in specific business components. This view contributes to specializing services and benefits organizations that deliver high value to its customers, employees or shareholders (IBM, 2005).

The specific business components have internal and external views. Internally, the components enable the organization to rethink how it can leverage its assets and capabilities. Externally, components help organizations identify the expertise that they cannot create by themselves.

The components put together business activities in discrete modules that can be shared in the organization. Furthermore, the components must work together in the context of the organization's business model (Carter, 2008).

According to IBM (2005), the Component Business Model serves as a tool to identify gaps and redundancies in order for the organization to be guided by business oriented services.

CBM®, through gap analysis, identifies and consolidates activities within cohesive business units and tests them in terms of interoperability between units. The result is a business component map shown in Figure 6.

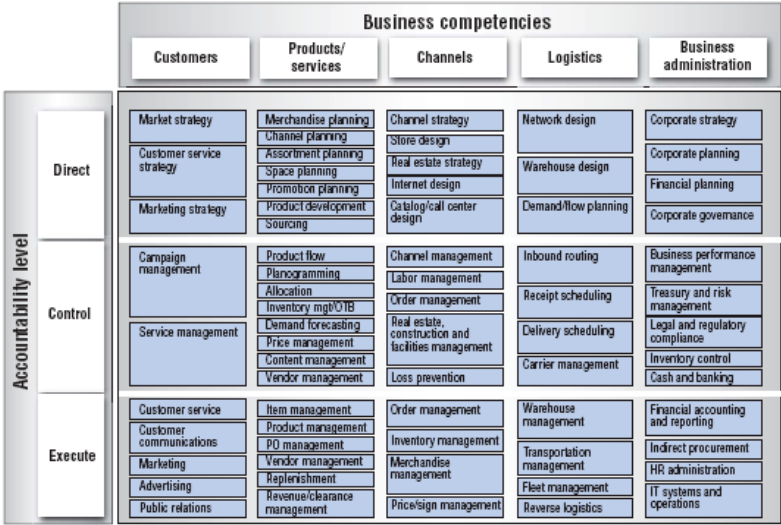


Figure 6: Business Component Map (Source: IBM Business Consulting Services)

The business component map provides a basis for developing new strategic and operational ideas. In evaluating the strategic value of the map's different components, managers can determine which components require immediate attention.

Each component encompasses five dimensions: business purpose, activities, resources, governance and business services (IBM, 2005).

Business purpose represents the logical reason for the component's existence in the organization. This logical reason is defined by the value it provides to other components.

In **Activities**, each component leads to an exclusive set of activities to achieve the business purpose.

In **Resources**, each component requests resources, people, knowledge and assets that support their activities.

In **Governance**, each component is managed as an independent entity based on its own governance model.

Business services are similar to standalone businesses, where each component provides and receives business from the business services (Figure 7).

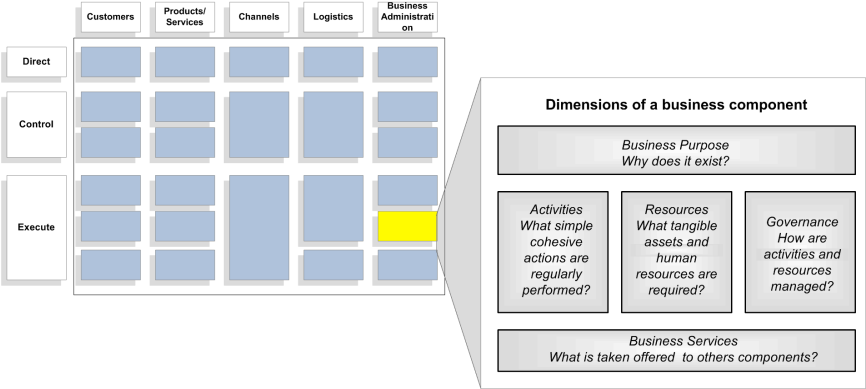


Figure 7: Dimensions of Business Components (Source: IBM Business Consulting Services)

3. Support Model for Governance Dimension Proposal

Aiming to promote the alignment of business with IT, how the enterprise can be decomposed into business components will be shown, considering the aspects of the IT organization cited previously. Moreover, a governance cycle to be applied to each component of the organization will be proposed.

3.1. Merger of the three levels of performance with the three subsystems

Uniting the performance levels with the IT subsystems will be considered in order to understand the operation of an IT organization from a business and IT point of view.

Figure 8 illustrates this union, in that we have a defined set of standardized requests, application units, resulting from business demands and with a service portfolio as output. These demands can be identified and organized into four types of standard applications: idea exploration; projects; services; and incident reports.

These demands may be endogenous, from the IT area or exogenous, external to the IT area. The service portfolio is used to manage the life cycle of all services and includes waiting services (proposed or in development), services catalog and discontinued services. This representation takes three areas into account: architectural structure (focusing on alignment between levels and areas), processes and functionalities to explain the functioning of an IT organization.

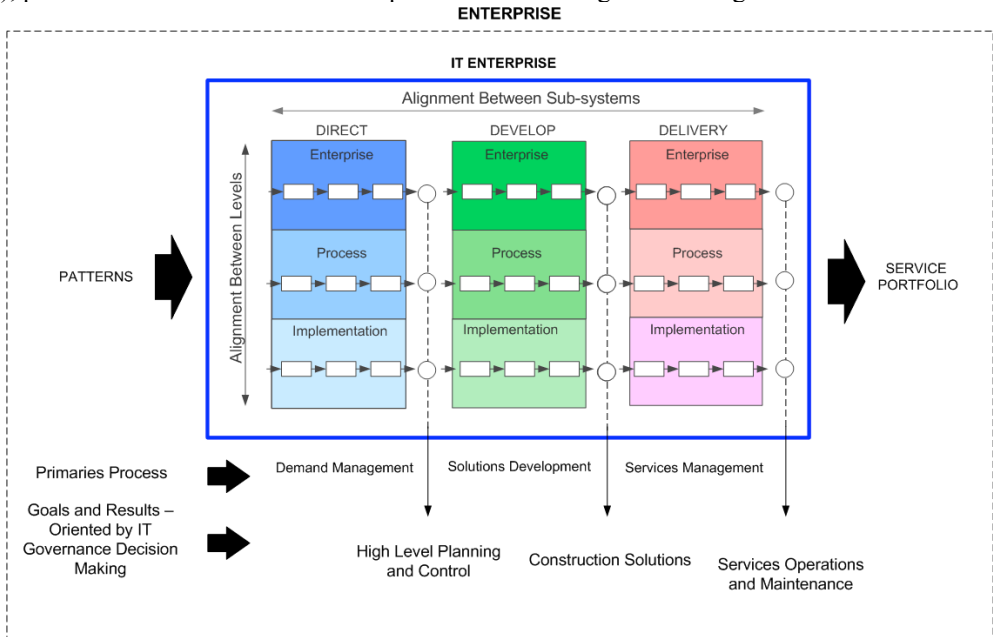


Figure 8: Model of systems and subsystems that comprise an IT Enterprise

Each level has distinct characteristics that align themselves to management models, strategies, processes, organization structures, people, technologies and knowledge.

While going through these three levels, an accumulation of knowledge occurs in the organization, resulting in the importance of creating and maintaining a knowledge base. This base will positively influence the learning process and growth inside the organization.

3.2. The components and their relationships

The components are related as a network with reference to the range of services offered by each. Thus, the relationship of the components is determined by the relationship of supply and demand, in which one component supplies a service to another component and that one receives a business event at the same time it can consume a service generating a business event for another component.

This relationship establishes that which is supplied by a component is consumed by the other and vice versa. Figure 9 illustrates this relationship, in which component A, arrow 2, provides a service to component B in response to a business event, arrow 1. The same applies to the component that generates an event for component B, arrow 3, and receives a service supplied by component B, arrow 4.

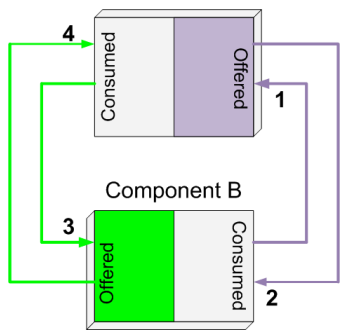


Figure 9: Relationship of Supply and demand of Services between Components

Considering an organization with multiple components, in which each one can provide services to all other components and from them receives business events, it is interesting to adopt a graphic representation that facilitates communicating the relationship between components. In this work, a graphic notation used to demonstrate these relations is represented by Figure 10.

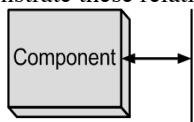


Figure 10: Representation of inputs and outputs of Component

In Figure 10 the arrow represents the range of services supplied by the component and the bar represents a means of communication used so that all other components can consume the services supplied.

3.3. Business Component Map for Enterprises

A zebra approach could be used to understand the decomposition of an organization. Initially, the entire organization is considered a system that is understood by its external interactions, as if it were a "black box". But when the external interactions are dominated one can observe what

happens within the system, and now the system is a "white box". The “white box” in turn can be decomposed into other components. These new components are seen as a "black box" until all interactions are well defined. When this happens, the ideas emerge and its contents can be observed (Hopkins, Jenkins, 2008).

Through the zebra approach and considering the CBM® aligned with the systemic characteristics presented by IT, a hypothetical Architecture Components Map for Aligning the Organization with IT was produced, considering the relationships among its components. This map also has decomposition levels applied to components, establishing a hierarchical relationship. The analysis of the IT component considered the three breakdown levels in detail, as shown in Figure 11.

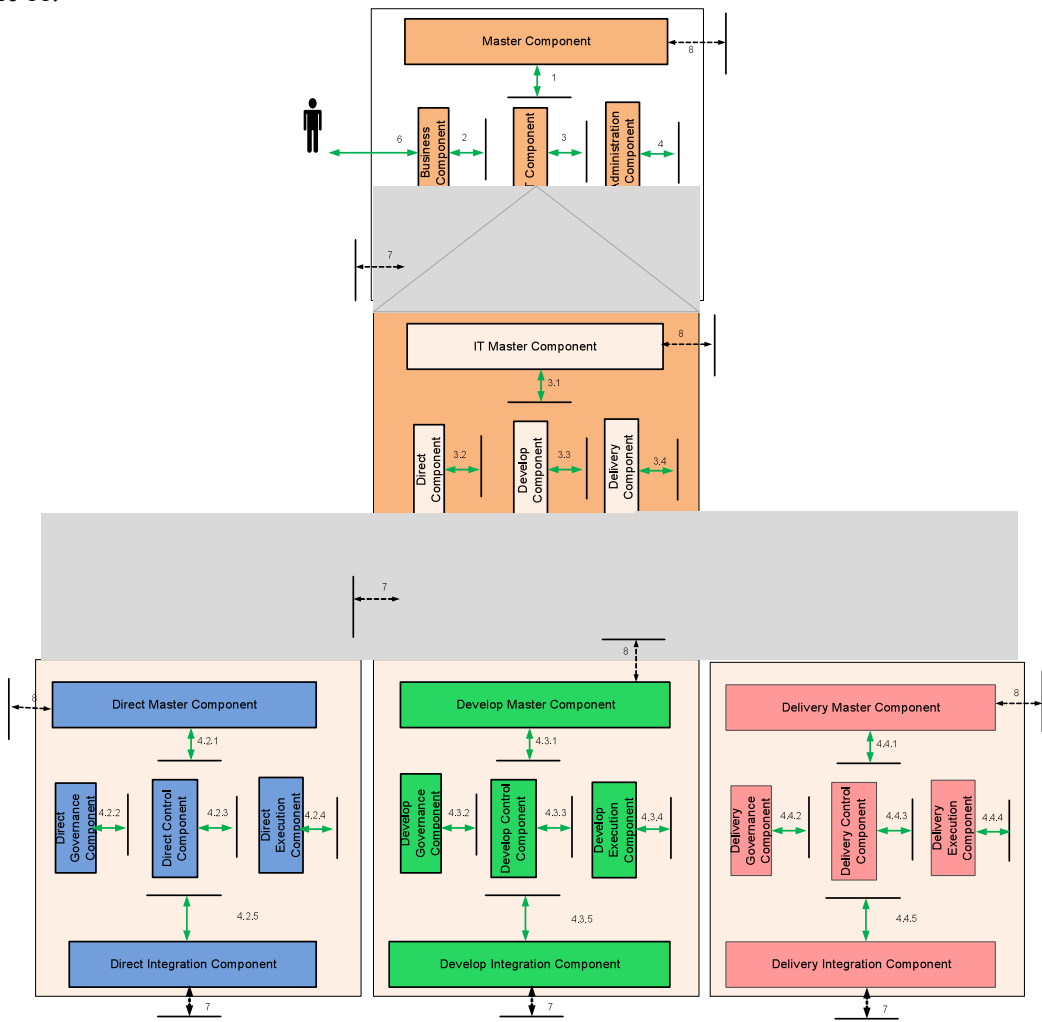


Figure 11: Architecture Components Map for Aligning the Organization with IT

At the first level of decomposition, there are five components: master, business, IT, management and integration. The business, IT and administration components are all federative,

meaning that they do not have a vision of the whole, so the integration and master components have the mission of guiding and integrating all other components. In the master component, the strategy of the organization is developed and in the integration component a base of information that integrates all the information generated by the components and its disseminations is found.

It is important to note that for all other levels underlying the first level, there are versions of the integration component and the master component. These versions are the link with the remaining components. Specifically, for the master components on the levels above and below, these are actually a mirror of the component from which they originated. For example, for the IT component, it is represented by the IT master component in the second level as well as the direct component which is represented by the master direct component on the third level.

At the second level there are three components that represent the direction, development and delivery subsystems, and there are two other components: the IT master component and the integration component.

The third level consists of three components, reflecting the decomposition of the components: direct, development and delivery, where each has the components: governance, control and execution, including versions of the master and the integration components.

3.4. Analysis of the Enterprise decomposed into Business Components

Following the establishment of the Architecture Components Map for Aligning the Organization with IT, an analysis is performed where the components that add more value will be highlighted. This analysis consists of three phases:

- 1. Survey of components that add value;
- 2. Design of architecture;
- 3. Decision to invest and monitor the transformation.

In Phase 1 there are certain components which generate competitive advantages for the enterprise. For that, one can use the Theory of the Firm Resource Based View, which gives value to a resource when it has the following features: rarity, valuable, inimitable and irreplaceable, (Gottschalk, 2007).

In Phase 2, two sub-phases are established for the design of the architecture, which are the construction of strategic architecture and business architecture (Figure 12). Strategic architecture is responsible for procedures to transform the component, which includes moving from the current situation to the desired situation. Architecture business is responsible for representing the structure used to supply and demand services.

Both architectures, strategic and business, are composed of social architecture, business process and technical architecture. Social architecture takes into account organization structure, performance metrics, skills and organization culture. The business processes reflect the business model of the organization in terms of activity flows. The technical architecture includes systems applications and technical infrastructure (Prahalad, 2008).

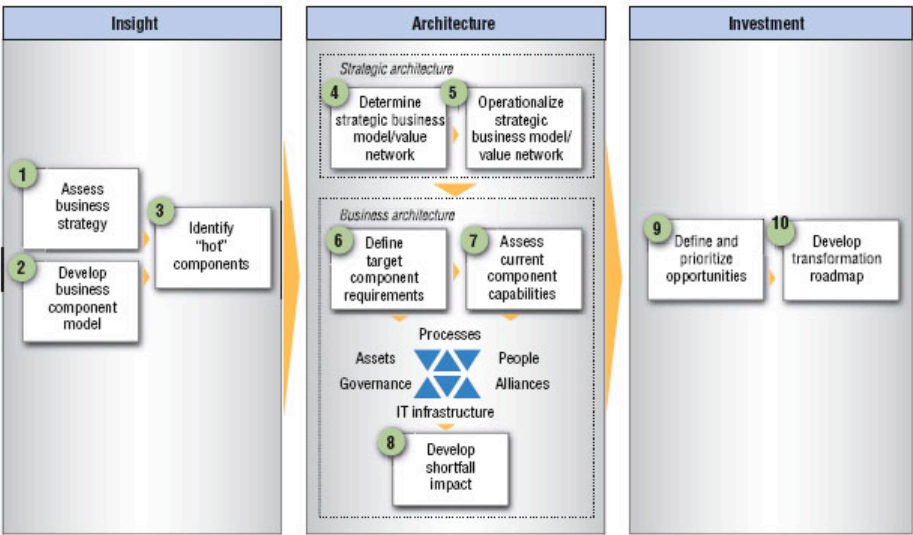


Figure 12: Stages of Business Component Analysis (Source: IBM Consulting Services)

Both, strategic architecture and business architecture are features of enterprise architecture. Therefore, when enterprise architecture is used to perform the transition from the current situation to a desired situation, it will be called strategic architecture. If enterprise architecture is used to describe the operation of day-to-day life of the component it will be called business architecture.

In Phase 3 the interaction of strategic and business architectures occurs considering the aspects of social architecture, business processes and technical architecture that must be applied to each business component (Figure 13). In this phase investment issues have already been discussed and the governance and management cycle is applied continuously.

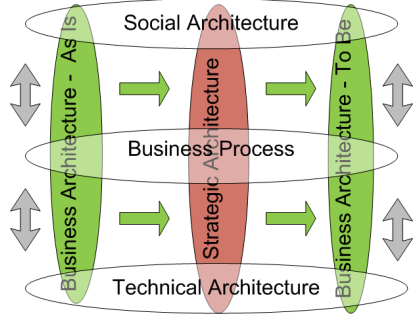


Figure 13: Interaction Architecture

3.5. Governance and Management Cycle

The governance and management cycle, represented by Figure 14, supports the dimension of governance and management of each business component. An evaluation of business results, strategy clarification and improvement of business models, through decision-making is involved in the aspects of governance.

Governance treated here includes both corporate governance and IT governance. Corporate governance is a system by which companies are directed and monitored. The system of governance allows that the mission, vision, and strategy are transformed, keeping in mind the goals and desired results. The dependency of organizations in relation to tools of information is vast and the issues of governance cannot be resolved without the intensive use of information technology.

Thus, an integral part of corporate governance is IT governance which consists of managing organization structures and processes to ensure the sustainability and expansion of the strategy and objectives of the organization (Grembergen, 2004 apud IT Governance Institute, 2001).

With respect to management, the cycle involves the design and implementation of strategic architecture and the operation of day-to-day business services. It is noteworthy that the management of IT is focused on the internal supply of IT services and products, as well as on effective and efficient management of the current operations.

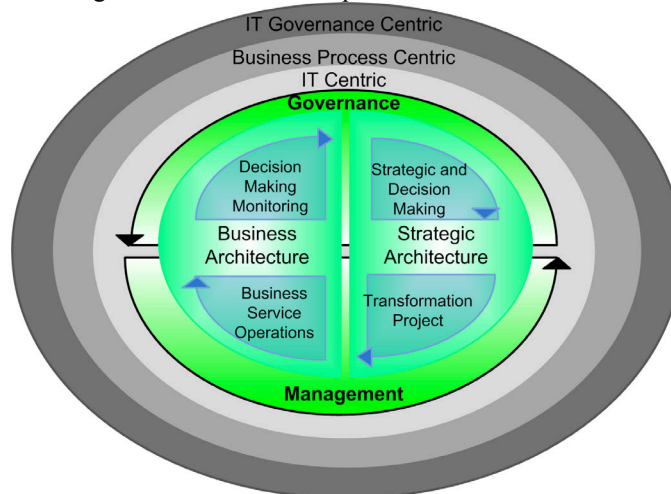


Figure 14: Governance and Management Cycle

4. Conclusion

Considering organizations as systems composed of other interconnected systems and subsystems conditions the analysis of how these relationships are established among all organization entities. Knowledge of these relationships is fundamental to good decision making on all organization levels, even if the object of study is Information Technology.

Currently, organizations are applying the enterprise architecture concept as a way of aligning various organizational entities. But what has been seen is a focus of enterprise architectures on certain visions such as, IT-centric, business process-centric or governance-centric.

This article sought to demonstrate that the alignment of business with IT can be achieved without needing to be restricted to a single vision. Initially, a model that represents the IT systems and subsystems was considered.

In the second place, IT alignment with the organization was developed based on the Component Business Model - CBM ®, by way of business components and also a model that supports the dimension of organization governance was proposed.

Finally considered was how business components may be governed and managed independently, but following certain architecture and business strategy principles that aim at full

integration of social aspects, processes and techniques as the best way to establish corporate governance and the IT of an organization.

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Alignment IT to business using OODA loop

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Abstract: In this article is proposed a new approach, framed under enterprise architecture, it guarantees a high level of response to the applications development or configuration as improves its alignment to business by solving some limitations of traditional software development solutions namely: difficulty in gathering clients requirements, which should be supported by the applications, difficulty to connect the organisation processes used to answer the client, which must also be integrated in the applications and the difficulty to develop the applications that can follow the business cycle. To test the approach, this was applied to a real case study consisting in the configuration of an application that manages the relationship with clients.

Keywords: enterprise architecture; alignment model; aggregation of value; Information Systems Enterprise Architecture; Applications; business processes; information.

1. Introduction

The use made by the Information Technology (IT) is recognised as crucial to the good performance of an organisation (Laudan, Laudon, 2003). Different factors have been promoting and conditioning the changes on the IT namely (Spewak, S., 1992), (Henderson, 1999): minor duration of the company's business cycle; markets globalisation and group activities, competition and technologies revolution.

Pressure for changing (Fig. 1) may occur due to different reasons. For the new IT to be efficient, their development must be done in an organised way. The strategy of change of the IT must be consistent with the business strategy. This is the only way to justify the investments on IT (Amor, D, 2002) (Maes, R., 2000).

The framing of new technologies in the business offers great possibilities for the organisations that are able to benefit from the advantages of their use but it also means challenge to the IT management as the organisations become more dependent on them and their management specificity. In this complex scenario, the challenge means to identify the risks and the benefits that the IT represents to the organisation targets. In principle aspects, which are always present, are identified (Lankhorst, M., 2005): administrative automation, rationalization of means and processes remodelling.

This article proposes the introduction of some principles promoting the success of applications, namely (Reich, B., 2000): Simplify; Automatize and Integrate. As such, we use an

approach to the development of applications that enable a continuous and fast increase in opposition to more complex and more expensive solutions whose development is prolonged over the time and represents a major risk of failure.

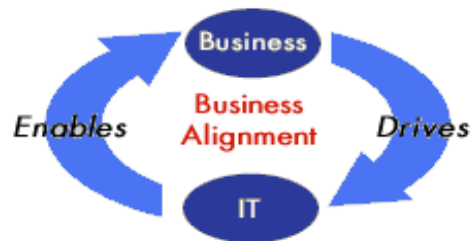


Figure1 – Alignment between Business and IT

This article follows the sequence of others previously done namely “Strategic Planning under Enterprise Architecture (Serra, N., Gonçalves, A., Serra, J., & Sousa, P., December 2008) and “Enterprise Architecture and Dynamic Alignment” (Gonçalves, A., Serra, N., Serra, J., & Sousa, P., February 2008).

The first work established the alignment between the company’s IT with its business strategy. The results obtained were: definition of a business strategy and choice of a tool to control the information complexity (Figure 2). Here the innovation consists in relation strategy and IT through the connection between Hoshin Kanri matrix (Jackson, T., 2006) and the CRUD matrix.

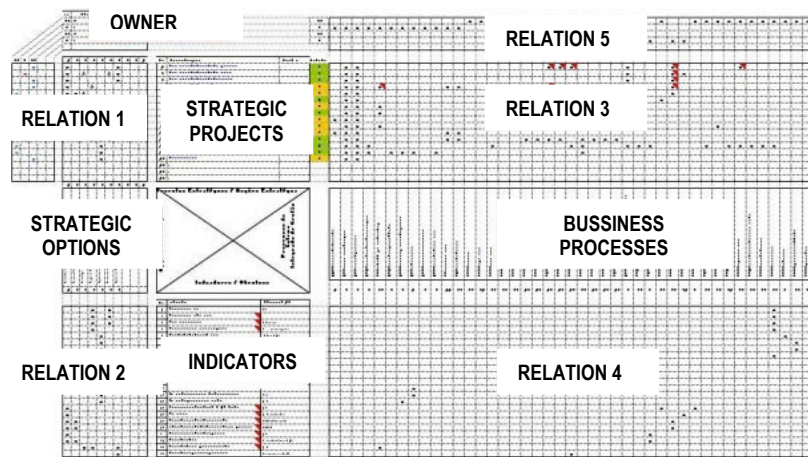


Figure 2 – Matrix Hoshin Kanri

In the second work two concepts were described: Static Alignment and Dynamic Alignment between business strategy and IT. In the formulation definition phase, the alignment is made just once and sets the components of business planning and the IT components. In the next development phase, the alignment often occurs through the use of revision and control methods of execution of the plan components defined in the previous phase.

Once both works were finished the tools were applied in the organisation it was noted that business demand to the IT increased, new development requested occurred and changes to the existing applications. This is due to the IT exposition. In fact, the requests always existed but only now are justified and supported by a strategy and an alignment control model: the need for new applications development is based upon the trust the models give to those requesting them: the business or the infra-structure of the organisation. All this implies an increase of pressure on the IT and consequently on the computing professionals that will be liable if the business doesn't go as expected. The way a business specification which must be supported by applications is communicated as well as their framing on the company processes have now an important role in the IT development.

2. Description of the Approach Used

The contribution of this work proposed an approach composed by a method, a development strategy (OODA LOOP) and a set of participation principles of the collaborators in the method (figure 3).

The approach embraces some factors, which are considered as differentiate factors to the configuration or the application development under the context of an Enterprise Architecture, namely:

- Emphasizes the client needs, the organisation capacity and the application potential;
- Promotes continuous development by involving all organisation collaborators. The cooperation between people that understand business and those who configures the application is constant. It tries to contour the natural difficulty in writing procedures;
- Adopts a development approach, which implies a continuous evolution and allows a fast adaptation to changes. The goals to be reached have the tendency to change with time;
- It is efficient because it tries to achieve its goals that is the necessities of the costumers and the organisation capacities considered in the application;
- It is effective because economically uses the organisation resources to please a certain clients satisfaction level.

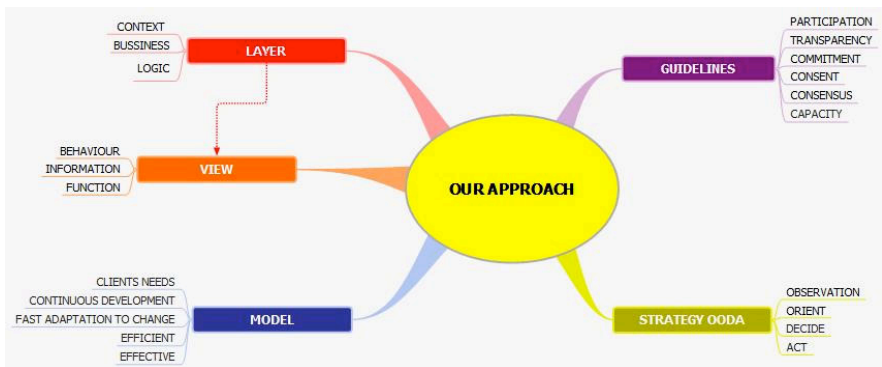


Figure 3 – Approach Description

The method was described by Don Awalt (Awalt A., McUmbler R., 2004) and uses some concepts gathered from *ArchiMate* Modelling language (Lankhorst, M., 1998). The method is composed by three layers (table 1):

- **Context:** Represents the client's vision and point of view about what he wants from the organisation and signifies the external stimulus to answer to, understand and improve the organisation internal behaviour;
- **Business:** Represents the organisation's vision and point of view and allows to identify and promote the use of the capacities the organisation has to answer to the client stimulus;
- **Logic:** Represents the vision of the application and its point of view and permits to define the development strategy or configuration of specific software.

Each layer represents a vision of the problem with a certain detail and a diverse refining described under a form of behaviour, information and functions. Each layer encapsulates the behaviour and the information of the previous layer. Each layer is described as following:

- **Behaviour:** Describes the activities, tasks and events related to a service rendered;
- **Information:** Fragment of relevant data for a certain behaviour. It may be informal or conceptual or both;
- **Function:** Represents the responsibility it has under the behaviour of an entity (person or company department).

Table 1 – Method Description

Layer	Description	Behaviour	Information	Function
<i>Context</i>	Describes the demand of the costumer that is what he expects from the organisation	The demands the client makes to the organisation	Information Model that needs to be understood by the costumer to complete a transaction.	Which are the organization department involved with client
<i>Business</i>	Describes the interaction of the client with the organisation collaborators	Describes the activities performed due to the interaction between the client and the organisation.	Model of the information that must to be understood by the client and the collaborators to complete a transaction.	Which are the organization department that are involved and that have a relationship with the client
<i>Logical</i>	Describes the mapping of behaviour and information in the application components	Describes how the activities are mapped in the application	Mapping between information and data application	How and whom maintain the application

The strategy adopted was developed by John Bloyd (Angerman, S., 2004), known by the cycle O-O-D-A (Figure 4). Boyd said that, in a competitive environment, the entity capable of guiding the decision process formed by the cycle “observe; orient; decide and act” in a faster and efficient manner shall perform his task more successfully than his opponents.

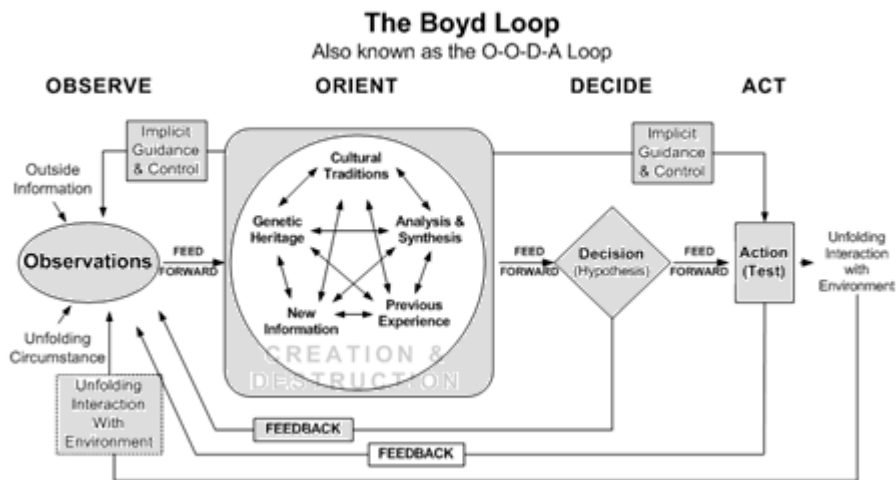


Figure 4 – Strategy O–O–D–A Cycle

Initially designed for military applications the concepts developed from Boyd' ideas became used in several other areas. As example of the use of this methodology in project management field can be found in (Rosa, Marcelo, 2005) and was used as a source to choose this strategy. It was necessary to frame the phases of the O-O-D-A cycle (Figure 5) in the chosen method:

1. **Observation** includes acquisition and data and information compiling: CRUD matrix, Hoshin Kanri matrix, processes diagram, entities related to the expected development, new orders made by business and the organisational frameworks, external data on existing technology to support development, background knowledge of solutions to problems raised as well as the knowledge of the organisation weakness and strengths;
2. **Guidance** consists on analysing scenarios based upon observations, experience, organisational vision, organisational culture, points of view, etc. Guidance results on the construction of mental diagrams that show reality in a way that the actions possible to be performed make sense. Guidance is dependent from existing view. This also means dependent from the tacit knowledge that each element has on the organization. This phase helps the team to observe and obtain a global sense of what is observable respecting the vision each element has. Guidance consists in a way to promote sharing of knowledge each individual has and which is usually difficult to be formalized or explained to third parties, as it is subjective and inherent to each individual capacity. Guidance orients decision but also considers observation and action thus allowing alternative solutions.
3. **Decision** is made from the image produced in the Guidance process and defines which adequate answer for the situation in question is. The decision will be implemented by a selected action;
4. **Action** consists in materializing the decision made. Once performed the results and their alignment towards the business, namely in what regards processes must be evaluated periodically by different collaborators with distinct visions within the organisation especially at the level of the entities supported and also in the communication with the

remaining applications. If the result is not satisfactory or it ceases to satisfy the organisation, measures to amend eventual failures and to improve quality and efficiency must be made.

Boyd presumes that the major factor to obtain the expected results does not consist in observe, guide, decide and act in the best way. The most important thing is observe, guide, decide and act quickly that is the speed reached to interact. The interaction speed wins the quality of interaction meaning the improvement on the continuous process of the solutions found.

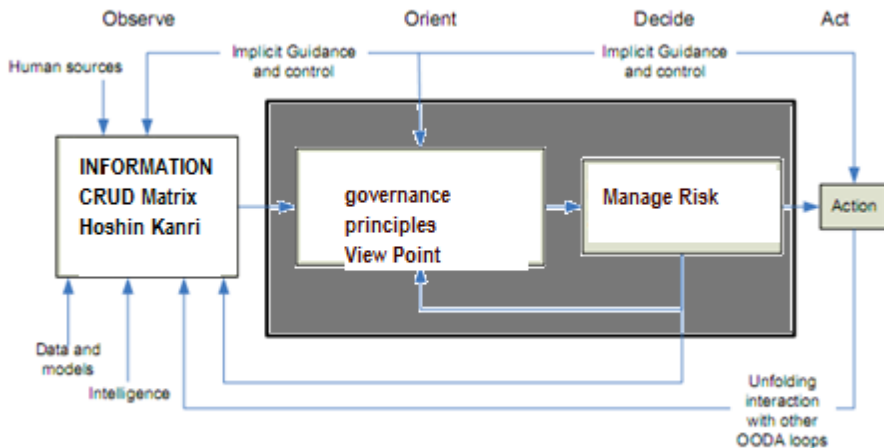


Figure 5 O-O-D-A Cycle: Adapted

The method also comprises a set of principles, which intend to promote: motivation, participation, decision capacity, autonomy and collaborators participation in the development of applications. These principles are (Weill, P.& Ross., 2004):

- 1 **Participation** – It means that associated processes must be participated by elements dispersed in the organisation. This may occur in a direct or indirect way. The participation implies the capacity to express the strengths and weaknesses of the applications and the capacity of association in groups, with different opinions on same application and the relevant context namely how to support the processes intervening in the business and their integration with the remaining applications. The principle is viable since there are clear and specific rules assuring the proposed terms and there are initiatives within the organisation tending towards the sustenance of the terms;
- 2 **Transparency** – The decisions taken and their supervision are made by known rules and regulations. All data is available and directly accessible to those affected by said decisions;
- 3 **Commitment** – The applications and the way they are managed aim to serve the organisation as a whole. The management processes must be prepared to answer the collaborators needs within a reasonable time;
- 4 **Consent** – The development decisions and applications management must consider that the best solution for collaborators is the one looking for consensus among the different interests. The aim in reaching consensus must be obtaining an agreement about the best

solution for the organisation as a whole. This way of obtaining decisions implies a long-term perspective so that a sustainable applications development occurs;

- 5 **Consensus** - The applications development must assure the equality of all groups of collaborators in view of the application targets within the organisation. The proposed path shall promote satisfaction of all groups;
- 6 **Capacity** - It must be assured that the applications are adequate to the organisation processes and the result goes towards its needs and, at the same time, make the best use of the available resources. This means that recourses are used in a sustainable way and in a controlled environment.

The use of these principles and actions assures that the collaborators needs and different opinions are taken into consideration. This means the needs of all participating in the organisation are considered in the decision of IT management.

Thus, it contributes to maintain the alignment of the IT towards business, to promote the capacity and agility for new business or to make adjustments in the present ones; it makes the relation between investment in IT and the return of the data value; it maintains the risks of business under control; makes transparent the importance of the continuity of IT in the business and, at last, is a measure that promotes the constant improvement of the IT performance.

3. Case Study

Due to the nature of the proposed techniques their validation was done in the configuration of a real software. The chosen software was Client Relationship Management – CRM by the following reasons:

1. It allows to test the processes related to the interaction with the client;
2. CRM, more than a tool is a philosophy though it is necessary the commitment of all the organisation;
3. It allows to test the participation of the administration in the project;
4. It allows to test the communication of the collaborators within the team;
5. It allows to incorporate the collaborators skills in the development of the application they are going to use;
6. It allows the use of the O-O-D-A cycle as the development of the functionalities is progressive and it will be necessary to adapt the system to support the business changes.

The team agreed to initiate the development of the CRM by the module regarding the sales force:

- **Accounts and Contacts Management:** permits the access to all clients data and their relationship with the contacts namely: information on clients, contacts, the role each contact has in commercial relationship, the relationship contacts have between themselves and their relationship towards the management of proposals;
- **Commercial Proposals Management:** permits the control of proposals type (layout), automatic generation of invoicing, treatment by period of proposal, automatize the emailing of proposals and the control of the composition of the price of each item;
- **Invoicing Management:** once a commercial proposal is accepted it is possible to create an invoicing order and manage the other relevant aspects such as placement of orders and invoicing;
- At last the modules allowing the **Products Management** and the **Price Lists Management** of products for each client were also implemented.

Three groups were formed, one for each model layer: context, business and logic. To facilitate the communication and the passage of models between the groups' collaborators were shared. A profound analysis of each model layer by each group being the following layer the only one able to initiate its activities after receiving the model of the previous layer. As such the business layer only initiated its work after receiving the models of processes and the entities of the context layer and, the logic level only started his work after receiving the models of the business layer.

Table 2 – Mapping of the Levels for the sales force

Description	Behaviour	Information	Function
LAYER I CONTEXT			
The client intends to contract consultants specialised in IT.	The client request the services of consultants specialized in technology IT; Client selects the consultants and closes the business, Client pays the organisation the experts' services.	Mail request with the information that describe the IT skills that they need;. Receive curriculum vitae from organization	There are two departments involved in the client: Outsourcing department- who make the request; 'financial department- who make the payment
LAYER II BUSINESS			
Organisation processes to perform the client request.	The client sends the request to the collaborator of its own account; The collaborator researches in the catalogue and tries to find a consultant offer; The collaborator sends the commercial proposal in accordance with the agreed prices schedule; The customer accepts the consultants; The collaborator updates the consultant catalogue; The collaborator requests the contract agreement with the selected consultant and sends data to the Human Resources department.	consultant; catalogue; account; commercial proposal; item; request; Invoice order; Order form.	There are four departments in the organization that collaborate with client: Recruitment department. That is responsible to manager curriculum vitae database; sales department that communicate with the client Outsourcing department and account department that send invoice to client and the HR department that manage the user that will work in the client.
LAYER III LOGIC			
Describes the high level components of the application and the way it is related to the previous levels.	The following modules are using and map to other layers behaviour: Accounts; Contacts; Opportunities; Products; Price Books; Quotes; Activities & Calendar.	Map for each application module each piece of information as data	The infrastructure of the application is support by the provider of service on demand. Internally the IT department will make the necessary changes as being requested by users

Each work session, of each group, followed the loop O-O-D-A strategy: existing data collection for analysis; preparation of new scenarios; analysis of different scenarios under a new information or development of models. In case there is a changing proposal in each layer (new behaviour or new information) it must be communicated to the other layers. The final changes will only be accepted after all layers include the proposed changes. The model resulting from work is briefly presented in table 2.

The activities developed by each group of work allowed detailing, specifying and checking the models thus creating a solid base for the development of a system lined up with business. The

group communications was supported by use case that describes the problems and validate the solutions regarding the changing proposals. The changing of models has created some difficulties but we understand change as a natural thing in this process.

The chosen platform supporting the logical development in the model was ZOHO CRM (Figure 6), due to the positive analysis made of the following aspects: i) the platform is available as a service software thus it stimulates the Information System Department to be constituted as a unit that passes from development and maintenance of the application to support the services that the platform offers; ii) the price of each license is substantially more economic than the other considered solutions; iii) the capacity of interaction with other applications through the REST communication that allows the use of a web interface using XML and HTTP, without the additional abstractions of the protocols based on patterns of exchanging messages, as the web services protocol SOAP; iv) the easiness to form a multidisciplinary team for the development of a solution by using O-O-D-A strategy.

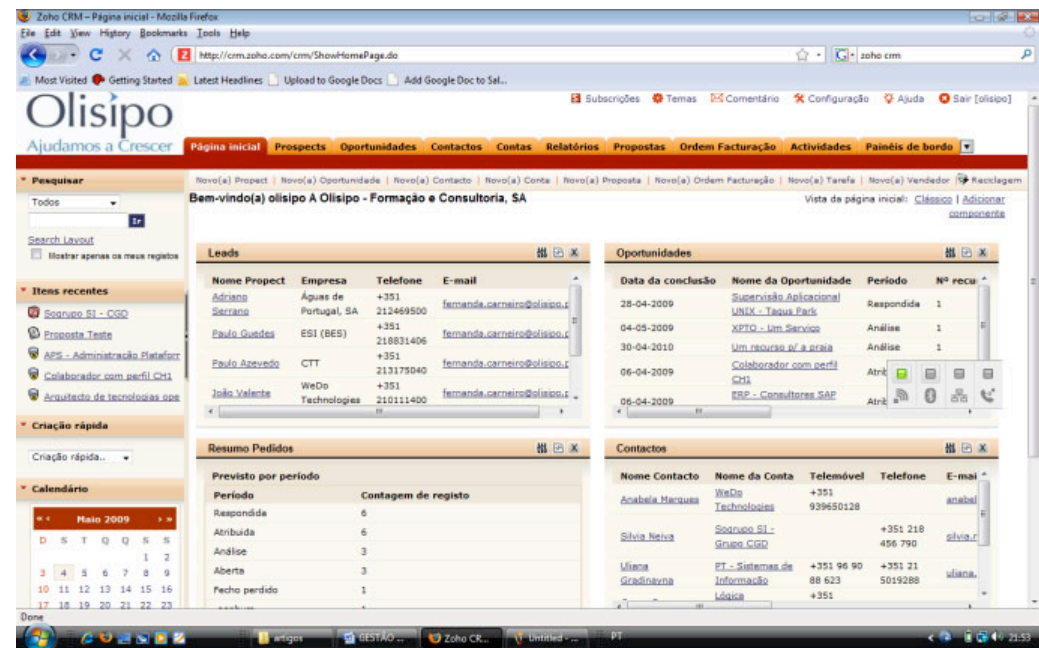


Figure 6 – CRM Platform

4. Conclusions and Obtained Results

The Enterprise Architecture is constituted by a set of artefacts, which describe the details, the business, information, application and the role people must have within the organisation at different layers. Its use is important to understand an organisation and can be a support tool to the continuous improvement we intended to achieve due to business changes.

In this work a method, a strategy and guidelines that help to integrate an application under the scope of an Enterprise Architecture.

The method aims to manage complexity through the analysis of the problem levels under different perspectives so that the application can contemplate all the organisation and client needs.

The loop strategy O-O-D-A triggers the process in order to look for a continuous improvement of the application maintaining business alignment.

The guidelines were introduced to promote the acceptance of the solutions found by collective responsibility of the collaborators that participated in the applications integration process.

It was possible to test the model application due to the fact it was being used in a real situation, which consisted on the configuration of a CRM platform.

By this study we conclude that: there is an increase in accepting the use of technology on business; the general satisfaction of the organisation is assured by fast delivery and continuous improvement of the CRM; promotes the alignment once the late changes are included in the development; the constant cooperation between the people, who understand the business, those who use the application and those who program it; focus on the individuals and interactions more than in tools.

In a future work we intend to develop the following activities:

1. Specify in the method the artefacts used in each layer, their relationships, concepts, priorities and restrictions;
2. Systematize its usage in strategy;
3. And at last clarify the principles guiding the participation of people in the method.

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Semantic SOA-Based Model to be Applied in Business Environments

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Abstract: Large scale, dynamics, and heterogeneity of Web Services may hinder any attempt for understanding their semantics and hence outsourcing them. This calls for techniques to organize the Web Services in a way that they can be efficiently understood and outsourced. The semantic SOA-based model involves Semantic Web Services to be applied in business environments in order to have a consistent framework that makes the data understandable for both humans and machines. The ultimate goal for using our proposed model is to transfer the enterprise Web into a medium through which data and applications can be automatically understood and processed. The main components of the proposed model and the vision of applying it to one of the business solutions will be illustrated in order to show how these components can work together to overcome the SOA-based solutions weakness.

Keywords: SOA; Semantic SOA-Based Model; Semantic Web Services, Ontology; Federated ERP; FERP.

1. Introduction and Problem Definition

The Web becomes a very helpful environment to share and extract the information from multiple sources that were not accessible previously. Web data had designed in a way that it is understandable for humans and one of the main obstacles which have to be considered is the lack of semantics which is critical to enable machines understanding and automatically processing the data which they can now only display. On the one hand, Semantic Web is an evolving extension of the World Wide Web in which the semantics of information and services on the Web are defined, making it possible for the Web to understand and satisfy the requests of people and machines to use the Web content (Berners-Lee, Hendler & Lassila, 2001). And on the other hand, research and industry have realized that the Semantic Web can facilitate the integration and interoperability of intra- and inter-business processes and systems, as well as enable the creation of global infrastructures for sharing documents and data, to ease and make the information searching and reusability more efficacious. That encouraged a lot of companies to move their entire information infrastructures towards the Web platform by applying Service-Oriented Architecture (SOA)-based solutions, offering a unified and standardized access for customers, suppliers and employees to the information and services offered by those companies (Brehm et al., 2008) (Cardoso, Hepp & Lytras, 2007).

Web-Service-enabled SOA solutions are completely depending on common Web Service technologies that allow interoperability by using standards like Universal Description Discovery

and Integration (UDDI) (Clement et al., 2004), Web Service Description Language (WSDL) (Christensen et al., 2001), Simple Object Access Protocol (SOAP) (Mitra, 2003), etc.

Federated Enterprise Resource Planning (FERP) system is one of the Web-Service-enabled SOA solutions and it is developed by the Very Large Business Applications (VLBA) Department in Carl von Ossietzky University of Oldenburg (Brehm, Lübke & Marx-Gómez, 2007), and it is based completely on standards. It allows the separation of local and remote functions whereby no local resources are wasted for unnecessary components. Furthermore, in FERP, single components are executable on small computers, which subsides the installation and maintenance costs by decreasing the degree of local system complexity (Brehm, Lübke & Marx-Gómez, 2007).

Since FERP is a SOA solution, it depends on typical Web Service technologies that allow interoperability by using standards like UDDI, WSDL, SOAP, etc. and it is based on the idea that business functionality is separated and published as services. In addition, this approach has some fundamental advantages that can be summarized as follows:

- Relying on standards provides a high degree of flexibility and offers an adaptable implementation;
- It becomes eventually possible to switch from a particular service to a different one without adaptations;
- And the high ability of reusing the functionality.

According to this, FERP approach offers a solution to the problem of standards by avoiding the central point of integration which is often a bottleneck in the previous solutions, also it reduces the number of point-to-point adapters because each interface is based on WSDL and it can communicate with each other WSDL-enabled interface. What it does not solve is the problem of making the semantic documentation of such interfaces.

In this paper, we are going to discuss the problems of the existing SOA-based solutions at the discovery and invocation phases. Firstly Traditional SOA service discovery problems can be described as follows: recently, Web Services appear to become more widely adopted allowing much broader intra- and inter-enterprise integration. However, developers will require automated systems for service discovery in order to enable further Web Service interactions with even less human effort. UDDI exists precisely for this reason. However, unless the service requester knows the exact form and meaning of a service's WSDL specification in advance, the combination of UDDI with WSDL and coarse-grained business descriptions are not enough to allow fully automated service discovery and usage of Web Services.

Secondly, the service invocation problem which can be described in the terms of dealing with systems that might differ in its invocation method by providing different interfaces (public processes) for the semantical same operation (Bussler & Fensel, 2002). For example, one system offers product purchasing with one single invocation while another system requires first the process of creation a user, then activation of the user and finally the purchase of the product. Therefore, in the first system, one invocation completely defines a user whereas in the second system several interface invocations are necessary to achieve the same functionality. More important than the invocation is its specific execution messages order or process heterogeneity problem: the activation of the user cannot be achieved before the creation of this user.

And as a conclusion, the problems of SOA-based can be stated as follows:

- (Semi)-Automatic service discovery;
- (Semi)-Automatic service composition.
- Data and process interoperability;
- And information sharing, finding, extraction, interpreting, maintaining and representation.

This means that nowadays the existing architecture of the enterprise Web has many defects such as lack of interoperability, massive unstructured data and an increasing number of various

systems waiting to be linked. To address these problems, new approaches are being proposed and developed, and Semantic Web Services (SWS) appears to be one of the soundest solutions as an important step on the road towards making the data understandable for both humans and machines in an automated manner.

The rest of our paper is structured as follows. In section two, we provide a short overview on the virtues of Semantic SOA and how it can overcome the above mentioned problems in the existing solutions. As we intend to analyze the work that had been done in this domain we give an overview (section three) on the background information of two important conceptual frameworks and two execution environments dealing with Semantic Web Services. Afterwards, section four describes the methodology and the architecture of the proposed semantic SOA-based model we are developing as a work on progress to be finished in the future by applying it on the FERP system. Finally, we give conclusions and future work in section five.

2. Semantic SOA Virtues

After the previous discussion about the problems of the SOA-based solutions, applying semantics on those solutions can overcome difficulties at both discovery and invocation phases.

As defined in the SOA concept, the main components in SOA architecture are service provider, registry and requester. By extending existing SOA-based solutions with semantics, semantic SOA-based model will be provided, and this model will support the use of Semantic Web Services. In order to add semantics to these components' interactions, semantic descriptions will be added by the service providers to the Web Services they provide in order to be advertised then in the UDDI registry. In addition, the requestor will send its request as a semantic goal, by using the support of ontologies in order to describe the desired functionality. In this way, our proposed architecture will deal with semantic goals and matchmaking processes will be done with the available Web Services in the UDDI in order to give the most related results back to the requester and these results are based on the requester needs by describing them in forms of semantic goals. More details about these issues will be described later in the architecture of our proposed model with clear definition about the functionality provided by each component of the model.

By extending FERP approach with semantics, we will provide a formal description of the Web Service functionality allowing the developers to make the manual integration, if necessary at all, on this knowledge about the meaning of the data (Mahmoud & Marx Gómez, 2008).

Semantic enriched FERP approach is actually the concept that supports the use of Semantic Web Services, and one of its duties is to overcome Web resources heterogeneity problems, since in such digital environment there is a need to deal with the differences in both ways; the way in which the requester wants to consume the functionality of a Web Service, and the way in which this functionality is made available by the Web Service back to the requester.

In other words, one of the most important functionality of this model is to overcome the enterprise Web resources heterogeneity problems both at data and process level (Mahmoud & Marx Gómez, 2009), in addition to have a mechanism for dynamic composition of Web Services by grouping them in categories and implementing them semantically based on a predefined metadata ontology. That will ease the dynamic composition process by generating dynamic workflows that will have the responsibility of composing the desired services based on the concepts entailed from the existing ones.

In the proposed framework, light weight Semantic SOA-based solution will be used to enhance information searching and retrieving in an automated manner and the ultimate goal is to transform

the enterprise Web into a medium through which data and applications can be automatically understood and processed.

3. Major Techniques dealing with Semantic Web Services

3.1. Conceptual Frameworks

There are two main conceptual frameworks dealing with Semantic Web Services and defining main elements to semantically describe services: Web Service Modeling Ontology (WSMO) (Bussler et al., 2004) and Web Ontology Language (OWL-S) (Burstein et al., 2004).

In addition, we are going to describe two execution environments: Internet Reasoning Service (IRS-III) (Cabral et al. 2004) and Web Service Execution Environment (WSMX) (Cimpian et al., 2005) that following conceptual models defined on WSMO.

WSMO is a formal model for describing various aspects related to Semantic Web Services, and it is based on the Web Service Modeling Framework (WSMF) (Bussler & Fensel, 2002). WSMO applies WSML as the underlying language based on different logical formalisms (Bussler & Fensel, 2002). It defines four main modeling elements for describing several aspects of SWS (Bruijn et al., 2007):

- Ontologies: Are formal explicit specifications of a shared conceptualization (Gruber, 1993). They link machine and human terminologies.
- Goals: Provide the means to express a high-level description of a concrete task, provided by the service requesters.
- Web Services: Offers service description to describe the functionality and behaviors of the service, provided by service providers.
- Mediators: Bypass interpretability problems and there are four types of mediators: OO-Mediators that have the role of resolving possible representation mismatches between ontologies, GG-Mediators that have the role of linking two goals, this link represents the refinement of the source goal into the target goal or states equivalence if both goals are substitutable, WG-Mediators that link Web Services to goals, meaning that the Web Service can fulfill the goal to which it is linked, WW-Mediators that are used for linking two Web Services in the context of automatic composition of Web Services.

OWL-S is ontology for describing Semantic Web Services represented in OWL. It combines the expressivity of description logics and the pragmatism found in the emerging Web Services standards, to describe services that can be expressed semantically and yet grounded within a well-defined data typing formalism (Hu et al., 2007). It is comprised of three top-level notions:

1. Service Profile describes both the functional and non-functional properties of a Web Service, for the purpose of service discovery.
2. Service Model contains descriptive information on the composition or orchestration of one or more services in terms of their constituent processes. This can be used for reasoning about possible compositions and controlling the service publishing and invocation.
3. Service Grounding gives details of how to access the service, mapping from an abstract to a concrete specification for service usage.

3.2. Semantic Execution Environments

IRS-III is an infrastructure for publishing, locating, executing and composing Semantic Web Services, and it is organized according to the WSMO framework. It supports capability-driven service execution. Goals and Web Services in IRS-III have inputs and outputs, the Web Services ones are inherited from goal descriptions and they are selected via assumption (in capability) (Cabral et al., 2005). IRS-III has a new type of mediators called GW-Mediator that transforms goal inputs into Web Service inputs while WG-Mediator transforms Web Service output for a goal. It also has the type GInv-Mediator that mediates between two goal invocations and is specific to runtime compositions.

Finally, WSMX is the reference implementation of WSMO and it is an execution environment for dynamic discovery, mediation and invocation of Web Services, it offers also a complete support for interacting with Semantic Web Services. WSMX supports the interaction with non-WSMO Web Services (classical ones), ensuring that the interaction with existing Web Services is totally possible.

In our future work, we will try to find a medium in which we can include all the methods and functionalities mentioned above and to develop a mediator-based framework to solve the possible mismatches that might occur between Semantic Web Service descriptions and semantic goals.

4. Semantic SOA-Based Model

The main idea behind this model is to have an ontology that has the role of dealing with Semantic Web Services as well as representing the whole concepts of a Web Service (WS); it has also category type and generic operations divided to syntactic, semantic, behavioral and qualitative operations. Starting from this point, new categorizing level has to be done by the help of cloud provider (see next paragraph) who will have the responsibility of grouping WSs in clouds. The classifying will be based on the domain of interest, each of these clouds is itself a WS and the cloud provider will advertise them in the WS directory.

At this point the WS provider system will search in the directory for its cloud based on its business domain and interests and will register itself in one of them to later on entail the required concepts out of that cloud and implement its own WSs to be registered also in it, and if there is no cloud matches with its purposes, the provider will ask the cloud provider to create a new one and advertise it in the directory as well, and here the concepts will be inherit from the metadata ontology.

The process of adding semantic on WS request and capability will take benefits from the semantic mediator-based system functionality by submitting semantic goal to be fulfilled with SWS capability depending on the aforementioned WSMO four elements. The mediation issues will be also applied depending on the variety of mediators provided by the mediator-based system as well.

At the later stages, the architecture will be applied on the SOA-based ERP system in order to extend it in a semantic manner having a semi-automated solution in the ERP world, and by using a workflow system we can use the market best practices by storing workflows in an internal database. Everything mentioned here will be described later on in more details in the following sections.

4.1. Component Description

The Semantic-SOA-based architecture has the following components:

- **User System:** Is the subsystem which implements the functions that will be used in the end users interface. This subsystem is able to generate user screens at runtime.
- **Workflow System:** Deals with business processes described in an appropriate XML-based workflow language. A workflow in this system is a plan of sequentially or in parallel-chained functions as activities in order to create or utilize business processes. Workflows implicitly contain the business logic of the overall system because it is the main unit in it and all the activities will be distributed to the other subsystems starting from here.
- **Web Service Consumer System:** Contains definitions and functions needed for the processes of Web Services discovery and invocation provided by different service providers.
- **Web Service Provider System:** Contains functions required for providing Web Services and dealing with HTTP incoming and outgoing user's requests, and has a connection to Web Service Directory in order to allow the publication of Web Services.
- **Web Service Directory:** Its interface has the responsibility of Web Services publication based on UDDI standard.
- **Semantic Web Service System:** The main two entities in this component are the ontology and the cloud of Web Services. Ontology here will be a metadata ontology that will serve as a base to provide concepts to help the service providers in the process of creating the clouds and the Web Services within the clouds by enabling them to derive the descriptions of the concepts in the creation process. While the clouds here are defined by the cloud provider as instances of the metadata ontology.
 - The cloud is a service itself, and it can be created, advertised, discovered and invoked in the traditional way. In addition, they are published in the WS Directory in order to let the service providers discover them to later on registering their services as members within it. Each cloud has a category type and generic operations.
- **Cloud Provider:** Will define the clouds as instances of the metadata ontology by assigning values to its concepts. The cloud providers can be normal service providers or businesses that share common point of interest (in most cases, profit organizations).
- **Semantic Mediator-based System:** Has the responsibility of solving the heterogeneity issues that might occur between the semantic goals provided by WS Consumer system and the semantic descriptions of Web Services given by the WS Provider system by performing the matchmaking and filtering results processes. The Mediator-based system may be embedded in a middleware as depicted in the architecture, or it can be an external Web service which accomplishes the mediating scenarios at run-time in a way that lessens the load of mediation process. This loose coupling promotes reusability and facilitates dynamic partner binding, especially at runtime. And all of these issues are to be considered in our future work.

For better understanding to the abovementioned structure, Figure 1 depicts all these components and the relations between them in the proposed architecture.

4.2. System Interactions

In this new model, the interactions can be detailed as follows:

- The cloud provider will define clouds as instances of the metadata ontology and the clouds then will be published in WS Directory so that the WS providers can discover them.

- Service providers will identify the cloud of interest and register their Web Services within it after adding the semantic descriptions on them, and during this stage the provider specifies the cloud concepts that are inherited by its WS (only some of the generic operations) and register them in the appropriate cloud (in the case that the service will be shared between more than one cloud, then the provider will register it in all of them).

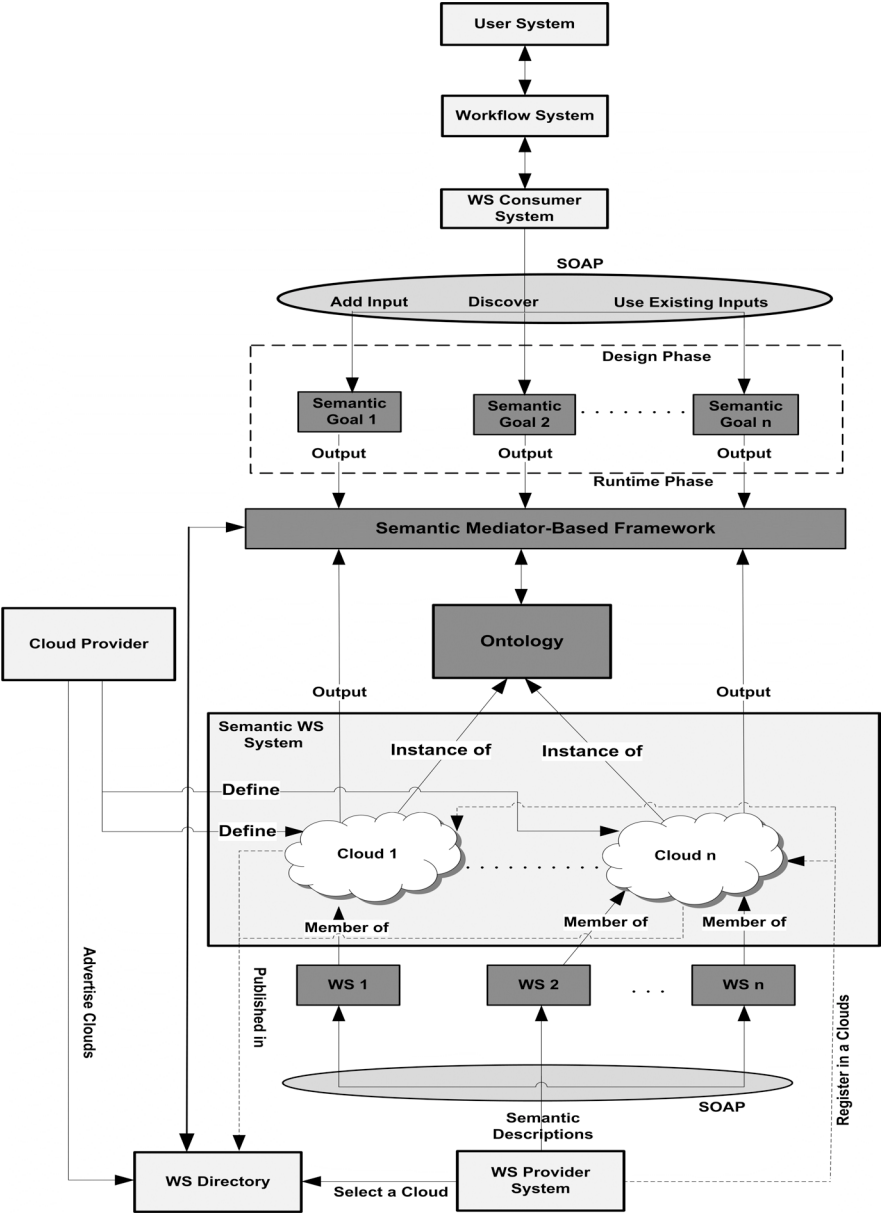


Figure 1 – Semantic SOA-based model for business applications.

- The workflow system will execute a workflow using an appropriate XML-based workflow engine like Yet Another Workflow Language (YAWL) (van der Aalst, ter Hofstede, 2005) or any other dynamic workflow engines and will pass the WS request to the WS consumer system.
- WS consumer system will have the responsibility of searching for desired services depending on the keywords, and that is done by sending SOAP request to WS directory.
- At this stage, the SOAP request will be forwarded to the Mediator-based Framework that applies semantics on the request transforming it into a semantic goal by adding, discovering or using existing semantic inputs compatible with the keywords provided in the previous step. The mediating framework then forwards the semantic goal to the directory and applies the matchmaking process (Agarwal & Studer, 2006) between the goals and capabilities in order to return firstly the appropriate cloud and in the second stage to invoke one of its Web Services (which are registered by the provider).
- It might happen that more than one WS fulfill the semantic goal, and at this point, a dynamic workflow is generated in order to compose the desired WS (if possible and depending on having such functionality in the Web Services advertised in the directory). In this case, a composite service may outsource operations that have different domains of interest and since these operations belong to two or more different clouds, the new composite service has to be registered in all of them.
- Each invocation of a cloud operation is translated into the invocation of one of its Web Services.

The proposed architecture will be applied on FERP system that consists of components that are distributed within a computer network (Brehm & Marx Gómez, 2005) (Brehm, Marx Gómez & Strack, 2007). FERP reference architecture is based on the concepts of SOA, and it is an execution environment for discovery and invocation of enterprise Web Services, it offers also a complete support for interacting with Web Services within the enterprise space or among enterprises. Because one of the main objectives of the FERP system is to integrate business components of different vendors, all components have to comply with standards. In this approach, these standards are described as XML schema documents (Brehm & Marx Gómez, 2007).

To solve the problem of the standards in FERP system, semantics will be introduced and Semantic Web Services will be involved within the new system that will be responsible of the matchmaking, filtering results processes; furthermore dynamic Web Service composition process will be enabled by including several Web Services at runtime, and there are two possible scenarios to achieve this: locally inside the enterprise domain by receiving this process from public Web Services directories and implement it internally, or by implementing this process remotely on those external directories.

4.3. Outcomes of Semantic SOA-Based Model

The main added values from this model over the existing approaches can be summarized as follows:

1. Light Weight Semantic Solutions: From one hand, the problems of SOA that occur at both discovery and invocation phases besides the standard problems can be solved by using the proposed architecture. From the other hand, applying light weight semantics in this architecture will reduce the complexity existing in Semantic SOA.
2. Reusability: The high ability of reusing the functionality in the architecture allows each component to be considered as a standalone input of the system.

3. **Generating Dynamic Workflows:** In the process of composing a new service that does not exist in the directory, a dynamic workflow will be created in order to produce the new service, and based on the concepts that are shared between services the desired service will be created. This approach will motivate the workflow designers to ask for new virtual Web Services that this new architecture can create. In addition, the workflows reusability is an important issue because they will be stored in internal repositories to possibly take benefit from their functionality again.
4. **Dynamic Composition of Web Services:** Because the Web Services in this architecture have the same root metadata ontology, it will be easier to compose services based on semantic goals. And this dynamic composition means that the composed services will be registered within the cloud that it had been created in, and if it is shared between one or more clouds then it will be registered within all of them.
5. **Categorizing of Web Services in clouds:** This will provide a second level of classification together with the traditional one in the directories and this will make the WS searching mechanism more powerful and will improve the response time of the discovery phase activities and the overall performance.
6. **Advertisement for new Web Services in the case of desired functionality absence,** by forwarding the concepts to the cloud provider who in turn will create new cloud for WS providers.

5. Conclusions and Outlook

In this paper, the main focus was to introduce an ontological SOA-based architecture that deals with the Semantic Web Services, in order to be applied later on to one of the business solutions, which is ERP system.

The upcoming implementations will include implementing ontology to create Web Services clouds, grouping WSs in these clouds, defining semantic goals (highly defined WS requests), performing the matchmaking process between goals and WSs, creating static and dynamic workflows and implementing them using workflow engine and enabling the interactions with normal WSs as well.

There is now an ongoing research for testing the quality of Web Services that are used in this architecture. Trust and security issues also will be part of the future work.

One of the main purposes of this architecture is to group the Web Services based on the actual domain that they are related to (the area of interest). In addition, we have the vision of creating general ontology to compose ERP-related Semantic Web Services out of it in order to have a general knowledge base shared between several Web Service providers based completely on ERP concepts. A concrete methodology for performing the dynamic Web Service composition will be defined in the future.

Finally, prototype implementations of the future will have to show the practicability of those concepts.

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Information Systems Architecture Frameworks: A review

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Abstract: Over the past years, the development and dissemination of Information Technologies and the strong organizational dependencies on Information Systems/Information Technologies has grown exponentially. Having this present, it has become essential to create strong representations to integrate the systems, allowing them to work with the existent complexity and, above all, making them so that they can easily be understood. Therefore, the organizations find in the architectural representations the perfect tool to meet this end, since they provide a clear vision and a global understanding of the existence, the localization, the role and all the related resources that rely on the Information Systems/Information Technologies. In the last years, several authors and entities, proposed a large set of frameworks to assist the implementation on the practices of architectural description. These frameworks include several areas of the architectures, such as the organizational, the information systems, the information technologies, the information itself and the software. In this article, a systematic description is done to 28 of those frameworks, indicating their origin, pointing out their goal and objective, the areas that they cover and the components which are inherent to them. Thus, it is expected this work can be a useful instrument for whom wishes to study and understand the concepts that are associated to the architectures.

Keywords: Architecture, Information Systems, frameworks, Zachman, and Comparative Analysis.

1. Introduction

Over the past decades, the field of Information Systems (IS) has been gradually covering new areas of interest. In the past, the IS was the subject of a strictly technological approach by many organizations, which often resulted in inefficient use of resources and no consideration of potential opportunities for their application.

Although this vision still persists, there is a growing awareness that the success of an organization depends, inevitably, of the adequate support of the IS at all levels. The challenge posed is thus to ensure that they are properly planned, developed and exploited. In other words, they are managed in a proper and consistent way according with their objectives and strategies.

Each organization needs to deal with different problems, involving different professionals with different training and experience, using different methods and techniques (Varajão, 1997).

In this context, are needed high-level logical structures (architectures) that, regardless of specific situations and conditions, allow the definition and control of interfaces and integration of all components involved in the reality to treat (Zachman, 1987).

Organizational Architecture (Lankhorst, 2005), Information Systems Architecture (Sowa *et al.*, 1992; Zachman, 1987), Information Architecture (Alamos, 1994), IT Architecture (Boar, 1999; Earl, 1989) and Software Architecture (Kruchten, 1995), are some of the concepts and types of architectures proposed in literature. However, setting limits and differences between these architectures is no easy task in that there is no general consensus on its definition and usage, which in part is explained by the complexity inherent to the concepts and little consistency in terms of interpretations architectures and specifications of the IS/IT. The growing importance and complexity of IS/IT for organizations in past few decades has led to the proposal of approaches that can lead to the definition of architectures of IS through a reflection of the entire organization on the role of IS/IT.

In this sense, a systematic review of tools (frameworks) is very important because that can be used in the development of an architectural description. The resulting analysis of framework should emphasize: the origin, purpose / objective, the areas they cover and the components that are inherent in them.

In this article, we focus concepts like architecture, the different types of architectures and their importance. In a very brief description we present 28 frameworks that cover the various types of architectures. We also make some final considerations, which highlights, the importance of architectures and the results obtained.

2. Background

Since the 80s, there was a continuous increase of information. Therefore, the organizations began to request from its IS/IT the implementation more complex tasks, demanding a greater response capability. This led to a strong growth on the IS/IT investment.

However, managing a vast amount of resources IS/IT has become a difficult task. In order to improve the management of information, it was necessary to introduce architectures on the IS, enabling organizations a global vision and an understanding about the existence, location, role and relationships of the various resources.

Generally, an architecture can be defined as a "plan to build something", in which all parties are brought together in a whole, to meet certain functional or artistic needs (Rodrigues, 2002).

By this way, Zachman defines the architecture as a set of itens of design or descriptive representations that are relevant to the description of an object so that it can be produced in accordance with the requirements (quality) and maintained throughout its time of life (change) (Zachman, 1997).

With the growing interest and importance in the system, appear in the literature various concepts and types of architectures: organizational architecture, IS architecture, IT architecture and software architecture. Figure 1 defines the different types of architectures and their respective frameworks that will be described during this article.

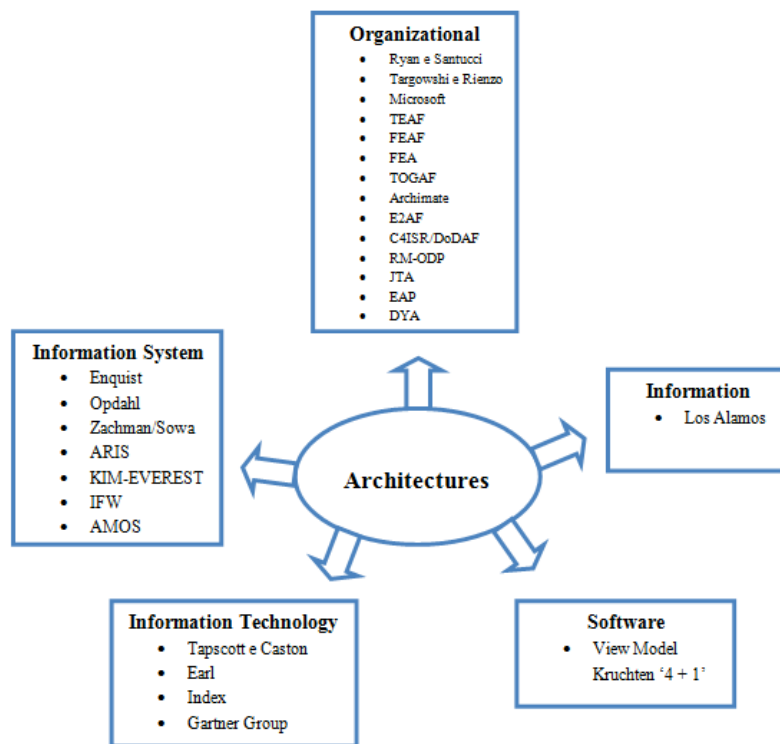


Figure 1 – Types of architecture and respective frameworks

The organizational architecture is the set of descriptive representations that are relevant to the description of an organization, to be produced in accordance with the requirements (quality) and can be maintained throughout its time (change) (Zachman, 1997). It can be defined as a set of principles that guide the design, selection, construction, implementation, installation, maintenance and management of information infrastructure of an organization (DeBover, 1997).

For Zachman, the IS Architecture is basically the number of different perspectives on the data, functions, networks (Zachman, 1987), people, time and motivation (Sowa *et al.*, 1992).

In a wider definition, Amaral (Amaral, 1994) defines the IS Architecture as the result of a process of designing a global vision for the organization of IS, which includes the Information Architecture, complemented with the description of IT involved in its support, the identification of applications and support services to the processes of the organization and definition of the business of developing applications and services.

The Information Architecture illustrates how the activities of the organization and the data needed for these activities can be grouped and ordered so that it is planned in a rational development of its IS (Amaral, 1994). Traditionally, the Information Architecture is seen as a mapping of high level of information requirements and the structure of processes that use such information (IBM, 1984).

The IT Architecture is a set of principles, guidelines, plans, standards and rules that guide an organization through the acquisition, construction, modification, and resources for IT in the organization. The resources of IT include hardware equipment, software, communication

protocols, systems, databases, modeling tools, organizational structures and IT data. With the migration to distributed computing environments, an architecture of IT defines what is important and demonstrates the interoperability, scalability and portability of applications and their components in the architecture (Boar, 1999).

Software architecture is the structure of components of a program/system, their relationships, principles and guidelines governing the design and evolution over time (Garlan *et al.*, 1995)

3. Architecture Development Frameworks

The use of frameworks has allowed the simplification and acceleration of the development of architectures, ensuring a complete coverage of the design of the solution and will guarantee that the chosen architecture allows future changes that are necessary to the business. Over the years, several frameworks have been developed, each with its methodology and proposed solution.

In the subsections that follow are briefly introduced 28 frameworks designed for the Organizational architecture, the Architecture of Information Systems, the Information Architecture, the Architecture of IT and Software Architecture.

3.1. Organizational Architectures Frameworks

Here, we present 15 frameworks regarding organizational architectures that have unique characteristics that makes them distinct from each other:

- Santucci and Ryan framework;
- Targowshi and Rienzo framework;
- Microsoft Solutions Framework;
- Treasury Enterprise Architecture Framework;
- Federal Enterprise Architecture Framework;
- Federal Enterprise Architecture;
- Open Group Architecture Framework;
- ArchiMate;
- Extended Enterprise Architecture Framework;
- Command, Control, Communications, Computers, and Intelligence, Surveillance, and Reconnaissance framework;
- Reference Model of Open Distributed Processing;
- Joint Technical Architecture;
- Enterprise Architecture Planning;
- Dynamic Architecture;
- Integrated Architecture Framework.

The **Santucci and Ryan framework** (Ryan *et al.*, 1993) was created to develop organizational architectures. This kind of architecture framework allows companies to face rapid change of business requirements. This framework is divided into seven elements: environment, business requirements, data architecture, applications architecture, infrastructure, software and hardware.

The **Targowshi and Rienzo framework** (Targowshi, 1996) leads to the development of organizational architectures. This framework is divided into five blocks, which are part of the data architecture, information, knowledge, software, networks and computer systems.

Microsoft Solutions Framework (MSF) emerged in 1994 and aims to organizational architectures (Microsoft, 2008). The MSF is a set of principles, models, disciplines, concepts, guidelines and best practices for software development projects. This framework considers four perspectives: the business, applications, information and technology. For each perspective are associated three views: conceptual, logical and physical (Microsoft, 2002).

The **Treasury Enterprise Architecture Framework (TEAF)** (TEAF, 2000) was established by the Department of the Treasury of the United States. The purpose of TEAF is to provide a framework to produce an organizational structure and guidance to use and manage the same activities. To reduce the complexity and scope of developing an organizational architecture, the TEAF subdivides into perspective, views and work products.

Federal Enterprise Architecture Framework (FEAF) (Council, 1999) was developed by the Chief Information Officers (CIO) Council in the response to the Clinger-Cohen legislation. This framework was created to support the creation and maintenance of organizational architectures. In this framework design the CIO Council identified eight components: Driver Architecture, strategy, current structure, future architecture, transition process, part of the architecture, models, architectures and standards.

Federal Enterprise Architecture (FEA) (FEA, 2007) was developed by Office of Management and Budget (OMB) in 2002, it is an evolution of FEAF framework and a methodology for the creation of organizational architectures. The goal of FEA is to identify opportunities in order to simplify the processes, re-use the Federal IT investigation and unify the agencies work inside the business lines of the Federal Government. FEA is composed by five reference models, which are: *Performance Reference Model (PRM)*, *Business Reference Model (BRM)*, *Service component Reference Model (SRM)*, *Technical Reference Model (TRM)* and *Data Reference Model (DRM)*.

The **Open Group Architecture Framework (TOGAF)** is a set of methods and tools to support organizational development architectures (OpenGroup, 2003). This framework was developed by the Open Group and in 1995 the first version was released. The scope of organizational architecture in TOGAF includes architecture for business processes, application architecture, data architecture and technology architecture. The combination of the data architecture and application architecture is also referred to as the architecture of information systems.

The **ArchiMate** was developed in Holland in 2004 by a consortium led by the Telematica Instituut that recently are part of the Open Group and is a modeling technique to describe enterprise architectures (ArchiMate, 2007a, 2007b). ArchiMate distinguishes three main layers: a business layer, an application layer and a technology layer.

The **Extended Enterprise Architecture Framework (E2AF)** introduced a new approach in organizational architectures, since the processes and activities expanded beyond the conventional boundaries, defining a shared environment for all entities involved in a shared process. This framework was developed by IFEAD¹³ in 2002 and is the distinction of six levels (Scheckerman, 2004c): contextual level, the environment, conceptual level, logical level, physical level and level of processing, and four areas: business or organization information, information systems and technology infrastructure.

The **Command, Control, Communications, Computers, and Intelligence, Surveillance, and Reconnaissance framework (C4ISR)** was developed by the Department of Defense (DoD) and had the task to provide comprehensible indicators, on all matters related to the area of defense, in order to ensure interoperability and reduction of costs in U.S. military systems (AWG, 1997). This framework has been redesigned, appearing as the Department of Defense Architectural Framework (DoDAF), which was established on 30 August 2003 by the DoD and it

¹³ Institute For Enterprise Architecture Developments

was to expand the applicability of architectural principles and practices. This framework is to organizational architectures (DoDAF, 2007). The DoDAF is divided into three views: operational, systems and services and technical standards.

The **Reference Model of Open Distributed Processing** (RM-ODP) is a standard ISO/ITU that defines a framework for the specification of distributed systems architectures. The standard aims to provide support for interoperability, portability and distribution, and therefore allows the construction of open systems, integrated, flexible, modular, manageable, heterogeneous, secure and transparent (Lankhorst, 2005). The RM-ODP is divided into five points of view: the enterprise, information, computer, engineering and technology.

The **Joint Technical Architecture** (JTA) is a leader in the acquisition and development of new and emerging IT systems and covers the area of organizational architecture (JTA, 2001). The JTA identifies only a minimum set of definitions and emerging standards that are critical for interoperability. This framework is a guide in the acquisition and development of new and emerging IT systems and covers the area of organizational architecture. The areas of the JTA are: C4ISR, Combat support, Modeling and Simulation, and Weapons systems (JTA, 2003).

The method **Enterprise Architecture Planning** (EAP) was created by Spewak and Hill in 1992 (Spewak *et al.*, 1995) for the development of organizational architectures. The EAP emphasizes interpersonal skills and techniques to organize and manage projects, obtaining commitment from management, this plan of management and leading the organization through the transition from planning to implementation. This methodology is composed of seven components divided into four layers, which represent a distinct vision of what needs to be done. They are, the beginning of the project, modeling the business, technology and current systems, data architecture, applications architecture, technology architecture and implementation plans and migration.

Dynamic Architecture (DYA) is a Sogeti® vision on how to work with architectures. Concerns the creation and management of organizational architectures (Sogeti, 2003b). This framework is composed of objects of an architecture: business architecture, and architecture of different forms of architecture: principles, policy guidelines and models (Sogeti, 2003a).

Integrated Architecture Framework (IAF) was developed by Capgemini® in 1993 with the objective of creating organizational architectures and covering the areas of business, information and technology (Capgemini, 2006). The strategy of the IAF is based on separating the problem into smaller problems related to the Business areas (people and processes), information (including knowledge), Information Systems and Infrastructure Technology, relating them later with two areas which are located in specific aspects of leadership and security of all those areas. The analysis of each of these areas is further divided into 4 levels of abstraction: Contextual, Conceptual, Logical and Physical.

3.2. Information Systems Architecture Frameworks

In this section, we describe seven frameworks that target the development of IS architectures. Each one of them has unique characteristics that are presented:

- Enquist framework;
- Opdahl framework;
- Framework for Information Systems Architecture;
- Architecture of Integrated Information Systems;
- Information Systems Architecture;
- Information Framework;
- AMOS framework.

The **Enquist framework** (Enquist, 1992) was developed to support the description of Architectures of Information Systems (ASIS). According Enquist an ASI should be described in two levels: macro and micro.

The **Opdahl framework** (Opdahl, 1996) was created to assist the development of ASIS. This framework may be useful as a conceptual and mental tool and in the same way, it is a general model. This framework is divided into five dimensions, they are, agents, activities, resources, guidelines and responsibilities.

Framework for Information Systems Architecture was developed in 1987 by John Zachman (Zachman, 1987). For the construction of this framework, Zachman based on the processes, architecture and engineering, the result was an approach to the construction of architectures that allow the description of the IS of an organization from different perspectives and different dimensions. This model uses descriptions of different types of IS. Initially, the model proposed three types of descriptions (size) for IS: data, functions or processes and networks. Later in 1992, Zachman and Sowa (Sowa *et al.*, 1992) added to the framework three more dimensions: people, time and motivation.

The **Architecture of Integrated Information Systems** (ARIS) was developed by Scheer and provides a structure for developing integrated IS, optimized and converted into technical implementations, Electronic Data Processing (EDP) (Scheer, 1999). This architecture was built with the aim of describing architectures of information systems. The ARIS framework consists of five views: function, organization, data and control outputs.

Information Systems Architecture was proposed by Y. Kim and G. Everest in 1994 (Kim *et al.*, 1994). It was developed based on the work of Zachman. Zachman's work focuses primarily on developing and implementing the architecture covering all the detailed descriptions of IS. This model focuses more on the aspects of planning, explicitly linking different levels of planning with the corresponding levels of architecture. The model defines the architecture of IS according to four complementary architectures: the architecture of processes, the data architecture, the control architecture and technology architecture.

Information Framework (IFW) was created by Roger Evernden (Evernden, 1996) during the 80s, and is licensed exclusively to IBM. The IFW is a tool for analysis and structuring the information. It is used to help structure the information or changes in organizational flexibility and agility. The framework is organized by views (Organizational, Business and Technical) and prospects (Level of construction, level of composition and level of implementation).

The **AMOS framework** by Isaac and Leroy (Isaac *et al.*, 1995) was created for the development of ASIS. These authors, Isaac and Leroy defend that the systems architecture is the integration of elements of the system in an orderly manner. The AMOS divides the ASI in four architectures: functional, logical, organizational and technical.

3.3. Information Technology Architecture Frameworks

Following are described four frameworks which purpose is IT architectures development:

- Tapscott and Caston framework;
- Earl's framework;
- Index framework;
- Gartner Group framework.

The **Tapscott and Caston framework** (Tapscott *et al.*, 1993) is for the development of IT Architectures. This framework gathers five architectural models inter-related. Each model represents a vision or different perspective on how the IT supplies the desired results for the company. The five perspectives are: business, work, technology, application and information.

The **Earl's framework** (Earl, 1989) is aimed at the development of Information Technologies Architectures. The purpose of this framework is to demonstrate that IT can be used for competitive advantages and the potential impact on business. Earl's framework consists in four elements: computing, communication, data and applications. Although each element has to be treated separately, they are interdependent.

The **Index framework** (Boar, 1999) was created to support the development of architectures for IT. The framework is divided by perspectives and aspects. Regarding prospects, we have the infrastructure, data, applications and organization. So, in this way, we have: the inventory, principles, models and standards.

The **Gartner Group framework** (Boar, 1999) was created in order to facilitate the development of architectures for IT. This framework comes in form of matrix and is composed of perspectives (horizontal) and points (vertical). Thus, the prospects are the executive management, the architecture of the organization, the application architecture, architecture of data, the service layer, the layer of facilities, the platform and finally the network. Belonging to the aspects we have, the values, principles, procedures, rules and list of purchases.

3.4. Information Architecture Framework

In this section, we introduce a framework that targets the development of information architectures:

- Los Alamos framework.

The **Los Alamos framework** (Alamos, 1994) aims the development of architectures for information. It is a model for planning and coordination of information and communication activities. Point as constituents an information architecture, the information, applications and infrastructure.

3.5. Software Architecture Framework

Here, we present a framework that suits the development of software architectures:

- model views Kruchten '4 + 1'.

The **model views Kruchten '4 + 1'** (Kruchten, 1995) were created by Kruchten for the development of software architectures. This list of software deals with the design and implementation of high-level structure of software. This results from the integration of a number of architectural elements to satisfy the key features and performance requirements of the system and non-functional requirements such as reliability, scalability, portability and availability. This model contains five views: logic, development, processes, physical and scenarios.

4. Conclusion

In current days, collection and availability of information is increasingly critical for organizations. The rapid dissemination of information is to reshape the way of operating the business and work in society itself.

The growing importance and complexity of IS/IT has led to the creation of several approaches that can lead to the definition of architectures through a reflection of the entire organization on the role of the IS/IT (Carvalho *et al.*, 1993).

In this paper, were identified and briefly described the main concepts associated with various types of frameworks for the development of architectures. This way, issues such as the origin, purpose/objective, the areas of coverage and the components that are attached to each framework were stressed out.

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Organizational knowledge

The Knowledge Perspective of Data Warehouse: Knowledge Warehouse Conceptual Model

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Abstract: A firm's capability to assimilate its existing knowledge to various stakeholders and bring knowledge into action determines its success in the current globalizing word and volatile business environment. However, many firms focus on systematically managing data and information while managing knowledge remains a controversial issue. One of the reasons for that is the inconclusiveness as to what knowledge is and whether it can be managed. To this aim, a Knowledge Warehouse Conceptual Model (KW-CM) is proposed for a practical and systematic assimilation of knowledge. This conceptual model integrates knowledge aspects encompassing business processes, stakeholders and other organizational information systems within the existing Data Warehouse (DW) conceptual model. In addition, the paper presents a formal architecture, definitions and guidelines, which describe the KW components and processes for leveraging data and information into knowledge. The proposed KW-CM is demonstrated with an example of a DW which handles information regarding customers' product usage.

Keywords: Data warehouse; Knowledge Management (KM); Customer Relation Management (CRM); Enterprise Resource Planning (ERP); and Conceptual Model.

1. Introduction

Data warehouse (DW) and Knowledge Management (KM) both aim at facilitating decision making processes. While DW enables complex analysis of organizational transactions, aiming at providing analyzed information to support decision makers (Rizzi, 2007), Knowledge Management (KM) efforts seek solutions for supporting decision-making processes. In addition, KM can contribute to decision-making processes by providing organizational resources (Holsapple, 2001) and facilitating decision sharing of decentralized strategic decisions taken by autonomous managers, allowing the organization to be more responsive to a volatile environment (Nicolas, 2004). In this regard understanding the different aspects of information and knowledge is important, particularly in the current social and economic trends of globalization, ubiquitous computing, and the knowledge-centric view of the firm (Prusak, 2001). However, the distinction between knowledge and information is not always clear and sometimes even discussed simultaneously:

"Knowledge management has inspired a shift from a transaction to a distributed knowledge management (DKM) perspective on inter-organizational information processing. [...] Each player in the network acquires specific knowledge from other players for decision support." (Pedersen & Larsen, 2001, p. 139).

According to Stenmark (2002) knowledge is considered tacit while information is explicit and tangible. Knowledge practices involve reasoning about information and data for leveraging performance, problem solving, decision making, learning and teaching (Adamson & Venerable, 1998). In the proposed DW conceptual modeling a Newell (1981) argument was adopted:

"If a system has (and can use) a data structure which can be said to represent something (an object, a procedure, whatever), then the system itself can also be said to have knowledge, namely the knowledge embodied in that representation about that thing." (p. 2)

Furthermore, Prusak (2001) claims that one of the challenges of organizations today is managing knowledge that cannot be digitized, codified, or easily distributed. The presented DW conceptual model deals also with the decision-maker interface, on a collaborative information technology, which might connect various stakeholders during decision-making processes and foster sharing that kind of knowledge.

This paper focuses on integrating KM perspectives within existing DW conceptual modeling methodologies, which deal mainly with operational information. Much research of DW systems has been carried out so far, establishing a vast theory regarding DW design methodologies (e.g. Adamson & Venerable (1998), Giorgini et al. (2005), Guo et al. (2006), Holten (2003), Kerschberg (2001)). However, the research of KM systems is still an emerging discipline which has not yet evolved to have systematic, sustained design methodologies, in particular when applying knowledge aspects into Information Systems (IS) Jongho et al. (2006). This research aimed at developing an extending conceptual modeling methodology of a Knowledge Warehouse (KW), encompassing KM aspects of stakeholders, business processes and other organizational IS.

The paper is organized as follows: in section 2 the theoretical background of KM, DW, and the linkage between the disciplines are discussed. In section 3, the KW concept is presented, followed with its conceptual modeling entitled Knowledge Warehouse – Conceptual Modeling (KW-CM) in section 4. Finally, section 5 concludes and discusses future research directions. Throughout the paper the KW-CM concepts are demonstrated with a DW example which handles information regarding customers' product usage.

2. Theoretical Background

The nature of knowledge and its representation have long been studied in the Artificial Intelligence (AI) discipline Newell (2002), realizing that knowledge can not be represented only by a structured symbolic form, but requires both structure and process representations. In addition, although knowledge is an abstract concept, it must be coupled with some formal level representation to make a viable view, naming it the knowledge level. In this spirit, the proposed KW-CM exhibits the knowledge level as an extended DW concept model with a knowledge perspective tier.

2.1. Conceptual modeling of Data Warehouse (DW)

DW is based on aggregating operational transactions that represent events, from various organizational databases, allowing online analytical processing (OLAP) for supporting decision makers. The DW and OLAP are frequently conceptually modeled with multidimensional modeling (Rizzi, 2007), which represents the transactions' data in a cubic metaphor where each aggregative transaction is considered a cell. Furthermore, the cubic dimensions stand for analysis criteria, which consist of hierarchy of attributes that further describe them. This conceptual model is often represented with a STAR schema, including a fact table with aggregated data, surrounded by the source tables. In general, conceptual modeling and representation facilitate the design process by abstracting away implementation considerations. This provides a higher level of abstraction in describing the DW process and architecture that can be better understood both by designers as well as end-users.

Several approaches for conceptual modeling of DW systems have been proposed. For example: the extension of the Entity/Relationship (E/R), extension of the Unified Modeling Language (UML) and extension of Dimensional Fact Model (DFM) (Malinowski & Zim'anyi, 2006; Rizzi, 2007). In addition, a hierarchy conceptual model, named MultiDimER (Malinowski & Zim'anyi, 2006), allows each dimension to be represented in hierarchy of attributes that represents any organizational, geographic, or other type of structure that is important for analysis. For instance, a spatial dimension might have a hierarchy with levels such as country, region, city and office. Hierarchies are also required for enabling roll-up and drill-down operations needed for DW analysis.

However, these modeling techniques address operational related concepts of the transactions' data bases such as facts, dimensions, measures, hierarchies and cross-dimension attributes. While they support the OLAP processes, which provide reports to decision makers, they lack the KM dimensions that may support integrating these passive knowledge objects within the active decision making processes. The DW conceptual modeling which is presented in this study is designated to bridge this gap with a specific KM layer that handles various knowledge resources.

2.2. Knowledge Management (KM)

Knowledge is considered as the main competitive asset of the organization, enabling the enterprise to be productive and to deliver competitive products and services (Druker, 1993). KM addresses knowledge-related practices, such as the knowledge chain model (Holsapple, 2003) that identifies five primary knowledge manipulation activities: knowledge acquisition, knowledge selection, knowledge generation, knowledge internalization and knowledge externalization; and four secondary activities: knowledge leadership, knowledge coordination, knowledge control, and knowledge management (KM). Another framework (O'Dell, C. & Grayson, 2003) discusses knowledge transfer that occurs through knowledge life-cycle practices: create, identify, collect, organize, share, adapt and use. In addition, environment factors – cultural and structural – are necessary for dynamic and successful KM processes.

The organizational knowledge is embedded in people, systems, procedures and products. Knowledge workers are required to improve their work on a daily basis in a process that cumulates into a significant improvement in performance for the entire enterprise. One of the cornerstones of KM is improving productivity by effective sharing and transfer of knowledge, which tends to be time-consuming and often impossible (Druker, 1993; Davenport & Prusak, 2000).

Nonaka (1986) distinguishes between tacit and explicit knowledge. Explicit knowledge is stored in textbooks, software products and documents; implicit knowledge is stored in the minds

of people in the form of memory, skills, experience, education, imagination and creativity, which are difficult to identify and manage. Alavi and Leidner (2001) claim that information is converted to knowledge once it is processed in the mind of individuals and knowledge becomes information once it is articulated and presented in the form of text, software product or other means. Then, when the receiver cognitively processes the information, it is converted back into tacit knowledge.

One of the greatest challenges of knowledge organizations is to extract tacit knowledge possessed by their knowledge employees, so as to apply the right knowledge at the right place when needed and to encourage innovation, hence establishing knowledge transfer (Nonaks, 1986; Holsapple & Joshi, 2003). One of the main barriers to KM initiatives is the separation between the work processes and the KM processes, and the focus on meeting deadline requirements that causes KM tasks to be avoided (Davenport & Prusak, 2000).

KM and decision making are correlated disciplines, and effective KM is considered a must for decision making (Bolloju et al., 2002; Nicolas, 2004; Raghu & Vinze, 2007). In this spirit, several decision support systems (DSS) frameworks incorporated the knowledge creation model (Nemati et al., 2002) that occurs through the synergistic relationship and interplay between tacit and explicit knowledge, through a four-step process of socialization, articulation, integration, and understanding/internalization (Bolloju et al., 2002; Nemati et al., 2002; Raghu & Vinze, 2007).

The proposed KW-CM seeks to embed KM activities within the business process, which may lead to better knowledge transfer and to overcoming identified barriers of KM initiatives. Furthermore, KW-CM allows decision makers to get a comprehensive view of DW reports, and establish decision-makers networking throughout the organization.

2.3. Organizational Knowledge

Organizational knowledge is often referred to as collective memory or Organization Memory (OM). OM can leverage the organizational effectiveness and work coordination by providing knowledge processes of acquisition, retention, maintenance, and search and retrieval (Jennex & Olfman, 2003; Nevo & Wand, 2005). For these purposes, OM resides in various IS, and organization employees are required to retrieve the relevant knowledge needed in their work context. However, Nevo and Wand (2005) claim that there are several barriers that prevent IS to manage OM. First, knowledge can be understood in its creation context and often misinterpreted when it is de- contextualized. Another problem relates to the difficult to combine different types of knowledge that reside in diverse locations (e.g. individuals; culture; transformations, procedures, and rules; structure and roles; and physical settings of the workplace). Other problems concern management of tacit knowledge, knowledge volatility and reliability. Therefore, instead of a IS layer which intends to support the processes involved in using OM, Nevo and Wand (2005) propose a conceptual model for supporting the management and usage of OM. Their approach is based on examining, via transactive memory systems concepts, processes which support the sharing of collective knowledge assets within small groups that establish communities of practice. Extending this approach to the whole organizational memory context is possible with IS support.

The transactive memory approach is based on the various ways human encode knowledge: internally, in the mind; externally in an external repository of some kind; or through linkage to someone who holds the knowledge. This linkage resembles a meta-memory, hence memory on memory, consisting of a label of the knowledge and a linkage to its location. In addition, the meta-memory is managed with a directory which supports operations of information updating, allocation, and retrieval. While human can establish a naturally transactive memory system within small groups, in organizational context it is impossible. This is because the required meta-memory is too large for the individual's memory capacity and it is not always clear who holds

specific information. For overcoming these difficulties, Nevo and Wand (2005) suggest to use information technology to support an organization-wide transactive memory system. Their concept views the organization as a group of communities of practices where in each group a transactive memory system has been established. These various communities can be linked through an organizational system which holds artificial directories containing transactive knowledge.

In order to establish organization-wide memory, knowledge should be formalized to set a perceptual common ground for sharing. For this aim an organizational ontology that defines the domain of organizational knowledge concepts and their relationships should be constructed. By this ontology they refer to knowledge, which is represented by generalized concepts (e.g. project plan) and concepts instances (e.g. project A plan) as well as knowledge retainers, represented by roles (e.g. project manager) and roles instances (e.g. project A's project manager, named "Linda"). In addition, the ontology includes a tacit knowledge representation that defines the natural tacit perceptions possessed by members of communities of practice, entitled meta-knowledge, addressing issues such as expertise, cognitive capabilities and source credibility (Nevo & Wand, 2005).

In this paper, a similar approach for the KW concept is adopted. The KW serves as a transactive memory for organizing the OLAP reports, using an organizational ontology for defining stakeholders, business processes and IS services, but without referring to these concepts' instances. However, the tacit knowledge dimension is not handled in a formalized manner, but rather through a collaborative environment that fosters natural shared practices. Moreover, connecting the KW to business processes context may improve knowledge transfer and acquisition.

2.4. DW and KM

Current trends in DW (Kerschberg, 2001; Nemati et al., 2002; Ralaivao & Darmont, 2007) indicate that organizations are now becoming e-Enterprises by moving their operations to the Internet; establishing partnership with external stakeholders such as customers and suppliers; and handling complex data, both structured (e.g. Enterprise Resource Planning (ERP), Customer Relationship Management (CRM)) and unstructured (e.g. emails, wikis), as well as incorporating collected web data into their information repositories. Therefore, DW research should address the need for extending the DW role in a broader perspective that relates not only to operational transaction-oriented data, but also to knowledge created by knowledge-workers within the enterprise, for facilitating business decision-making.

Several studies refer to the notion of integrating KM with DW. Kerschberg (2001) discuss the need to aggregate heterogeneous data, including web information into the data warehouse; Jongho et al. (2003) propose a systematic conversion of knowledge into hypermedia artifacts and data warehouse components; and Nemati et al (2002) argue that there is a need for a new expanded DSS, which incorporates DW concepts as well as knowledge creation approach, according to Nonaka's knowledge creation theory (1986). These studies however, deal mainly with architecture and conceptual model for Decision Support Systems (DSS) where DW is included, whereas this paper discusses an extended practical conceptual modeling of DW that addresses KM aspects, encompassing stakeholders, business processes and IS.

The current literature review has shown that none of the existing approaches for conceptual modeling of DW addresses KM issues as part of the DW model. This paper aims at bridging this gap by introducing a Knowledge Warehouse Conceptual Model (KW-CM) that extends the multidimensional modeling methodology (Rizzi, 2007) with a knowledge layer. The purpose of such a conceptual model is to ensure that decision makers will get comprehensive and appropriate

knowledge, including network to relevant stakeholders, in the context of their decision making processes.

3. Knowledge Warehouse

While DW aims at facilitating decision making in organizations, it is not clear whether massive data integration can support decision making in complex business processes (Tsoukas & Vladimirou, 2001; Holten, 2003; Maddalena, 2004).

“[...] more elaborate techniques are required to extract the hidden knowledge and make these data valuable for decision-makers.” (Maddalena, 2004, p. 54)

Several papers have addressed this requirement, but mainly focused on integrating knowledge views such as patterns (Maddalena, 2004), management views (Holten, 2003) and quality factors (Tsoukas & Vladimirou, 2001) to design and implementation of DW. In this article, the concept of KW as a central coordinator for DW usage is introduced. KW is part of a four layer knowledge system (Fig. 1). The first layer consists of the organizational systems that aggregate transactions (On-Line Transaction processing – OLTP). The second layer is the DW which is constructed based on the OLTP data, above which lays the On-Line Analytic Processing (OLAP) layer that processes queries on the DW, and produces reports for various stakeholders in the organization. The KW role is to handle these reports while providing the decision maker a comprehensive organizational view, by aggregating related knowledge in the context of a specific business process and pointing to other relevant stakeholders. The benefit of such a component is twofold; first the decision taken can consider other resources of information that may not be part of the DW reports, and second the decision taken becomes part of the current report linkage, available for other stakeholders in the current and future decision making processes.

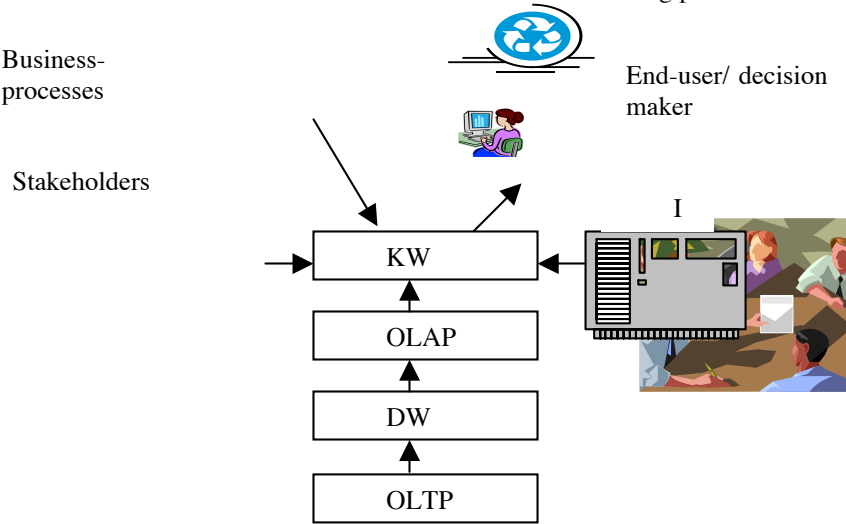


Figure 1: KW – Four-Layer Architecture

The main building-blocks of the KW are the OLAP reports, Business Processes, Information Systems and Stakeholders. The first stage of designing KW requires realizing the conceptual model of the KW layer which is based on the DW conceptual modeling approach. The KW approach can further support aggregating information regarding DW usage, which is an additional enhancement to existing DW capabilities.

4. KW-CM – Knowledge Warehouse Conceptual Model

The concept of the Knowledge Warehouse Conceptual Model (KW-CM) is an extension of the multidimensional DW conceptual modeling (Rizzi, 2007), addressing architecture, definitions and formalism issues. For the sake of brevity only the new extended part of the model is described (for a detailed description see Rizzi, 2007). In what follows, the KW architecture and conceptual modeling issues are explained and demonstrated including formalism of the main concepts. The KW-CM can help decision making by giving the decision makers a comprehensive understanding of the OLAP report, and contextualize its content with other organizational information and stakeholders, hence turn information into knowledge.

The KW-CM concept is demonstrated through an example of a DW, which handles information regarding customers' product usage. In this context, consider a scenario in which a manager gets an OLAP report, showing insufficient usage of a feature in a new product line. In order to support the manager in making an intelligent decision, more information is needed. For instance, data records in the Customer Relationship Management (CRM) system reveal reoccurrence of complains regarding that feature. Furthermore, the marketing information system informs which campaign management processes have been issued regarding this feature. In addition, the manager needs a point of contact in the R&D department for discussing the problems that were reported. These knowledge resources, and possibly more, may be relevant for the specific issue at hand. Therefore, aggregating the information and knowledge resources into one coherent environment may enhance the decision making process.

4.1. KW-CM Architecture

In order to facilitate knowledge assimilation that addresses the current needs of the learning organization, it is essential to discuss knowledge items in the broader sense of their business environment. Therefore, when decision makers discuss the DW OLAP reports, they need to consider: which organizational business processes are involved in utilizing the DW analysis reports? who are the organizational stakeholders that are interested in getting the reports? what other organizational IS can contribute in getting a more comprehensive perspective of the DW analysis reports at hand?

For answering these questions there should be a systematic definition of how to connect information regarding business processes, stakeholders and IS with DW analytic reports. To this aim the original DW that was constructed according to familiar practices (Adamson & Venerable, 1998; Kerschberg, 2001; Giorgini et al., 2005; Guo et al., 2006; Malinowski & Zim'anyi, 2006; Rizzi, 2007) remains unchanged, and considered as a black box. A new DW, entitled KW, is constructed, where the facts (events) are the OLAP reports with KW dimensions that consist of Business Processes, Stakeholders and IS (see Fig 2).

The KW dimensions exhibit the reports' metadata, which in this case means data about the report. This metadata is implemented with organizational ontology which maps the information

regarding the reports, business processes, stakeholders and IS into concepts and relations. Further, the organizational ontology concepts are installed in the KW according to the report that was issued and serve in the aggregating knowledge processes (see 4.2).

The KW processes are different from traditional DW processes. While DW processes aggregate data of organizational events into a new Data Base (DB) with OLAP capabilities, KW processes utilize the linkages metadata in the KW for linking IS, stakeholders and business processes to an OLAP report. These processes occur when observing a specific report in a specialized KW environment (see 4.3).

For each DW dimension there is a specialized KW process, entitled KW-Process. The IS KW-Process is implemented by services, which are software components that serve as interfaces to IS, for extracting the needed information. In case where no IS service is provided, a reference to the IS will be presented to the decision-maker, for self knowledge extraction. The stakeholders and business processes KW-Processes present the linkage information to the decision-maker within the KW environment. Having such an organizational ontology can support further development of interfaces to other applications across the organization.

Thinking about the example above, a manager who holds the report regarding the underused feature can use a service that aggregates all the information about the specific product's feature from the CRM and present it to the manager. Since the original OLAP report is based on specific fields, it is reasonable that part of them will be used for aggregating information from other IS systems as well. For example, in the former case, the product and the underused feature identification numbers are part of the OLAP report, and are also the parameters according which information will be extracted from the CRM.

The three KW dimensions, IS, business processes and stakeholders, have N:M relations with the OLAP reports facts table. For instance, in the discussed example, the report can have linkage to the CRM, as well as to the ERP system for aggregating data concerning the customers' information. At the same time, there is a linkage that connects the report to business processes of a new feature development and product bug review. In addition, the stakeholders who relate to the report are the R&D head of department, the specific product manager, the head of the marketing department and so forth. Therefore, three additional bridge tables are required for implementing these relations, but for brevity and comprehensibility considerations these tables are not presented in Fig. 2.

4.2. KW-CM Definitions

The presented conceptual modeling extends the DW conceptual modeling (Rizzi, 2007) which address the basic concepts of multidimensional DW with additional descriptive and cross-dimension attributes. A similar method for expressing the KW-CM definitions is being used, following formal representation of these definitions and guidelines for using the definitions during the modeling process. In what follows, and due to space limits, only a partial ontology will be presented and demonstrated. However, these examples illustrate the basic ideas of how to logically link the various KW components.

In order to formalize the KW-CM, the organizational ontology terms are presented by sets. For example term A is defined as a set: $A = \{x | x \text{ is an item in a set which represents a term in the ontology}\}$ (e.g. queries); Relation Re between terms is represented as a relation: $Re(x,y)$, where x is the first term and y is the second term (e.g. query x has "queryRelatesToReport" relation with report y). A Relational Data Base (RDB) R is defined as $SchR := \{at1, \dots, atn\}$, is a set of n attributes of RDB R (e.g. OlapReports). It should be noted that each organization needs ontology that is contextualized to its business environment. However, future research might focus on

building general ontology that can serve as basic organizational ontology to be refined according to specific organizational terms.

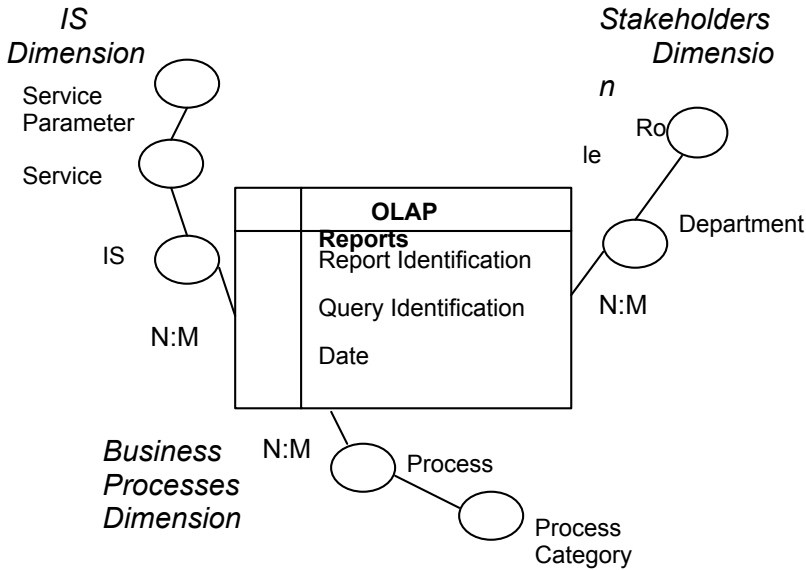


Figure 2: A basic fact schema for KW

Definition 1: A *DW report* is defined according to its query definitions, assuming that each query type has a unique term in the organization ontology and a specific process in the OLAP layer. Therefore, this term is included in the KW-CM fact table, enabling to connect a specific report to its query, serving also as a report type identifier.

Formalism 1: Q is the set which represents the organizational OLAP queries:
 $Q = \{y | y \text{ is a query processed by the OLAP layer}\}.$

Guideline 1: In order to build a coherent KW-CM, organizational ontology which holds the reports query terms should be defined. For instance, in our example the Q set includes a query entitled “UsageOfFeatureX” that aggregates information from operational DB and creates a report of the usage of feature X. This query has a unique identifier which will be part of the KW fact table.

Definition 2: A *KW-CM fact table* exhibits the DW reports that the OLAP layer produced. Each report is considered a primary event and appears only once with an identification number, the date it was issued and its query term, taken from the organizational ontology.

Formalism 2: KW-CM includes a RDB that is defined as $Sch_{KW-CM} := \{at_1=Ri, at_2=Qi, at_3=Date\}$. Where Ri is the report unique identifier, which is the same identifier in the reports' repository, and serves as the RDB primary key; $Qi \in Q$; and date refers to the day in which the report was issued. Although the date is part of the report data, it is inserted in the KW to enable further KW analysis.

Guideline 2: The KW-CM fact includes a reference to a report which exists in one of the organizational repositories, as well as an ontological term of its query. The KW-CM fact table is updated whenever a new report is produced. For example, the report that was described at guideline 1 above, will have a correspondence record in the RDB with an identifier number; $Q_i = \text{"UsageOfFeatureX"}$; and the date it was issued.

Definition 3: A *KW-CM service* is a linkage to a service that enables extracting information from a specific IS. Having such services is critical for aggregating information which is relevant to the KW-CM facts.

Formalism 3: IS is the set which represents the organizational Information Systems (IS), S is the set which represents the organizational IS services and P is a set which defines the services parameters.

$IS = \{x | x \text{ is an organizational IS}\}$. $S = \{y | y \text{ is a service provided by organizational IS}\}$. $P = \{z | z \text{ is a parameter of one or more services}\}$. The relation $IS-S(x,y)$ defines that service y is related to IS x. The relation $SP(z,y)$ defines that parameter z relates to service y. If $q \in Q$ then the relation $SQ(y,q)$ defines that service y relates to query q.

Guideline 3: Each IS component of the KW-CM should have a service and service parameters, which will serve as a gate through which information can be extracted. Following the ongoing example, there is a need to aggregate information regarding the management campaigns that relate to this specific feature. The IS set will include $IS_i = \text{"CampaignManagementSystem"}$, assuming that there is an organizational system IS that aggregates information about campaign management; the P set will include $P_i = \text{"Feature"}$ and $S_i = \text{"FindManagementCampaignsOfFeature"}$. In addition, there will be a relation of $IS-S(\text{"CampaignManagementSystem"}, \text{"FindManagementCampaignsOfFeature"})$ a relation of $SP(\text{"Feature"}, \text{"FindManagementCampaignsOfFeature"})$ and for the former $Q_i = \text{"UsageOfFeatureX"}$, there will be a relation $SQ(\text{"FindManagementCampaignsOfFeature"}, \text{"UsageOfFeatureX"})$.

Definition 4: A *KW-CM ontology* handles the KW-CM stakeholders and business processes terms. As explained above, only partial ontology is defined, therefore stakeholders' roles and departments related terms as well as terms that define business processes' categories will not be described.

Formalism 4: ST is the set which represents the stakeholders and BP is a set which defines the business processes.

$ST = \{x | x \text{ is a stakeholder in the organization}\}$ and $BP = \{y | y \text{ is an organizational business process}\}$. If $z \in Q$ then the relation $ST-Q(x,z)$ defines a stakeholder x that relates to query z, and the relation $BP-Q(y,z)$ defines a business process y that relates to query z.

Guideline 4: Each one of the KW-CM stakeholders and business processes components should have a representation in the KW-CM ontology. For example, if a stakeholder of a specific query is the R&D department, the KW-CM ontology should include such a stakeholder definition. The same is applicable for presenting the various organizational processes in such ontology. Such ontology can serve us further when extracting information from the KW-CM, such as finding all the business processes that relate to a specific query. For demonstration, in the context of the former example, $ST_i = \text{"headOfTheR\&Ddepartment"}$ and $BP_i = \text{"ProductSatisfactionReview"}$, and for the $Q_i = \text{"UsageOfFeatureX"}$ there will be relations of $ST-Q(\text{"headOfTheR\&Ddepartment"}, \text{"UsageOfFeatureX"})$ and $BP-Q(\text{"ProductSatisfactionReview"}, \text{"UsageOfFeatureX"})$.

Definition 5: *KW-CM ontology*, will hold for each query its input and output parameters. This will enable to connect the query parameters with the required services parameters.

Formalism 5: QIP is the set which represents the queries input parameters and QOP is the set which represent the queries output parameters.

$QIP = \{x | x \text{ is a query input parameter}\}$ and $QOP = \{y | y \text{ is a query output parameter}\}$. If $z \in Q$ then the relation $QIP-Q(x,z)$ defines that parameter x is an input parameter of query z , and the relation $QOP-Q(y,z)$ defines that parameter y is an output parameter of query z .

Guideline 5: The organizational ontology should define for each query its input and output parameters, assuming that these parameters are aligned with the services parameters. Therefore, the terms of the services parameters and the queries input and output parameters should share the same terminology. For example if a DW report aggregates information regarding the usage of a specific feature, based on specific user age attribute, the ontology will include $Q_i = \text{"UsageByAge"}$ which creates the report with $QIP_i = \text{"user-age"}$, as the query input parameter, followed a relation of $QIP-Q(\text{"user-age"}, \text{"UsageByAge"})$, as well as $QOP_i = \text{"customer-name"}$ as the query output parameter, and a relation of $QOP-Q(\text{"customer-name"}, \text{"UsageByAge"})$. In addition, the ontology may include a service entitled "CustomersByAge" that has input parameter of "user-age" that collects information from the ERP. Therefore, the ontology will include also the relation $SQ(\text{"CustomersByAge"}, \text{"UsageByAge"})$ that connects the service "CustomersByAge" to its related "UsageByAge" query.

4.3. KW-CM Environment

A *KW-CM environment* is part of the KW-CM which defines the interface where the KW-CM gathered information will be presented to its decision-makers. Beside the architecture of the KW-CM, its functionality should be defined, including search and information gathering capabilities. The design of such environment is beyond the scope of the current paper but there is a need to explicitly define its requirements.

The KW-CM aggregating information should be presented via a collaborative environment, rather than in a DW report. This environment includes a linkage to the specific DW report; the aggregative information, hence the relevant records which were found via the IS services as a result of searching the required fields; the report's relevant stakeholders; and the business processes for which the report is applicable. In case the linked IS does not provide service for extracting information, there will be an option to present the decision-maker a link to that system for further usage. Moreover, the KW-CM environment should include additional place for unstructured information where the stakeholders can express insights or share experience while discussing issues concerning a specific DW report.

In addition, the decisions taken following analyzing DW report can be managed also in such environment, including interfacing organizational decision support systems, if such exist. The benefit of such environment is obvious when tracking previous DW report activities within organization.

The KW-CM defined above serves as an organizational transactive memory, which links knowledge items, represented by OLAP reports, with other information items that exist in other IS, while connecting them to relevant stakeholders in the context of a business processes.

5. Conclusion and Future Work

The requirement of facilitating the usage of IS, and in particular DW, during decision making processes is well acknowledged (Tsoukas, H., Vladimirou, 2001; Stenmark, 2002; Holten, 2003; Maddalena, 2004). This paper pursues an enhancement to the usage of a DW by embedding a knowledge layer on top of existing DW and OLAP applications. The rational behind this stems from the need for embedding knowledge processes within business processes in a context which is relevant for their stakeholders. In this regard the KW-CM approach addresses both, managing the structured knowledge that come from the organizational IS, business processes and stakeholders ontology, as well as organizing unstructured information to be shared in a collaborative environment.

Nevu and Wade (2007) claim that there is a need to align system performance with stakeholder expectations. Therefore, encompassing the stakeholders view in the KW-CM, starting from the conceptual modeling, can enhance the usability and satisfaction from DW. Furthermore, the suggested environment can help in analyzing of DW usage and improvements. Since the KW-CM architecture defines a separate layer for the KW it is applicable for existing DW without the need to redesign them.

The presented KW concept modeling opens a new direction in DW research and implementation. Further work will address designing and implementing issues concerning KW-CM application and usage. This involves various aspects of IS such as IS services, organizational ontology related issues as well as KW processes and KW analytic processes, Human-Computer Interactions (HCI) and Computer Supported Collaborative Work (CSCW).

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The Applicability of Semantic Technologies in Enterprise Information Systems

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Abstract: In order to meet the challenges of today's Internet economy and be competitive in global market, enterprises are constantly adapting their business processes and adjusting their information systems. In this article, we shall analyze the applicability and the benefits of using semantic technologies in contemporary information systems. By using an illustrative case study of deployment of Semantic Web technologies in Human Resources sector at the Mihailo Pupin Institute, this paper shows how the latest semantic technologies could be used on top of existing Enterprise Information Systems and Enterprise Content Management system in order to ensure meaningful search and retrieval of expertise for in-house users as well as for integration in the European research space and beyond.

Keywords: Enterprise Information Systems; Semantic Web; Technology assessment; Applications; Human Resources; Case study.

1. Introduction

The main function of an Enterprise Information System (EIS) is the support of business processes. Traditionally, enterprise information systems were limited in their support for intra-organizational business processes. However, in order to meet the challenges of today's information economy and be competitive in the global market, enterprises are constantly adapting their business processes and adjusting their information systems. Whereas in the 1990's the companies concentrated on implementing systems with re-automated functions to provide specific benefits in-house, today's market demands new applications and better integration within and between the organizations. Nowadays, the modern enterprise information systems represent an interconnection of heterogeneous systems like frameworks, knowledge management systems, enterprise resource planning, databases, data warehouses, etc. Resources are more often distributed over multiple sites, thus requiring utilization of different technologies and approaches for data/document access and retrieval.

Semantic technologies provide standards and structures that allow information to be described in a way that captures *what it is*, *what it means* and *what it's related to* - all in a machine-readable form. This enables machines as well as people to understand, share and reason with them at the execution time. Semantic Web (SW) technologies are designed to extend the capabilities of the information on the Web and to enable enterprise systems to be networked in meaningful ways. This opens new perspectives that are far beyond the traditional approaches to information management.

In the present article we shall first more closely define the semantic technologies and the Semantic Web, and then, using an illustrative case study of deploying Semantic Web technologies at the Mihailo Pupin Institute (Belgrade, Serbia), we will discuss the transition from the older models of information management to new ways of data integration and leveraging the diversity of resources using Semantic Web technologies. In order to locate the types of problems semantic technologies can solve, we will analyze the W3C collection of Case Studies and Use Cases and discuss the extent of adoption of Semantic Web technologies in practice.

2. Research Framework

Semantic Web is one of the fastest developing fields within the ICT sector and, as such, under constant examination by scientists and IT professionals. Most of the academic work, up to now, has focused on the global public gains of adopting SW technologies (Alani et al., 2008), and to a significant degree has neglected the industry development and migration needs to meet the SW challenges.

Having in mind this situation, the present work will focus on:

- * presenting a brief account of the key application areas of Semantic Web technologies and a summary of the achieved benefits from them (based on the analysis of the W3C collection of Case Studies and Use Cases), that will give a picture of the present status of the SW technology implementation and needs thereof in industry development sector, and
- * presenting the results of a case study of the use of semantic technologies for integration and meaningful search and retrieval of expertise data, as an example of the new approaches to data integration and information management.

2.1. Semantic Web Background

The Semantic Web was envisioned by Tim Berners-Lee, inventor of the World Wide Web (Web), and is now being further refined by researchers and visionaries within the World Wide Web Consortium (W3C), which Berners-Lee directs. In (Berners-Lee, Hendler, & Lassila, 2001), Semantic Web is defined as '...an extension of the current Web in which information is given the well-defined meaning, better enabling computers and people to work in cooperation'. The main standardization body the W3C was created in October 1994, to "lead the World Wide Web to its full potential by developing common protocols that promote its evolution and ensure its interoperability."

Semantic Web is an extension of the conventional Web based on the HyperText Markup Language (HTML) and the Extensible Markup Language (XML). A markup language is a set of markup tags used to describe the web pages. A HTML Web document contains HTML tags and plain text. XML is a generic markup language for describing the structure of data. Unlike in the HTML, neither the tag set nor the semantics of XML are fixed. XML can thus be used to derive markup languages by specifying tags and structural relationships. Semantic Web languages, indeed, use XML syntax. Since the Semantic Web was conceived, numerous web technologies have been accepted as standards or recommendations by the W3C's Semantic Web Activity (Ayers, 2009). In an attempt to structure and relate these technologies, Berners-Lee presented several versions of the Semantic Web architecture where these technologies were layered into a so-called stack of increasingly expressive languages for meta-data specification (Gerber, van der Merwe, & Barnard, 2008). In short, W3C recommends implementing the Semantic Web in the layers of Web technologies and standards where the Application layer should be developed on top

of the Ontology layer, which in turn is developed on top of the Resource Description Framework (RDF) layer. RDF is a general-purpose language for representing information on the Web. It defines a framework in which independent communities can develop vocabularies that suit their specific needs and share vocabularies with other communities. In order to share vocabularies, the meaning of terms must be specified in detail. The descriptions of these vocabulary sets are called RDF Schemas. A schema defines the meaning, characteristics, and relationships of a set of properties, and this may include constraints on potential values and the inheritance of properties from other schemas. The RDF language allows each document containing metadata to clarify which vocabulary is being used by assigning each vocabulary a Web address. RDF Schema uses Uniform Resource Identifier (URI) references for naming. URI reference is a string that represents a URI, i.e., name or address of an abstract or physical resource on the Web. Ontology Web Language (OWL) facilitates greater machine interpretability of Web content than that supported by RDF and RDF Schema by providing an additional vocabulary along with formal semantics.

W3C does not prescribe ways of implementation semantic applications, and the Semantic Web layer cake (see W3C, <http://www.w3.org/2007/03/layerCake.png>) is not a technology stack in the engineering sense. After the standardization of the RDF and the Ontology layer, main efforts of the Semantic Web research community during last several years have been (and still are) devoted to: standardization of technologies (WSDL - Web Services Description Language and SAWSDL - Semantic Annotations for WSDL and XML Schema, recommended in 2007) for development Semantic Web Services and provision of tools that enhance interoperability; development of rule languages (SWRL - Semantic Web Rule Language, RuleML), development of Rule Interchange Format (RIF) and provision of engines (ontology reasoning and rule) that enhance reasoning; improvement of OWL and invention of new knowledge representation formalisms.

2.2. Knowledge Technologies and Processes in Traditional EIS

An enterprise is an independent legal economic entity, established with the aim to carry out particular business activities with a positive outcome. Depending on the type of primary economic activities, we distinguish manufacturing enterprises, retail enterprises, service enterprises, public enterprise, etc. The primary economic activities of an enterprise define also the structure of its enterprise business processes. For instance, the business processes of a research and development organization (R&D) will slightly differ from the enterprise business processes of a retail company. Roughly speaking, enterprise information flows could be divided into external and internal flows. External flows are directed towards clients, suppliers, partners and other legal entities. Internal flows are results of information exchange and business interactions between employees inside the enterprise. Both types of processes together form the enterprise business processes, such as: marketing, sales, purchase, customer support, research and development, manufacturing and management.

As shown in Figure 1 (Janev & Vraneš, 2005), enterprise management processes vertically can be divided into operational business processes and strategic business processes. Operational business processes that are aimed at carrying out the daily activities in an effective and an efficient way are based on transactional databases (DB). On the lowest level (Layer 1 in Figure1), enterprise resource management (ERP) systems integrate and automate all aspects of operational business activities from manufacturing and warehousing to sales and finance. Built around a centralized or distributed database, ERP systems are often preserved as back office systems for managing the internal information flows. The ERP systems' integrated functionalities ensure prompt connection of the employees with the customers, suppliers or partners. Information

technologies that have an integrative role on the enterprise level are (Layer 2 in Figure1): data warehousing technologies, collaboration solutions, portals, document management, workflow solutions and other ontology based and SOA oriented solutions. While managers on the operational level are concerned with the optimization of workflows, reduction of costs, and utilization of resources, the strategic managers (Layers 3 and 4 in Figure 1) are concerned with establishment of good position on the market, improving the customer satisfaction, meeting the business objectives and creating profit, protection and development of intellectual capital, etc. On upper levels specialized executive information systems that support strategic activities, such as goal setting, planning and forecasting and tracking performance, are used. Executive information systems, also called Business Intelligence (BI) systems, include decision support applications, operational research techniques, knowledge production technologies and enterprise performance measurement systems.

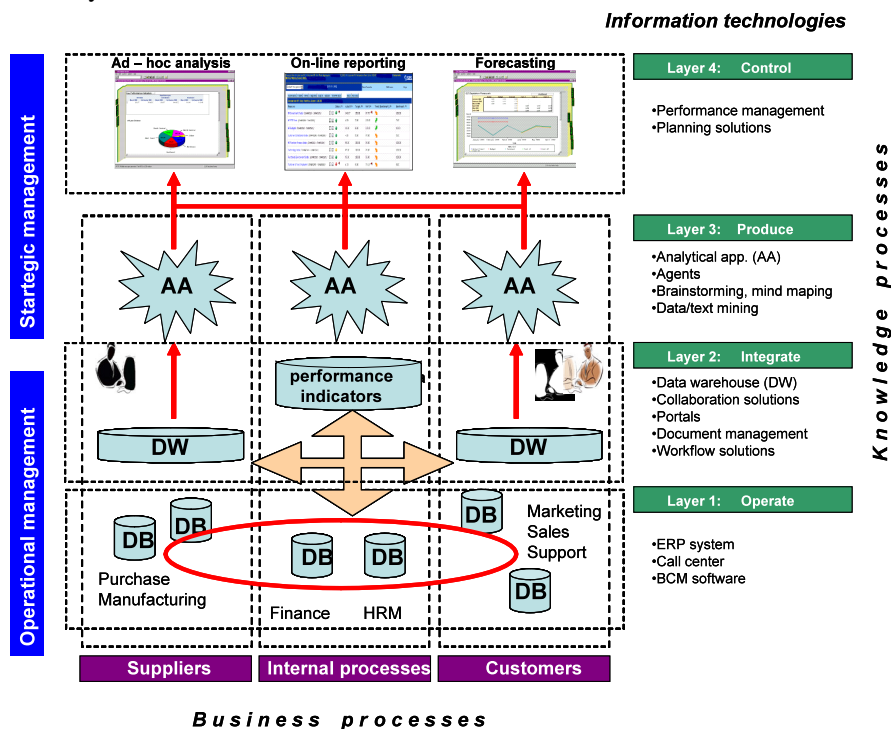


Figure 1 – Relating information and knowledge technologies to business processes in traditional EIS

2.3. Driving Forces for EIS Development

In order to increase the efficiency of business processes, organizations outsource business processes to service providers or use information technologies to shift the front-end process completely to the customer self-service and automatic retail of digital goods without any human interference at the provider side. New organizational models such as a “virtual organization”, whose members link their individual core competencies through cost-sharing and risk-sharing agreements so that the virtually integrated organization can act as a larger, single entity, invoke challenges such as inter-enterprise cooperation, interoperability and integration, migration and heterogeneity management. From here we can see the growing importance of interorganizational

(cross-organizational) applications of enterprise information systems, in particular in the e-business context (Nayak, Bhaskaran, & Das, 2001). This includes dynamical aspects in external links, e.g. with respect to offered functionality and/or with respect to collaborating parties. To provide integrated solutions, new approaches, technologies and architectures have emerged during the last decade (Gu, Xia & You, 2006) that include ontologies, Web services and Components technology, Workflow technology, Service-oriented architecture, Model driven architecture, the Grid Computing, etc. The Semantic Web technologies are the subject of investigation in this paper, especially their role in the contemporary software engineering and the ways researchers and practitioners are using them in practice.

3. Technology Assessment of Semantic Web Technologies

New technologies are usually subjected to experimentation, refinement, and increasingly realistic and exhaustive testing. This kind of information gathering, which looks beyond the immediately obvious and attempts to analyze a given technology's ramifications in as wide-ranging and far-sighted a manner as possible, is known as *technology assessment* (Braun, 1998). It is usually based on different forecasting methods, such as extrapolation, expert opinion (the Delphi method) and modeling, cost-benefit analysis, and cross-impact analysis. Prior to incorporating a specific technology into a system or subsystem, many of the world's larger companies and government agencies use a measure called *the technology readiness level*. At the lowest level, researchers begin to translate scientific data into applied research and development. At the middle level, they test the prototype system (or technology) in a real environment, and at the highest level, they integrate the new technology into an existing system.

Aiming at providing an updated picture of the applicability and adoption of Semantic Web technologies in practice, we have analyzed the collection of W3C Semantic Web Case Studies and Use Cases (www.w3.org/2001/sw/sweo/public/UseCases/). The W3C, the main standardization body for the Semantic Web, established a collection of Semantic Web case studies and use cases in 2007, based on an enterprise survey conducted by the SW Education and Outreach Interest (SWE0; www.w3.org/2001/sw/sweo/) Group. The "case studies" include descriptions of systems that have been deployed within an organization and are now being used in a production environment. The "use cases" include examples of built prototype systems that have not yet been used in practices. As of this writing, the database stores 39 entries, in which 27 are case studies.

For better understanding the usability of SW technologies in real applications, we have used the cross-tabulation analysis to find relationships between variables such as the enterprise *Activity area of*, the *Application area of SW technologies*, the *SW technologies used*, and the *Benefits of SW technologies*. Researchers typically use cross-tabulation analysis, also known as contingency table analysis, to analyze categorical (nominal measurement scale) data. A cross-tabulation is a two- (or more) dimensional table that records the frequency of respondents with the specific characteristics described in the table's cells. Our primary objective was to identify the W3C SW technologies applied in a particular application domain and the benefits gained. The results are summarized in Table 1.

Analyzing the *Activity area* of the companies that utilize SW applications, we found that most of them are public institution, followed by health care, IT and telecommunication and publishing companies. Analyzing the *Application area of SW technologies*, we concluded that most of the applications solve data integration problems i.e. either the in-house integration, the **Business-to-business (B2B)** integration with suppliers and customers or business organization. Also, lots of SW applications improve search and content retrieval.

Table 1 – Relating *Benefits of SW* to *SW technologies used*

	23 - DSR	21 - IS	10 - ECR	6 - INR	4 - P	4 - RRC	2 - RTM
34-RDF(S)	18	20	10	6	4	2	1
25- in-house voc.	13	13	8	3	2	2	
18- public voc.	11	11	4	3	3	2	1
19- OWL		11	5	2	1	2	
13- SPARQL	11	7	4	4	2	2	1
6- Rules	3	2	2		1	1	
4- SKOS	2	2	1		1	1	1
3- RDFa	3		1		1	1	1
2- GRRDL	1	1			1		
1- WSMO	1						1

Legend: DSR – Data share and re-use data; IS - Improved search; ECR - Explicit content relation; INR - Ident. new relation; P – Personalization; RRC - Rapid response to change; RTM - Reduced time to market.

Our analysis has also indicated some of the *Benefits* that end-user organizations gain by utilizing the SW technologies, including data share and re-use, improved search, explicit content relation, identifying new relationships, personalization, rapid response to change, and reduced time to market. From the results presented in Table 1, it is obvious that SW technologies are very suitable for data sharing and reusing, as well as knowledge search. Using the faceted navigation technique, knowledge bases could be full-text searched, as well as filtered and sorted using semantic relations. Analyzing the *SW technologies* that have been applied, this analysis has shown that in comparison with RDF(S), that is used in almost all data integration applications, the OWL is used in less than half. It is interesting to notice that SPARQL Protocol and RDF Query Language (SPARQL), which is a standard query language for RDF, is more exploited for data integration i.e. syntactic matching of different knowledge schemas, than for querying and retrieval. The search and content discovery function rely both on public and in-house vocabularies. It is encouraging that, besides the mature SW technologies (RDF and OWL), technologies such as OWL-S and Web Service Modeling Ontology (WSMO) that are still in the process of standardization are considered to be used for service integration.

One of the benefits reported is that “semantic technologies make the content relationships explicit and hence machine processable”. Semantic Web is an extension of the conventional Web, and therefore existing contents should be available on Semantic Web as well. For this purpose, W3C recommended several technologies including Gleaning Resource Descriptions from Dialects of Languages (GRRDL) mechanism, RDFa, and microformats. In addition, both the research community and the commercial sector offer various semantic annotation and ontology learning tools for online conversion of the existing unstructured contents on the web into a format understandable by computers. However, this process is not trivial and generally not an easy solvable task.

4. Deploying Semantic Web technologies: a Case Study of the Mihailo Pupin Institute

The business process of a modern organization (such as the Mihailo Pupin Institute - MPI) in the information and communication technologies – ICT sector, is a very complex one and is driven, on one hand, by market “pool” factors and relations with the industry (public and private sectors) and, on the other hand, by science “push” factors, societal needs and expectations (public sector). Since MPI performs applied research in the ICT sector, with outcomes directly applicable in the industry, it takes advantage of it and successfully performs technology transfer from academia to industry. As the most precious asset, apart from knowledge artifacts and standardized business processes, the MPI knowledge resources include the creative human resources and their explicit and tacit knowledge and experience. Since R&D organizations’ innovation charter demands a focus different from that of other types of organizations, specifically, to nurture open access to human resources’ extensive knowledge and experience, explicit and tacit, significant adjustment of standard information management solutions and practices are necessary to suit their needs.

In this Section, we shall discuss to what extent the semantic technologies can address these specific needs.

4.1. Knowledge Management in HR Sector

Knowledge management systems (KMS) support all aspects of knowledge processing and sharing, including knowledge extraction, representation and retrieval. KMS in HR domain should respond to challenges such as management of entities in the HR domain (organizational units, people, jobs, competences) by continually recording the experts’ knowledge, expertise profiling and by building community oriented competency repositories, expertise gap analysis, expertise planning and development, etc. They should answer questions such as those presented in Figure 2.

In 2008, MPI has introduced the *SAP® Enterprise Resource Planning* (ERP) system and thus has integrated in-house processes related to material management, sales and distribution, financial and management accounting, human management, project management, etc. The *SAP® Human Capital Management* (SAP HCM; www.sap.com), that is part of SAP ERP, supports core HR processes including employee administration, organizational management, time management, benefits, payroll, and legal reporting. SAP HCM covers the whole life-circle of an employee from her/his recruitment, training, development, deployment to retirement and thus enables tracking of employee movements and adequate tracking of changes in organizational structure. It supports skill management and gives managers and HR professionals reporting and analysis options that provide a real-time insight into employee qualifications.

During its introduction (Janev, Đokić, Minić & Vraneš, 2008), it was concluded that considerable modifications have to be made in the standard SAP HCM solution in order to meet the specific MPI requirements and the adopted ISO 9001 Quality Assurance standards (Mihailo Pupin Institute, 2004). Modifications concern, firstly, the specifics of the MPI organizational structure and, secondly, the specifics of human resources data in the research sector. Taking into consideration the recommendations of the Serbian Ministry of Science for compilation of the Researchers files (Serbian National Scientific Council, 2008), the SAP employee master data was supplemented by data specific for scientific research environments including: scientific and professional skills and expertise, information about engagements in projects with details about roles and competences, scientific achievements (patents, technical solutions, scientific articles / books), other achievements / awards, etc. Presently, this system stores the information for about

450 current MPI employees and the complete employment history of 900 past MPI employees from 1960 until now. The established knowledge pool of employees' professional and scientific results and achievements is used by HR department staff on everyday basis for different reporting purposes.

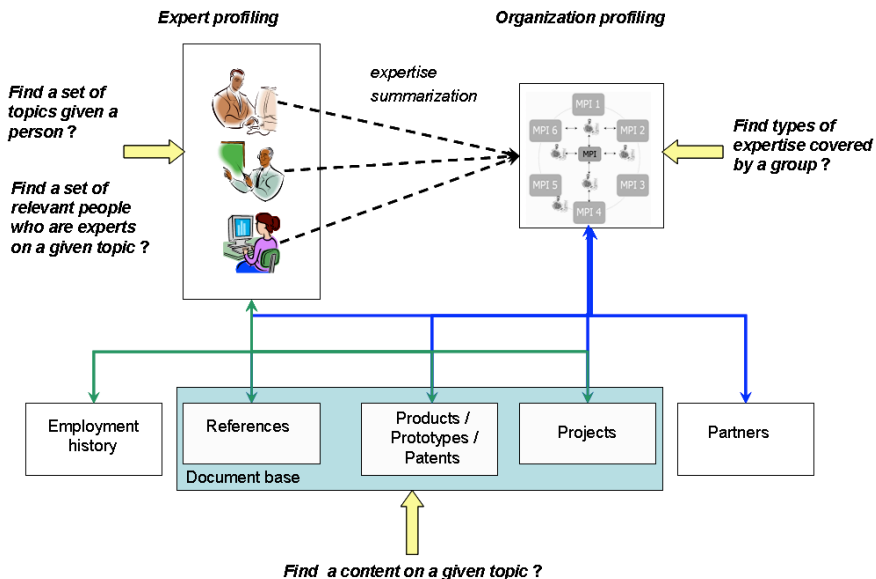


Figure 2 – Expert profiling vs. Organization profiling

With regards to expertise management, the disadvantage of this approach is that the resulted personal profiles rely on the self declared expertise. This approach is error-prone since the experts are typically subjective/biased and reluctant to update their files regularly. Also, manually created key qualification lists cannot be an exhaustive description of the person's expertise areas. Further on, the data centric approach in SAP HCM does not offer integration of whole documents, e.g. scientific papers or other publications that document the employee's expertise. Finally, the exported personal profiles documents are in a form of PDF document without possibilities for assigning explicit meaning to the document contents.

4.2. Semantic Web Based Approach to Expertise Profiling and Retrieval

Semantic Web technologies (i.e. ontologies and semantic web services) offer new possibilities for employees' expertise data integration. Roughly, ontologies correspond to generalized database schemes made up of concepts, and the relations between them, that are relevant for a specific domain of knowledge. However, an ontology not only provides a database scheme for storing metadata but also facilitates semantic content annotation, i.e. assigning semantics to a set of knowledge sources (documents), and definition of rules that are both tractable by machines and understandable for humans. Therefore ontologies, as was shown in the above analysis, are nowadays very often used for building integrated inter- and intra-organization business services, and to make the search and retrieval both efficient and meaningful.

Figure 3 depicts the components (building blocks) of the proposed holistic MPI knowledge infrastructure for the HR domain. Instead of proposing a data warehouse for data/knowledge integration (as it was practice 10-15 years ago), we are suggesting ontologies because they are explicit knowledge representation forms and made the instance data locked in legacy systems interoperable with similar applications at other sites. Using inference services, the explicit data could be checked for consistency and new knowledge could also be generated.

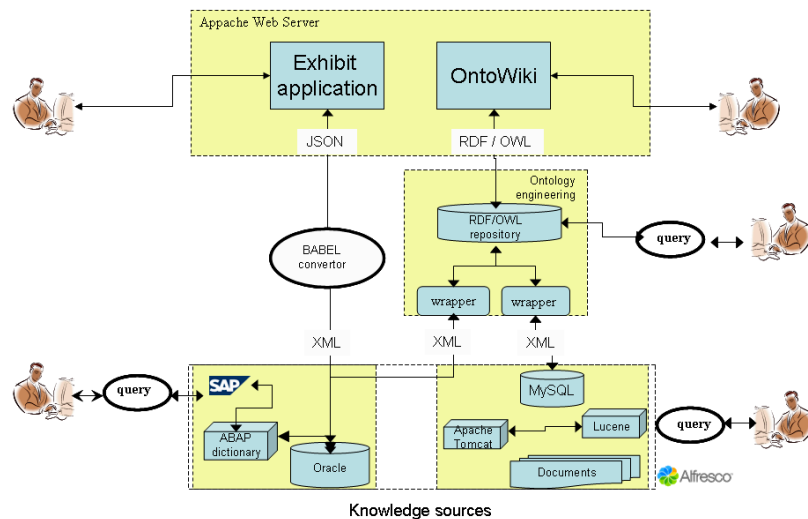
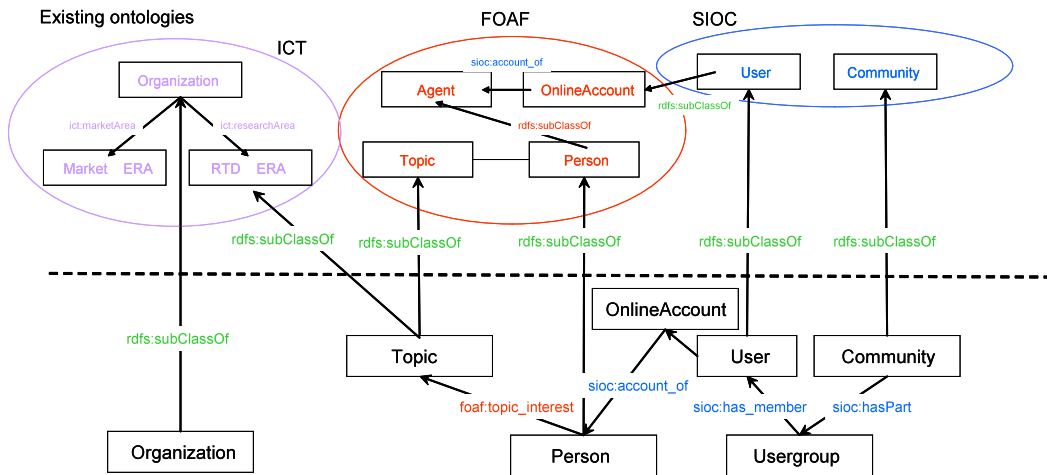


Figure 3 – The MPI human capital management solution

The holistic MPI knowledge infrastructure is based on two disparate knowledge sources: the SAP® HCM and Alfresco open-source Enterprise Content Management (ECM) software (www.alfresco.com). The Alfresco document base serves to integrate knowledge items such as published research papers, products' documentation, marketing materials, etc. Alfresco ECM is based on a set of document management (to import, classify, store, search, access and control content) and collaboration services. The Alfresco workflow engine enables organization and automation of the process activities. In addition, Alfresco integrates WebDAV server and Apache Lucene full text indexing and searching service. Using Lucene one can explore the document contents as well as the automatically extracted and user defined metadata. The new social software functionalities (e-mail, forum and blog support) enable capturing the additional valuable information about the users' expertise. On top of SAP® HCM and Alfresco ECM we can use an engineering tool for establishing and managing an ontological knowledge base. Tools such as the *TopBraid Composer™* (www.topquadrant.com), that is one of the most comprehensive commercially available semantic modeling and development environments, or the open source *Protégé Ontology Editor and Knowledge Acquisition System* (protege.stanford.edu) can integrate and further process the personal profile documents exported from SAP® HCM knowledge pool and metadata extracted from documents stored in the Alfresco document base. This approach allows enhancing the personal profiles with information automatically extracted from the user business activities.

The MPI ontological knowledge base was established using common ontologies such as FOAF, SIOC, DOAC, Dublin Core, and others. On the top of this knowledge base, the OntoWiki Portal was mounted that allows searching the ontological base and exporting the data in format recognizable for the broader Semantic Web community.

4.3. Building the MPI Ontological Knowledge Base



MPI ontology

Figure 4 – Reusing existing ontologies

Prior to importing source data/documents into an ontological knowledge base, we have to model the ontological knowledge base in a way that it is optimized for semantic expertise search and retrieval. Common public ontologies relevant for building an expertise finding system in ICT domain are the following:

- * FOAF (xmlns.com/foaf/0.1/), a vocabulary for expressing personal profile and social networking information. It defines machine readable information/metadata for people, groups, organizations and other related concepts.
- * DOAC (ramonantonio.net/doac/0.1/), a vocabulary for describing professional capabilities of workers gleaned, for example, from CVs or resumes. DOAC has been designed to be compatible with the European CV.
- * SIOC (rdfs.org/sioc/) ontology for expressing information contained within online community sites (weblogs, message boards, wikis, etc.).
- * bibTeX (zeitkunst.org/bibtex/0.1/) vocabulary for describing bibliographic data.
- * ICT taxonomy for describing the ICT research areas.

Figure 4 illustrates the interoperability between the MPI ontology and the public vocabularies/ontologies. The main “components” of the MPI ontology are defined as subclasses of the public concepts (*foaf:Person*, *foaf:Organisation*, *foaf:Document*, *foaf:PersonalProfileDocument*, *doac:Education*, *doac:Skill*, *doac:Experience*), while links/relations between the components are defined as sub-properties of *foaf:interest*, *foaf:made/maker*, *foaf:topic*, *foaf:primaryTopic*, *foaf:homepage*, etc. Additional classes and properties specific to the MPI are defined manually with elements from the RDF Schema (www.w3.org/TR/rdf-schema/) or defined automatically via the mapping facilities of the engineering environment during the data import from the relational database. As a result, the ontological database is a set of interlinking public ontologies and in-house ontologies in RDF/OWL format as is shown with the following code:

```
<owl:Ontology rdf:about="">
<owl:imports rdf:resource="http://www.imp.com/publications.owl"/>
```

```

<owl:imports rdf:resource="http://www.institutepupin.com/projects.owl"/>
<owl:imports rdf:resource="http://www.imp.com/ict.owl"/>
<owl:imports rdf:resource="http://www.wiwiss.fu-berlin.de/suhl/bizer/D2RQ/0.1"/>
<owl:imports rdf:resource="http://purl.org/dc/elements/1.1"/>
<owl:imports rdf:resource="http://purl.org/dc/terms"/>
<owl:imports rdf:resource="file:/C:/TopBraidComposer/WorkSpace/DOAC/doac01.rdf"/>
<owl:imports rdf:resource="http://www.w3.org/2004/02/skos/core"/>
<owl:imports rdf:resource="http://xmlns.com/foaf/0.1"/>
<owl:imports rdf:resource="http://www.institutepupin.com/Researchers.owl"/>
<owl:versionInfo rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
>Created with TopBraid Composer</owl:versionInfo>
</owl:Ontology>

```

In order to profile the MPI activities with the topics relevant for MPI ICT fields we have initiated the MPI Business Topic Hierarchy with the following topics: Information and Computer Science, Automation and Control, Sensors and Measurements, Telecommunications, Traffic Management, and Robotics. The subtopics of the Information and Computer Science topic are: Business Information Systems, Communications, Databases, Document Management, DSS and Artificial Intelligence, Groupware and Collaboration, Semantic Web, System Architectures, etc.

4.4. Searching the MPI Ontological Knowledge Base

The screenshot shows the SPARQL query editor in TopBraid Composer. The query is as follows:

```

SELECT ?Person ?Job ?Skill ?Level ?Topic
WHERE {
  ?Person :jobTitle ?Job.
  ?Job :requiredEngineeringSkill ?Skill.
  ?Skill :skillLevel ?Level.
  ?Person foaf:topic_interest ?Topic.
  FILTER (regex(str(?Skill), 'SystemAnalysis'))
  FILTER (regex(str(?Topic), 'Semantic'))
}

```

The results table displays the following data:

[Person]	Job	Skill	Level	Topic
Jovan_Dudukovic	ResearchAssis...	BasicSystemAnalysis	1	ict:Semantic_Technologies
Mladen_Stanoje...	SeniorResearc...	ProfessionalSystemAnalysis	5	ict:Semantic_Technologies
Sanja_Vranes	ScientificCoun...	ProfessionalSystemAnalysis	5	ict:Semantic_Technologies
Valentina_Janev	ITConsultant	ProfessionalSystemAnalysis	5	ict:Semantic_Technologies

Figure 5 – SPARQL sample query against the ontological knowledge base

Expertise profiling is a technique for identifying and classifying knowledge and expertise of individuals. Assuming that both information sources described previously could provide plenty of data about an employee’s expertise, we have introduced

- * *imp:PersonalProfileDocument*, based on *foaf:PersonalProfileDocument* class that aims to integrate all expertise data for an employee, and
- * *imp:RnDProfile* that serves to infer the R&D profile of an organization.

Using semantic relations such as *foaf:topic_interest*, *foaf:primaryTopic*, *doac:organization* links can be established between the classes *imp:Person*, *imp:Organization*, *imp:PersonalProfileDocument*, *ict:RTD_ERA* and questions can be answered such as the ones presented in Figure 2 using the SPARQL Query Language for RDF.

Figure 5 gives an example of a search for experts with “System Analysis” qualifications in “Semantic Technologies” area when SPARQL query is run interactively via the SPARQL query editor in TopBraid Composer.

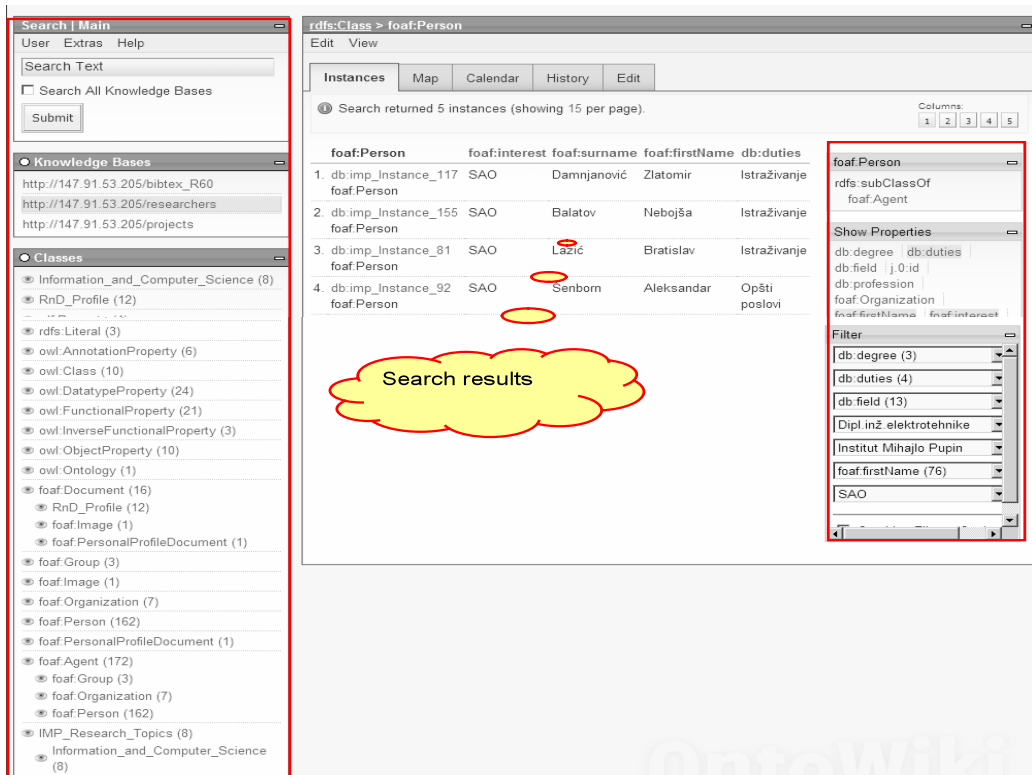


Figure 6 – Expertise search with OntoWiki

A far more comfortable way for querying the ontological base is, however, to use free of charge open-source tools, such as the OntoWiki (ontowiki.net), in order to improve the expertise search, analysis and retrieval. OntoWiki uses SPARQL to access the underlying databases. Using the OntoWiki tool (see Figure 6), the RDF/OWL expertise data can be full-text searched (see the “Search” panel in the upper left corner), browsed using semantic relations (see the “Classes” panel in the lower left corner) and searched using faceted navigation method (see the “Filter” panel in the right most side).

5. Conclusions

The study presented in this article analyses the current status and trends in the Semantic Web and discusses the adoption the Semantic Web technologies in practice. The results of the analysis have shown that semantic-based technologies have been increasing their relevance in both the research and business worlds in recent years. W3C, together with universities and IT research organizations, and in cooperation with the major software companies and government agencies, has already accepted many specifications, guidelines, protocols, software, and tools that are the basis for realization of the Semantic Web vision. Innovative enterprises (the Mihailo Pupin Institute, for instance) interested in catching new opportunities from the Semantic Web and also developing new business models are already introducing semantic technologies that facilitate data integration and interoperability, as well as improve search and content discovery. Considering the

benefits from introducing SW applications, the analyzed early adopters from the W3C collection of Case Studies and Use Cases report that SW technologies are useful for sharing and reuse of data, to improve search and to establish explicit content relations.

From the presented Mihailo Pupin Institute case study and the overall analysis, we may conclude that the Semantic Web technologies are finding their ways to applications, and that rather than being another research issue, the Semantic Web technologies have emerged as solutions for the new requirements and challenges of future enterprise information systems.

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BI-FIT: The fit between Business Intelligence end-users, tasks and technologies

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Abstract: This paper aims at investigating the factors that influence the “fit” between Business Intelligence (BI) end-users, tasks and technologies (BI-FIT). Based on an extensive literature study on the elements of BI-FIT, in this research a BI end-user segmentation model is developed that shows the most relevant factors and the interrelationships between BI end-users, tasks and technologies. This model can be used to help organizations to identify and fulfill the needs of BI end-users, thereby improving adoption and increasing satisfaction of the BI end-user base. The BI-FIT model is evaluated empirically through a multiple case study to enrich and validate the theory.

Keywords: Business Intelligence; End-user segmentation; Adoption; Task-Technology FIT.

1. Introduction: the information gap

In today's globalized economy —especially during times of recession— the uncertainty that organizations are facing when taking decisions has become bigger. In order to deal with this uncertainty, organizations process information (Daft & Lengel, 1986). According to Galbraith (1974, p. 28) “the principle of a managerial task is to reduce uncertainty by processing information.” The demand for profits, increasing (global) competition, and demanding customers all require organizations to take the best decisions as fast as possible (Vitt, Luckevich, & Misner, 2002). Therefore, the ability to quickly take advantage of the exponential growing amount of information has become an extremely critical component for the success of the modern organization (Barlow & Burke, 1999; Huber, 2003). The need for fast decision making on the one hand, and the longer time needed to acquire the right information on the other hand causes a so-called “information gap” (den Hamer, 2005; van Beek, 2006). Business Intelligence (BI) is implemented in order to narrow down this information gap.

1.1. Problem definition

Over the years BI has increasingly been moving into the mainstream of knowledge worker computing (Negash & Gray, 2003). No longer are BI solutions solely being used by information

specialists or analysts. This is reflected in the population of BI-end users, which is becoming increasingly more heterogeneous in both the skills that end-users bring to BI-systems as well as in the demands they place on them (Gile, 2003). Unfortunately, according to several authors many BI projects fall short of their promise to deliver value. According to Raden (2004, p. 10), “business intelligence applications have low adoption rates within organizations”. Furthermore, Biere (2003, p. 8) states that “too many organizations take the easy technology-driven route by selecting some tools, hoping the end users will “magically” emerge with what they want.” Finally, Ferguson (1996, p. 13) states that “less attention is devoted to actual BI usage on the problem of getting data out of the system. This approach has diminished the potential benefit of BI systems since it assumes that all users are capable of finding their way around in this ‘ocean’ of information.” In other words, an implementation from a technology-driven perspective does not ensure the adoption and usage of end-users, which constrains organizations to benefit from the potential of their BI investments.

Looking from an end-users perspective, end-users simply want a better way to solve data-related business problems. The end-user’s perception of the benefits received from a BI solution is dependent on the degree of productivity increase or the amount of positive results that they receive. If a BI solution helps them look better, and lets them do their job better, they will be more likely to use it (Turban et al., 2007). While BI-software enables organization-wide decision support, problems are encountered in the fit between systems’ provision and changing requirements of a growing amount of (end-) users (Dekkers, Versendaal & Batenburg, 2007). The main reason why this “fit” (hereafter referred to as BI-FIT) is missing is that when BI-solutions are implemented in practice, end-users are usually considered (if considered at all) to be equal in their adoption and usage of the system (Biere, 2003), which is not always the case (Borgman, 1989). If end-users get provided with a BI-solution that does not fit their capabilities or tasks, they will most likely not use it, or use it in the wrong manner, or even become negative about the BI-solution, which obviously does not contribute to a positive result. However, if end-users are equipped with a BI-system that fits their needs, they will produce better intelligence to support their decisions, and in the end reduce uncertainty. In order to establish this fit, this paper develops a model which provides an answer to the following research question:

“What are the major factors influencing the fit between Business Intelligence end-users and Business Intelligence solutions?”

1.2. Research motivation and methodology

Although BI is widely applied in practice, scientific research in the field is limited. Several authors state that BI research “seems to have flown under the radar of academics” (Negash & Gray, 2003; Pirttimäki, Lönnqvist, & Karjaluo, 2006). Most available literature focuses on BI technology such as data-warehousing (Barbara, Wixom, & Watson, 2001; Kimball, 2008), OLAP (online analytical processing) (Chaudhuri & Dayal, 1997; Tremblay et al., 2007) and data-mining (Fayyad & Uthurusamy, 1996; Han & Kamber, 2006). Unfortunately, considerably less attention is given to the organizational side of BI, investigating BI processes and BI organization (Philips & Vriens, 1999; Pirttimäki & Hannula, 2003; Zeng, Xu, Shi, Wang, & Wu, 2006a). By investigating BI-FIT, this paper provides new insights into research on the organizational aspects of BI as well as a better understanding of BI end-user adoption.

In general, the goal of Information Systems (IS) research is to produce knowledge that enables the application of information technology for managerial and organizational purposes (Hevner, et al., 2004). The main goal of this research is to develop a model that depicts the major factors influencing BI-FIT, which can be used to assist organizations in identifying and defining

differing BI end-user groups and their needs, in order to provide end-users with a BI solution that fits. For this purpose, a design research approach is used. By means of constructing an artifact, new scientific knowledge can be generated (Hevner et al., 2004; Vaishnavi & Kuechler, 2007). In this research the artifact is the BI-FIT model, which is developed according to the steps (problem awareness, suggestion and development, evaluation & conclusion) in developing design research artifacts as described by Vaishnavi et. al. (2007). Awareness of the problem area was raised in discussions with BI practitioners from the field, BI literature reporting BI success and failure, and in articles in BI professional magazines and blogs. A detailed problem description was provided in section 1.

Based on the problems as described in section 1 it has become clear that when implementing BI, more time and attention need to be devoted to the actual end-users of the BI solution, instead of purely focusing on technology. However, because limited knowledge on BI end-user adoption is available, it was decided to investigate the main factors influencing BI usage from an end-users perspective as described in section 3. Furthermore, the factors identified are used to develop a BI end-user segmentation model which can be used to assist organizations in providing their end-users with a BI-solution that fits their needs, as described in section 4. The segmentation model has been evaluated by carrying out a multiple case study within six organizations, following Yin (2008; 2003). Hevner et al. (2004) also suggest case studies as an appropriate evaluation method in design research. Results of the case studies are discussed in section 5. Finally, section 6 discusses the conclusions.

2. End-User FIT

The relationship between investment in information technology (IT) and its effect (IT-impact) on organizational performance is a major area of interest for (IS) researchers and practitioners. It must be clear that it is not the investment in technology that is the driver for IT impact, but the actual usage of the technology (Devaraj & Kohli, 2003). Persuading end-users to adopt information technologies persists as a major challenge confronting those responsible for implementation. An important question in this context is: What causes individual end-users to adopt new information technologies, and in particular BI-systems? The term "individual" is used explicitly because this research starts from the observation that the growing amount of BI end-users are heterogeneous, both in the skills they bring to BI-systems and the demands they place on them (Gile, 2003). The same IT-system can be seen as successful by one individual end-user or group but as a failure or at least problematic by another end-user or group (Agarwal & Prasad, 1999). Several interconnected factors seem to influence this.

2.1. Factors influencing Adoption / Utilization

In literature several models have been proposed that intend to explain the factors that influence end-users IT adoption and utilization and therefore explain IT success or failure. The Information Success Model (ISM) developed by Delone and Mclean (1992) was a breakthrough because they proposed a model to assess IS from the end-users' perspective. Basically, the ISM suggests that system quality and information quality determine IT success. However, among others Davis (1993) criticizes the ISM model by stating that quality is not the only factor determining success, and has developed the Technology Acceptance Model (TAM). The TAM has been proposed to explain the factors that influence an end-users decision to utilize a system or not, and is a widely cited model in IS research. Basically, the TAM defines the constructs "perceived ease of use" and

"perceived usefulness" to predict an end-user's attitude towards using and actual system use (Davis, 1993). Both factors themselves are influenced by so-called "external factors" like for example individual characteristics of end-users or IT-system characteristics. Although the TAM is a widely cited model, it is criticized concerning its "lack of task focus", because it does not take into account that end-users use IT even if they do not like it, simply because it improves their job performance (Goodhue & Thompson, 1995). Furthermore, one of the main properties of the TAM, is that it is designed for voluntary use of IS systems (Davis, 1993), which is not always applicable.

In response to the critique on existing IT acceptance models, Goodhue & Thompson (1995) developed the Task-Technology-Fit model (TTF). The 'fit' is explained as "the extent to which technology functionality matches task requirements and individual abilities" (Goodhue & Thompson, 1995, p. 216). In other words, "the TTF posits that IT systems will be used if, and only if, the functions available to the user support (fit) the activities and individual capabilities of the user" (Dishaw & Strong, 1999, p. 11). Furthermore, the TTF model has proven that not only the individual factors (individual characteristics, task characteristics, technology characteristics) are important, but also the quality of the "fit" between them. To conclude, the discussion of IS acceptance models has learned us that several interrelated factors influence BI adoption and usage. An overview is depicted in table 1.

Table 1: Overview of IS acceptance models

Authors	Model	Factors influencing adoption
<i>Delone & Mclean (1992)</i>	Information Success Model	System and information quality.
<i>Davis (1993)</i>	Technology Acceptance Model	Individual end-users "perceived usefulness, and perceived ease of use."
<i>Goodhue & Thompson (1995)</i>	Task – Technology– Fit Model	Fit between Individual -, Task- & Technology characteristics.

Based on the TTF model, the BI-FIT model is proposed, which depicts the main factors that influence the fit between BI end-user and solutions. The BI-FIT model is included in figure 1. Adopted from the TTF model, the BI-FIT model assumes that a high degree of "BI-FIT" has a positive effect on adoption, which positively influences performance and a low degree of "BI-FIT" has the opposite effect. Since the BI-FIT is considered to be dynamic, and therefore should be monitored because of changes over time in individual, task or technology characteristics. This research does not employ the TTF model as an instrument to measure constructs, but rather to contribute to a better understanding of the interrelationships between and consequences of BI-specific individual, task and technology characteristics.

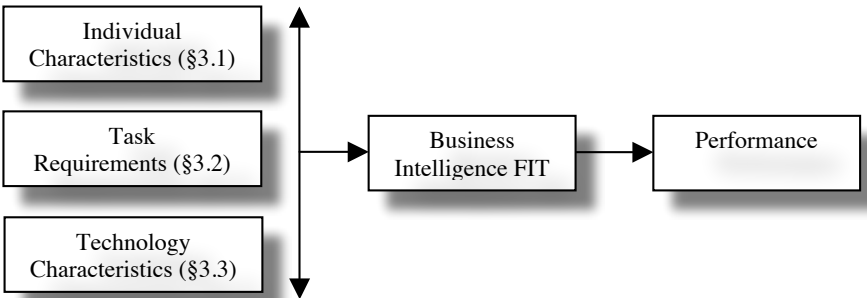


Figure 14: BI-FIT Model, based on the TTF model (Goodhue & Thompson, 1995)

3. BI-FIT Framework

One of the main objectives of any BI-implementation is to meet the diverse needs of a diverse set of end-users. Therefore, the first requirement is to understand “who” the end-users are in order to determine “what” they need (Gile, 2003). As discussed above, end-users are not equal, and therefore have different requirements. Unfortunately, in most cases it is not possible to develop a customized solution for each individual end-user. Therefore, there is a need for segmentation, in order to understand the needs of the different user constituencies within the BI end-user community, since each has a different set of requirements and preferences. Based on the factors that influence the BI-FIT which were discussed above, a BI end-user segmentation model is developed which is described in the remainder of this paper.

3.1. Individual Characteristics

Individuals within an organization need the ability to perform their task efficiently by applying information technologies and systems to their work , also defined as end-user computing competency (Yoon, 2008, p. 415). Several studies have examined acceptance and usage of BI or related systems (DSS, EIS, ESS, MIS etcetera) focusing among others at individual characteristics, and have identified computer proficiency (also named IT know-how, computer experience, IT skills) and analytical capabilities as influencing factors (Agarwal & Prasad, 1999; Dixon, 1999; Hung, 2003; Pijpers et al., 2001; Seeley & Targett, 1999; Taylor & Todd, 1995). A BI end-user with a high computer proficiency is more likely to successfully use advanced BI-tool functionalities and contrariwise. The same applies for analytical capabilities. For example, the degree of computer proficiency and analytical abilities required to understand and draw conclusions based upon a simple report is quite different from the capabilities necessary to create a customized report.

Therefore, computer proficiency and analytical capabilities, are used to classify BI end-users focusing on their individual characteristics, by dividing them into three groups: Novice, Power and Expert end-users, as depicted in Table2. In addition, end-users are divided based upon whether they solely consume or also produce information. The reasoning behind this is that some end-users will take a hands-on approach to tools and data, while others wait for finished analysis and reports. One is oriented to the analytics, while the other just wants the resulting information (Biere, 2003). Therefore, novice users are classified as information consumers, and power and expert users are as information producers.

3.2. Task Requirements

In addition to individual characteristics, as discussed above, an end-user's decision to adopt and use a system also depends on whether it enhances or "fits" the end-user's task. Tasks have been broadly defined as the action(s) carried out by an individual for turning inputs into outputs (Tremblay et al., 2007). End-users use BI-systems to get relevant information which helps them to reduce uncertainty when taking decisions, and enables them to make decisions based on a solid foundation of facts (Nemati et al., 2002). Since the details of business decisions are quite different for each organization, level (i.e. operational, tactical, or strategic), process and user-task context, it is not possible to investigate task requirements for every specific decision task to be supported within an organization.

However, it is possible to examine what BI end-users expect to get out of BI applications, not specifically looking at the content but by examining how and in what way end-users want to interact with information. According to several authors (Haller, Jenichl, & Küng, 1998; Nemati et al., 2002; Wong et al., 2002), the various ways of processing information can be separated into two "modes": Verification mode and Discovery mode. In verification mode the user proposes a hypothesis (e.g. business questions) and uses the information to either confirm or reject it, whereas in the discovery mode the end-user does not use a predefined hypothesis, but desires to discover new information, without preconceived notions of what the results would indicate (Fayyad & Uthurusamy, 1996). According to Azvine et al. (2006), the analytical needs of business end-users all come down to answering the following three questions, sorted by ascending complexity:

- What has happened?
- Why did it happen?
- What will happen?

Simple or routine analysis is conducted to answer the often recurring "what happened" question (verification mode) and if exceptions are found, less frequent occurring ad-hoc analysis is conducted to try to answer the more complex "why" question (verification mode). Future oriented analysis aims to figure out "what will happen" (discovery mode) is considered to be the most advanced type of analysis. In addition, data usage and distribution seem to be influenced by the complexity of the analytical question. For example: Routine analysis is often recurring daily, weekly or monthly, usually presented in standardized preformatted reports which are often "pushed" to end-users by e-mail or other electronic distribution means whereas when carrying out less regular ad-hoc analysis or advanced analysis, end-users actively use the system to fetch or "pull" their required data for analysis, which varies along the nature of the analytical question. As depicted in table 2, analytical tasks are divided into routine, ad-hoc and advanced analysis tasks, based on their analytical complexity, data distribution, and variation in data usage.

3.3. Technology Characteristics

As discussed earlier, organizations have huge amounts of detailed operational data, usually spread across many departments in the organization or locked into a sluggish operational IT environment, which keeps business decision makers from getting the right information in time (Zeng et al., 2006b). This is demonstrated by the following statement: "I know the answer to my problem is hidden in my data... But I cannot dig it up!!" (Michalewicz et al., 2007, p. 1). Therefore, the most important aspect of most BI projects, is "to provide the best possible mechanism for information delivery to business end-users". To make this happen, organizations can choose from a broad spectrum of BI front-end functionality (also referred to as analytics)

ranging from (simple) predefined reporting to (advanced) data-mining tools to fulfill their analytical needs (Breitner, 1997).

According to den Hamer (2005), the selection of the appropriate BI instrument strongly depends on the type of question that needs to be answered varying from simple ‘what’ to complex ‘why’ questions. This is supported by Azvine et al. (2005) who states that data-analysis tools can be categorized looking at their ability to support end-users in fulfilling their analytical needs (as defined in section 4.2). Furthermore, as the analysis becomes more complex, the required BI functionality also places a higher demand on end-users’ abilities. Based on their purpose and complexity, BI tool functionality can be classified into three categories: Basic, Root-cause and Advanced analytics, as depicted in table 2.

3.4. BI end-user segmentation model

Multiple groups of business end-users, within different skills, preferences and tasks throughout the organization spread among various organizational levels use BI tools to facilitate their decision making processes. Unfortunately, business end-users —while being experts in their area— do not necessary possess expert skills in data analysis (Kohavi, Rothleder, & Simoudis, 2002; Nauck, Spott, & Azvine, 2003). Therefore, the BI end-user segmentation model, as depicted in table 2 has been developed in order to assist organizations fulfilling their end-users needs. It is important to note that there may not be a relationship between the end-users’ skills (abilities) and organizational position (i.e. operational, tactical, strategic). Obviously, there is no doubt whether a expert end-user is able to deliver added value, but it is not necessarily the case that an end-user with a better ability to use BI systems will have a bigger impact on business (Biere, 2003).

The BI end-user segmentation model , depicted in table 2, shows a “fit” between end-users’ individual capabilities, tasks and technologies on the horizontal rows of the model. For example, a novice user carries out routine analyses, using basic analytical tool-functionalities. A “fit” can also exist when a power user carries out a routine analysis, using basic tool functionality, but only if the power users is also provided with root-cause analytics to conduct further analysis if exceptions are found. However, this is not possible the other way around. An important question in this context is: What happens if a novice user finds an exception and is required to do further analysis? This is an example of a “misfit” between end-users individual capabilities and task. According to the model the novice user does not possess the required capabilities to do so, therefore no “fit” exists. In this case two options are possible. The first option is that the novice user contacts a power user, and asks the power user to do the extended analysis. The second option is to educate the novice user, in order to become a power user, if the novice user has a regular need for further analysis.

A “misfit” can also exist between task and technology. Consider an expert end-user who needs to conduct an advanced analysis, like e.g. data-mining, but is not provided with the required tools. In this case the user will feel limited in his or her possibilities, and will not adopt the BI-solution, and probably start searching or developing alternative solutions. To conclude, the BI segmentation model is the result of an extensive literature study on the elements of BI-FIT. It shows the most relevant factors and the interrelationships between BI end-users, tasks and technologies. Having discussed the problem awareness and suggestion and development phase of the research approach (see chapter 2), the next step in the research is to evaluate the theory in practice.

4. Evaluation of the BI-FIT model: Multiple case studies

Focusing on the problem area of this research, use cases seem an appropriate choice of research method, because case study research is well suited for organizational issues rather than technical issues (Yin, 2008). This also applies to this research, which investigates problems of organizational nature. The case study research method is applied in this research to capture the knowledge of practitioners and to validate the theories created. In order to enrich and validate the theory created with experiences from practice, it is investigated how organizations deal with differing BI end-users and the factors influencing of BI-FIT, by identifying and comparing the end-users’ constituencies and their BI usage in the case organizations with the BI segmentation model. In addition the elements of the model are validated by discussing the relevant segmentation criteria used to distinguish BI end-users. Despite the fact that all individual cases are interesting, this chapter focuses on the overall results.

Table 2: BI End-user segmentation model

End-user				Task				Technology		
Definition	Computer proficiency	Analytical capabilities	# Users	Definition	Distribution mechanism	Data-demand	Analytical complexity	Definition	Techn. complexity	BI- Tool Functionality
Novice Users (information consumer)	Low	Low	High	Routine Analysis	Push	Static	Simple	Basic Analytics	Simple	Preformatted reporting , Parameter-driven reporting, Scorecards, Dashboards
Power Users (information producer)	↕	↕	↕	Ad-Hoc Analysis	↕	↕	↕	Root-cause Analytics	↕	Ad-Hoc reporting, Online analytical processing (OLAP)
Expert Users (information producer)	High	High	Low	Advanced Analysis	Pull	Dynamic	Complex	Advanced Analytics	Complex	Data-mining, Advanced statistics, (predictive / historical), Simulation.

4.1. Case organizations

The case studies have been conducted at larger organizations of differing sizes, operating in several types of industries, and offering a wide variety of products and services. The main criterion in our search for suitable organizations was that all approached organizations have a professionally implemented BI system in place. Important criteria for selecting respondents per case were that the cooperating respondents had an overall view of BI usage in their organization and that they had been actively involved during the implementation. To increase the validity of the results, triangulation is applied because multiple respondents have been interviewed per case and in addition to interviews also documentation was studied. An overview of the case study organizations and respondents is provided in table 3&4.

Table 3: Case Overview (figures taken from 2008 annual reports)

Organizations	A	B	C	D	E	F
<i>Type / Branch</i>	Electronics	Transport	Food & Beverages	Non - Profit	Telecom-munications	Transport
<i>Market</i>	B2B & B2C	B2B	B2B & B2C	G2C	B2B & B2C	B2B
<i>Revenue € (million)</i>	26.385	3.5	485	112	14.602	1.330
<i># Employees</i>	+/- 120.000	+/- 100	+/- 2.900	+/- 550	+/- 40.000	+/- 2.750
<i>BI front-end tool</i>	SAP BW	Microsoft Reporting	SAP BW	Business Objects	Cognos	Webfocus
<i># BI End-users</i>	+/- 250	+/- 20	+/- 700	+/- 250	+/- 1500	+/- 100

Table 4: Respondent overview

Organizations	A	B	C	D	E	F
<i>Respondent 1 Function</i>	Project manager	BI consultant	BI consultant	BI consultant	BI manager	BI manager
<i>Respondent 1 project –role</i>	BI project manager	Project manager / analyst	Developer / analyst	BI project manager	BI manager	BI manager
<i>Respondent 2 Function</i>	Key-user F&A	BI Consultant	BI manager	BI support	NA	BI support
<i>Respondent 2 project-role</i>	Key-user	BI Developer	BI manager	Functional support	NA	Functional / technical support

4.2. Validation of the segmentation criteria

After introducing the research topic, all interviewees responded to have recognized the problem area, and stressed the importance of end-user adoption. Furthermore, there was consensus about the fact that especially when a high amount of end-users needs to be addressed, end-users cannot be satisfied with a ‘one size fits all solution’. Next, after discussing the main assumptions and elements of the BI-FIT model, respondents were asked to identify the relevant individual characteristics applicable for BI. It appeared that in addition the above discussed computer proficiency and analytical abilities, most respondents consider process knowledge, as an important capability of BI end-users. So basically when conducting analysis using BI tooling, an end-user must know how-to analyze (analytical capabilities), how-to use the tool (computer proficiency), and must also possess knowledge of the business process that is analyzed, in order to interpret the outcome of the analysis, and to be able to understand the impact on the business.

Furthermore, as the complexity of the analysis goes up, a more profound business knowledge is required. Therefore, business knowledge seems like a plausible contribution to the model.

4.3. Findings – BI usage in practice

While investigating the case organizations’ end-user communities it appeared that in some organizations an explicit end-user segmentation model had been developed, while others had not explicitly done so. In the case of organizations A and C, end-users are explicitly divided into groups, and it appears that next to the purpose of segmenting end-users, as discussed in Section 3, such as establishment of the end-user fit, other purposes of end-user segmentation are to ensure a flexible reporting process (because of the responsibility of the “power” user, as discussed below), and to select the appropriate form of training, as e.g. novice users require different training than expert users.

It appears that in each organization explicitly or implicitly —after some time of BI usage— end-user groups are formed, which in general can be compared to the end-user types as defined in the model, although using different terminology. An overview of the used terminology is depicted in table 5. In addition to terminology differences in practice an additional level of BI usage exists, as found in organization A, C and E. These end-users are defined as “receivers” or “consumers”, conducting solely routine analysis, using predefined reports, in most cases send out by e-mail. The main difference between receivers and novice users is that they are not required to have any BI tool/computer proficiency, do not require tool training, and tool license (or a cheaper license, depending on the BI-tooling). In the segmentation model these end-users belong to the group of information consumers, and are placed above the novice user, as entry level BI users.

Table 5: Terminology Overview

User Segments	Terminology
<i>Novice User</i>	Information consumer, Knowledge worker, Manager, Receiver.
<i>Power User</i>	Power user, Analyst, Business user, Tactical user, Builder.
<i>Expert User</i>	Expert user, Data-miner.

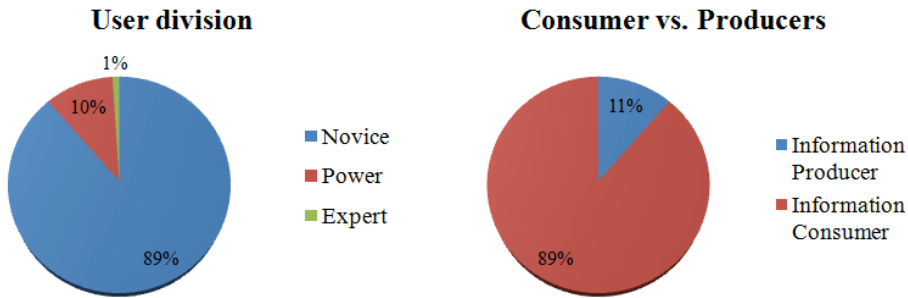
Furthermore, an interesting finding is that the power user has an important role, which is to support the novice user. In most organizations novice users are by far the largest amount of end-users. While conducting their standard analysis, it often happens that the novice user is in need for further analysis or has a request for change. As explained earlier, in this case the novice user can obviously consult an analyst of the BI department or competency centre (BICC) in place. However, as in most cases BI support is integrated into the generic IT departments, usually it takes a long time for change requests to be handled (as IT departments are often optimized for supporting operational systems). If this happens more often, the novice user will lose his or her trust in the system, and stop using it and start developing his or her own solution in e.g. Excel. Or maybe even try to adapt the reports themselves, if they have access to the required tooling. Either way, ad-hoc development is not efficient in general, and abandoning of the BI system does not positively influence organizational results.

However, as one of the respondents stated “a change in today’s business, needs to be reflected in tomorrow’s reports”. This basically means that BI requires a flexible and quick requirements process. Therefore, it is important to have a substantial amount of power users in

each process, that can assist novice users. Especially, because in addition to the required tool and analytical skills, power users also possess the required business knowledge (in contrast to organization wide BI support) in order to support the novice users in their process. Therefore, power users play an important role to ensure the required flexibility of the BI process. In addition to the above findings, it was also investigated how many end-users are present in each segment. Figure 2 shows that the focus is largely on novice usage (i.e. information consumers) with considerably less power users and hardly any expert users. Although it was expected to have less power and expert users, because of the higher demands placed on their individual capabilities, especially the power user group was expected to be bigger. Furthermore, following Negash and Gray (2003) most BI tooling focuses on the power user. Perhaps this is a signal for BI vendors to start developing tooling that aim at bringing more analytical functions to novice users. However, obviously we must be aware that not only the ability to use a tool can help to make an end-user a good analyst, also the analytical abilities and business knowledge are important.

Another interesting finding is that hardly any expert users were around. This could mean that organizations are not making use of the full potential of BI, since advanced analysis often brings valuable results. To conclude, in order to benefit from the potential of the available data in an organization, and to ensure a flexible BI process it is important to be able to include a substantial amount of power users in each process, and a relatively few expert users to fully benefit from the possibilities of BI technology.

Figure 15: Division of end-users



5. Conclusions

This research has identified the main factors influencing a BI end-users choice to adopt and use a BI solution or not. For an end-user to adopt BI, it is important that a “fit” is established between the BI end-user and the BI solution. The end-user fit can be established by making sure that end-users are provided with a solution that matches their individual characteristics, and provides added value in task execution. The BI end-user segmentation model has been developed in this research, to support organizations in establishing this fit. It can be used to help organizations to identify and fulfill the needs of end-users, thereby improving adoption and increasing satisfaction of the BI end-user base.

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Supporting a Telecommunications Decision with OLAP and Data Mining: A case study in Azores

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Abstract: This paper addresses a project for supporting an investment decision on Electricidade dos Açores the electric company in the Azores Islands. The core decision was to ascertain if communications between islands should be moving to VoIP from present telephone lines. The solution approach integrates OLAP cubes in a data mining project, based on CRISP-DM process model. The objective was to get accurate operational data and analyze it in order to inform the proper decision makers. The DSS translates big flat files in a data warehouse, including importing, evaluating data quality and populating relational tables. Multidimensional data cubes with numerous dimensions and measures as call length, number of calls and price, were established. Data mining models for forecasting, clustering, decision trees and association rules identified several inefficient procedures and even fraud situations. Not only was possible to support the investment decision, but several models were also deployed to control and strategic decision levels.

Keywords: Decision Support Systems, Telecommunications, Data Mining; OLAP, operations efficiency.

1. Introduction and Problem Statement

This paper is based on a project which intended to support a decision of investment on telecommunications infrastructure in Electricidade dos Açores (EDA) the local Electric Company in the Azores Islands, Portugal. The main decision was if EDA telecommunications between islands should be moving to Voice over IP (VoIP) from present telephone lines and, if the answer is positive, how to do it. This is not a full structured decision and must be based on technical and non-technical criteria. For the technical criterias a Decision Support System (DSS) was developed based on data from an external telecommunications company and mainly MS SQL technologies. The objective of this DSS is to collect data and generate knowledge which can be used to support the specific decision in consideration but, also, other tactical controls as fraud detection.

The EDA company (www.eda.pt) is responsible for the production, transport and sell of electric energy in all Azores islands. Other companies can also produce electrical energy, but they must sell it to EDA, because it is the only one certified to transport and resell electricity to consumers. Data from the 2007 fiscal year indicates a turnover of 138 million euros, and 113.995

customers spread over the 9 islands of the archipelago of Azores. EDA company has 646 employees, and is the head of EDA group, which include 5 other companies, approaching 870 permanent employees. EDA has a specially complex telecommunication system because of the dispersion of clients spread over a wide discontinuous area of 66 thousand squared kilometers (see Figure 16).

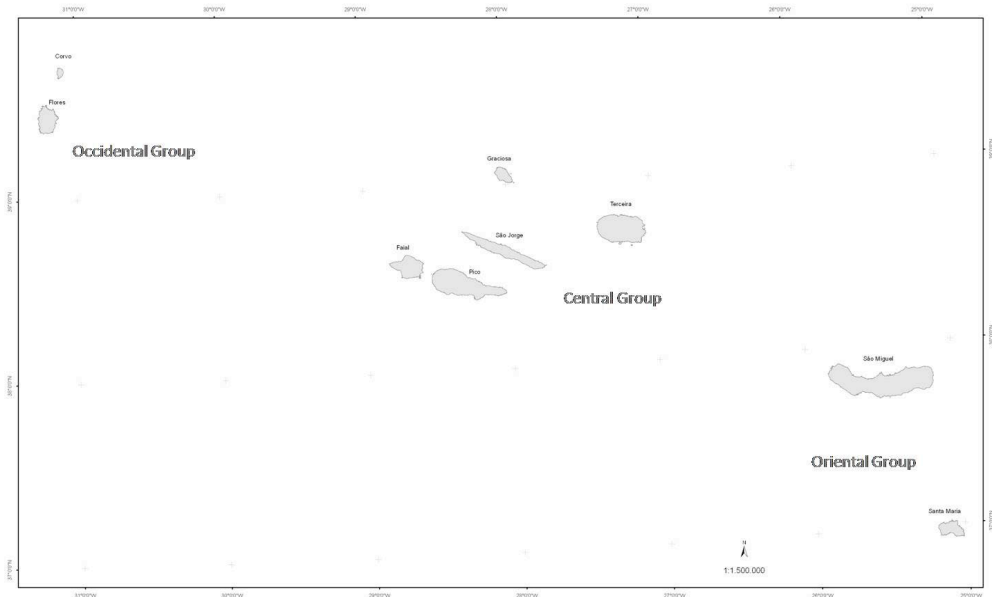


Figure 16 – Azores archipelago showing the nine islands dispersion.

The business objectives defined by the top management are to reduce costs of fixed telephone service on group EDA, moving from external telephone service operators to Voice over IP (VoIP), handled internally. The previous situation was a lack of information about internal calls using external service operators. The needed data includes working patterns, number of calls, duration, frequency and use in peak hours. The company has a LAN and WAN networks, covering all islands with IP Services and 700 numbers of fixed telephones on the group EDA with access to external calls. There are also inside experience on VoIP and IP Telephony.

As was expected, the cost evaluation of the several decision alternatives was a fundamental criterion for decision making. But, this decision is a semi-structured one, as it is necessary to know the evolution of the number of calls and price, if there are seasonality and identify inefficient processes to full implement the new solution. Since Keen and Scott Morton (Keen and Morton, 1978) seminal work, has been known that data analysis systems are very useful to tackle these semi-structured decisions. As the major part of the work would be to analyze telephone calls from the external company, we suggested an approach based on OLAP and data mining. This approach was discussed with EDA specialists and decision makers, and was accepted. In this way, MS SQL Server software was selected as been adequate, and, more decisively, accessible for the EDA specialists to manipulate and improve the system to follow user needs, in an iterative and interactive process initiated by this project.

This paper describes the OLAP and data mining solution implemented to support the telecommunications decision. In fact, the solution was found useful also for operation control and telecommunications efficiency improve. As being an interpretative case study it illustrates a contemporary application and diminishes the gap between theory and practice. This kind of work

was considered one of the major faults in DSS literature by Arnott and Pervan (Arnott and Pervan, 2005).

The DSS survey presented by Eom and Kim (2006) identified a majority of DSS applications in industry and operations management. These applications to industry ranged from product design, production planning, control systems, master scheduling to demand forecast. Eom and Kim found 4 DSS applications on data communication topic. In these articles, as through the work of Cortes and collaborators (Cortes *et al*, 2001), the main objective is to design the network, making them mainly network optimization applications. Other works in telecommunications industry, as the one presented by Tcha and Choi (Tcha and Choi, 1999) are mainly allocation problems.

Neither did the case of the problem in this paper, as we intended to decide about changing the communications technology for a network already existing. In this case study the decision was considered not dependent on the network design. Even Kobbacy and collaborators (Kobbacy *et al*, 2007) in their recent review of Artificial Intelligence (AI) and Operational Research (OR) applications didn't find any application similar to the one presented here. This paper describes the development process of the DSS components. Next section presents the methodology employed to develop the system and the following sections will illustrate the application of the methodology. Finally the results and conclusions are presented.

2. Solution Approach

The defined goals for this project included the need to understand telephone communication costs and durations at several aggregation levels and support decisions about voice over IP adoption. This process needs learning from data as is defined in knowledge management literature (Wijnhoven, 2003). For learning we employed two main approaches: a business Intelligence approach based on OLAP technologies (MS SQL server) and a data mining one which statistics and machine learning models. Our primary research hypothesis is that a DSS based in OLAP and data mining algorithms, developed using a process model, can be a fast way to support the telecommunications decision EDA executives face.

The Cross Industry Standard Process for Data Mining (CRISP-DM) process model (www.crisp-dm.org) was applied as a way to define methodological phases and to integrate both parts of the project. Several authors have been suggesting process models for knowledge extraction from data bases (*e.g.* Fayyad *et al*, 1996; Berry and Linoff, 1997; Hand *et al*, 2001; Klösgen and Żytkow, 2002; Gachet and Haettenschwiler, 2006). In spite of that, the CRISP-DM has been progressively becoming more visible, as the users recognize it as been well structured and practical. The initiative that lead to CRISP-DM was conducted by companies in software development, consulting firms and also clients of data mining results with the objective of been business sector and software application independent (Clifton and Thuraingham, 2001; Lavrač *et al*, 2004). The CRISP-DM project developed a very well specified process model where even the user intervention or domain knowledge was not forgotten. Figure 17 illustrates the six phases of the process model version 1 used in this project (Chapman *et al*, 2000).

1. Business understanding. Understand the business objectives, define and evaluate the problem and establish objectives for the data mining project. The main output is a project plan.
2. Data understanding. Includes activities as data collection, exploration and data quality verification. The main objectives are to get familiar with data, to detect specially interesting subsets, and to discover first insights.

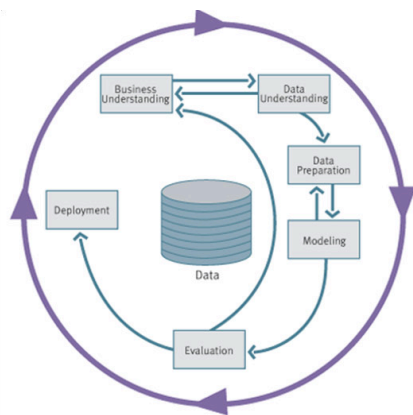


Figure 17 – CRISP-DM v. 1.0 process model (reproduced with authorization from www.crisp-dm.org).

3. Data preparation. Includes ETL (Extract, Transformation and Loading) and pre-processing activities, as select data, data cleansing, data fusion and integration, and all other activities needed to prepare data for modelling.
4. Modelling. Several modelling techniques are applied to the data set and modelling parameters are optimized. Compare model quality by applying the model to new data or data set apart from the modelling data.
5. Evaluation. Before accepting the model or models resulting from the last phase, a through evaluation is imperative. This evaluation uses mainly domain knowledge and knowledge generated by the process, especially in business and data understanding. A key task is to verify if the solution solves the initial problem in a suitable way.

6. Deployment. The deployment are ways to spread the models and/or the knowledge generated by the project, and make sure that the appropriate decision maker or user understands and uses it. This phase can be as simple as writing a report or as complex as implementing an application for model renew whenever needed.

This process model can be compared with the OR decision methodology (White, 1975) or general problem solving methodologies as is easy to show the high similitude between them. Comparing with the Hillier and Lieberman OR modeling approach (Hillier and Lieberman, 2006) the phase 1 and 2 corresponds roughly to the problem formulation phase. The phase 3 are specific for data oriented approaches and have no corresponding phase in OR methodology. Phase 4 corresponds to the construction of a mathematical model and driving a solution phase in OR methodology, making clear the OR emphasis in mathematical modeling and exploring search procedures. Phase 5 is clearly testing the model and solution and phase 6 the implementation phase.

In this process model, like in the OR methodology, there are numerous feedback loops connecting the phases. This adaptive development process is not new to DSS literature. In 1980, Keen describes continuous actions cycles that involved significant user participation (Keen, 1980). As each evolutive cycle is completed the system gets closer to its established state like an evolutive spiral. In fact, as Arnott and Pervan (Arnott and Pervan, 2005) noted, data warehouse and data mining development are dominated by IT departments. As IT professionals have little experience with decision support, some basic concepts of DSS have recently been rediscovered like evolutionary development.

Several authors, like Poon and Wagner (Poon and Wagner, 2001), recognize as a major critical factor in DSS adoption the executive and operational sponsorship. In this project, top EDA management was the client, beeing the users the IT specialists that design and developed the system with the authors. The latter was profoundly involved in the system development and were also responsible with all the communication with the project client.

Following CRISP-DM process model we first collect data over the company and main business. This was a easy phase, as the EDA collaborators collected all the data and answered all the questions. The following phases were more tricky and so interesting for case study proposes.

3. Data Understanding and Exploration

The main data is received from the external phone company, every month, in text format with around 60 thousand lines corresponding to individual calls. Table 6 describes the several attributes included in such data table. This data was incorporated in pre-existing data as the locations, phone numbers, and the identification of the user accountable for the phone terminal. The data understanding was made by using tools like statistical packages and R-software for table and graphic data exploration. The relations between variables found were discussed with EDA systems professionals. In this phase, the initial idea of the project was extended and the objective was clarified, from the debate knowledge was shared.

Table 6 – Information about data in CSV (comma separated values) text format.

Date (MMDDYYYY): month, day, year of the call
Hour (HHMMSS): hour, minute and second
Origin (number): identification of the source equipment
Destination (number): dial number (external)
Service type (nominal): Direct call, Call by human operator, 808 shared costs prefix
Island (nominal): region of call destination
Call type (nominal): call for a mobile network, local call, other call types
CostPeriod (nominal): Economic (less expensive), Mix, Normal (more expensive) in accordance to different day hours.
Duration (number): call duration in seconds
Cost (number): call cost not including taxes (in Euros)

Facts like the three almost perfect direct linear relationships between cost and call duration, were almost completely explained by the 3 different time cost periods. Obvious seasonality on the number of calls, much higher during weekdays with strong reductions in weekends were also simple to explain, as only maintenance personnel works on holidays and weekends. Similar seasonality was easily identified by day hour. By graphing duration in a histogram, a distribution similar to an exponential distribution was recognized, with almost all calls very short but some can be very long. Some long calls were especially noticed by EDA professionals. By graphing two years of daily costs in telecommunications some other seasonality were identified as lower activity during the summer due to vacations and a period during 2005 due to EDA major building transfer to a new location.

To make data exploration and dicing easy to any user, OLAP cubes were implemented. The Software tools used were based on Microsoft SQL Server technologies, already known and used

by the EDA information systems professionals. The main components included the Data Base Engine, Analysis Services and Integration Services from Business Intelligence (BI) Studio. In spite of all this tools, some actually helpful, the construction and management of data cubes was a long and hard phase, more difficult than expected, as we had to handle a version change from MS SQL server 2000 to 2005. Process flows from Integration Services were identified as one of the most important tools for data preparation, as the generation of new fields, tables' relational integration and for populating fields. One example, for the transformation and preparation of the foreign keys in relational tables for new months, and establishing several relations with existing ones, is shown in the Figure 18. The nodes in the process flow stands for SQL coding and some other parameters.

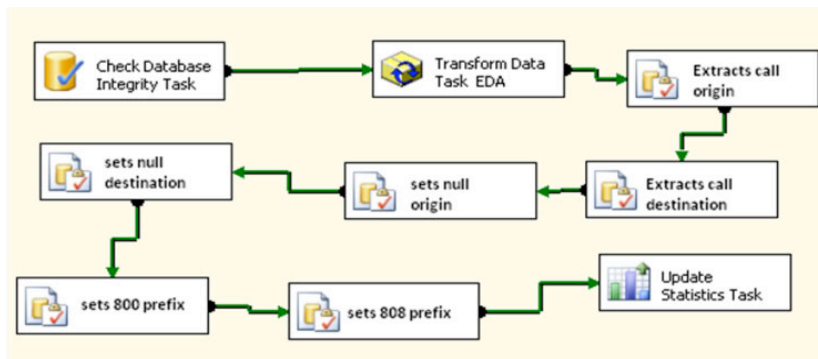


Figure 18 – Process flow example.

In spite of several tests made to the data received from the external communication company, no major data quality problems were identified. Just for the safe side some process flows were coded for simple operations of data cleansing, as removing lines with only zero values or correcting decimal symbols from points to commas.

In 1993, E.F. Codd (sited in Larson, 2006), one of the fathers of relational database and OnLine Transaction Processing (OLTP) theory, proposed a different type of system that would be tuned to the needs of data analysts. He called this an OnLine Analytical Processing System (OLAP). The criteria Codd originally laid out for an OLAP system were not generally accepted, but the acronym and the name are widely used today for systems designed to quickly access, aggregate and explore large data tables.

With SQL Server 2005, Microsoft introduced a new technology called Unified Dimensional Model (UDM). A UDM is a structure that sits over the top of a data mart and looks exactly like an OLAP system to the end user. The claim is that UDM is very flexible as can be built over one or several OLTP systems, data marts, data warehouse, relational data tables or any mix of this (see page 53 in Larson, 2006). This claim was not fully tested in this project, as was decided to use UDM over a data mart which periodically updates itself from an OLTP system and the text data files received from the external telecommunications company. As the major part of data used for constructing the analysis services cube was not in a data base format, the UDM technology could not be used without an in between data mart.

For the data mart design, 3 measures were defined, namely number of calls, simply the row count of the data table, call duration and call cost. Dimensions were discrete fields used to define the aggregation degree of the measures. A very usefull concept of MS SQL 2005 is a hierarchy which is a way to organize dimension in various levels. For instance, in Figure 19 the time period is used this way, as the year (*ano*) dimension is above the quarter (*trimestre*) and, this later one, above the month (*mês*). Many other dimensions are used in the cube shown in this figure, as the

company, telephone equipment, island of origin and destination, type of call, equipment user, period of the day, *etc.*. The majority are fiels in Table 6, but many are extracted from several OLTP data bases already available in the EDA group.

As you can see in Figure 19 the categorical fields were used as aggregation dimensions (as the 3 dimensions of time period in the example above) or as filters as the other dimensions over the table. To interchange the dimensions used to filter and to aggregate data is only necessary click and drag between both areas.

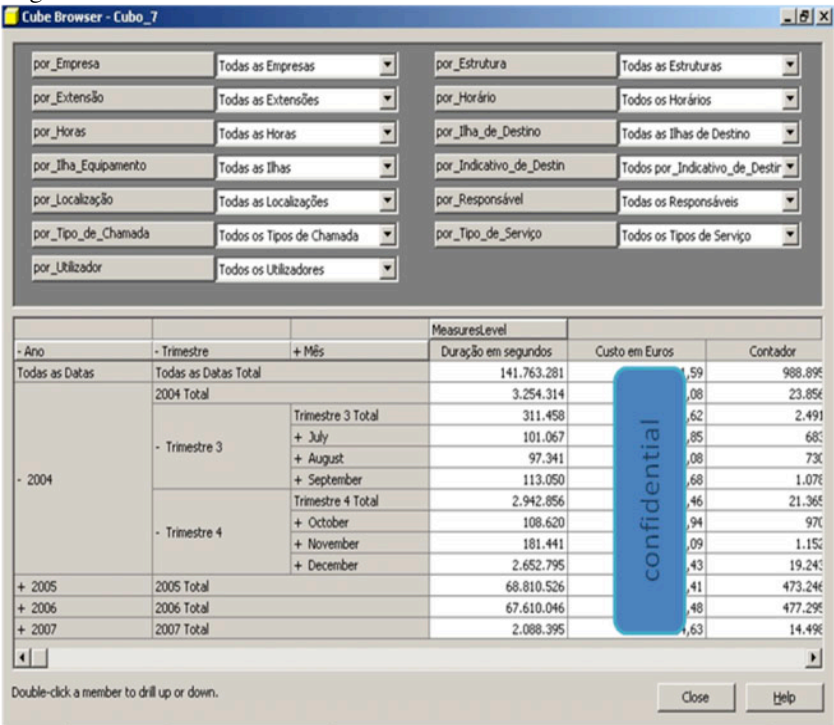


Figure 19 – The final data cube.

Several data cubes were constructed in an evolutionary process, as the discussion about data mart design went on and new data were integrated. The star scheme was selected as it is known to have less performance problems in a ROLAP architecture (see Chen, 2001 and de Ville, 2001).

4. Modelling and Learning with Data Mining

In fact, the OLAP project was much more than the data preparation and exploration phase of CRISP-DM methodology. With the final data cube we answered many of the initial questions and actually generated knowledge and business intelligence.

In spite of this, it is also clear that the main data preparation necessary for an OLAP project is also necessary for estimation of data mining algorithms. Many software houses recognize it by implementing both business intelligence technologies in the same infrastructure. In the Microsoft case the Business Intelligence Development Studio includes several tools for both OLAP analysis services and data mining. Both can use SQL Server Integration Services to extract the data, cleanse it, and put it in an easily accessible form.

For modeling, we employed the same data as the data used for the cube in Figure 19, in order to generate data tables for learning and testing. This data was used in a two fold scheme: 130 thousand lines (years 2005 and 2006) for model estimation (or learning), 25 thousand lines (a few months from year 2007) for validation (or testing). In this project, several algorithms were tried and four were regarded useful considering the results and the project objectives: Microsoft Naïve Bayes, Microsoft Decision Trees, Microsoft Clustering, and Microsoft Association. The others were regarded as not suitable for the defined data mining goals, inappropriate for the available data types, or we just couldn't find any interesting result.

In this latter case, we found the Microsoft Time Series algorithm. As the available data are chronological series this was regarded as one of the major algorithms to use for forecasting the latter defined measures (continuous variables). In spite of this, the unique autoregressive tree model used in this software does not allow the estimation of parameters we needed as seasonal factors (see Meek *et al*, 2002 for a complete description of the algorithm). For this reason we estimated regression models with dummy variables using statistical software for the calculation of the month seasonal factors presented in the Figure 20. The results were validated using 2007 data which resulted in a coefficient of determination of 87%, a root mean square of error of 5.9, a mean absolute deviation of 5.0 and the mean absolute percentage error of 19%. These are fair good results and were corroborate with domain knowledge from EDA professionals.

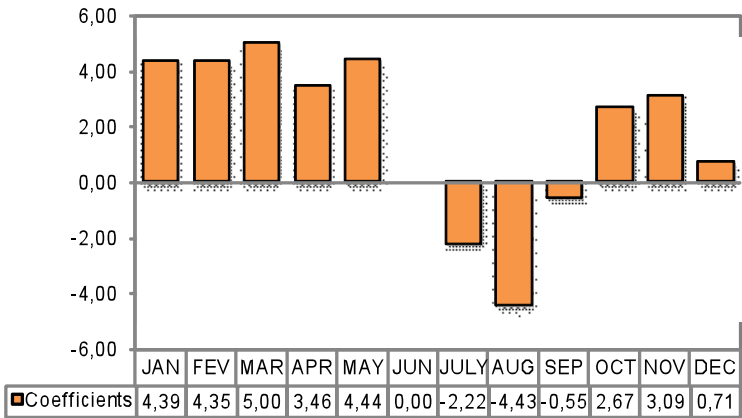


Figure 20 – Month seasonal factors for daily cost in communications using 2005 and 2006 data.

From the data mining algorithms provided with the software, the Microsoft Naïve Bayes was one of the most useful, because many of the attributes were categorical. In explaining call cost this algorithm ranked the hour in first place, followed by destination island, island of origin and service type.

Having in consideration only the more expensive calls, we found that 80% were originated from the main island where the headquarters are located, another 80% had duration between 3 and 10 minutes; 51% were made directly and 42% by human operator (the remaining 7% were for special numbers). This last figure were considered too high by the professionals and other models were demanded to understand what was happening. Note that the Naïve Bayes algorithm used in SQL Server 2005 does not consider combinations of attributes (Larson, 2006), which was unexpected in data mining software (*e.g.* Witten and Frank, 2005).

Microsoft Decision Trees is an algorithm that produces a tree structure defining logical rules for explaining a target attribute, using several explaining categorical or categorized attributes. In the MS implementation, it can be regarded as a generalization of Naïve Bayes algorithm or a form of Bayesian network (de Ville, 2001). Many trees were analyzed for the cost target attribute, using

several key attributes which define the aggregation levels for the data set. Excluding duration from the explanatory attributes it was possible to conclude that when the call destination is the island of São Miguel (the biggest one with half of the total archipelago population) the majority of the calls were not direct calls especially the most expensive ones. Why are the calls by human operator so common for this destination?

The Microsoft Clustering algorithm builds clusters of entities based on proximity measures calculated from the training data set. Once the clusters are created, the algorithm describes each cluster, summarizing the values of each attribute in each cluster. This algorithm has the originality of displaying results not only in tabular form, but also in a network scheme, where links and color codes relate clusters. From the many clusters defined in this way, cluster 6 was of especial interest as was characterized by long calls, had a strange distribution far from peak hours, and also abnormal destination numbers. This cluster represents a significant amount of suspicious calls. The Microsoft Association is a traditional association rules induction algorithm. It produces an ordered list of item sets, rules with precision values and a dependency network. This algorithm was considered very interesting and was one of the most used in this study. For instance was possible to conclude that was a high support for calls by human operator with origin and destination in the same island, which seems suspicious as these calls may easily be made by a direct call using the company network.

All models were validated using the tools for this propose in MS SQL Server, lift charts and classification (or confusion) matrixes. These are charts that compare the precision of the classification (or forecast for continuous attributes) for the different models used. These charts can take a long time to build and where useful only to compare models with each other and the worst case scenario. They confirmed that rules induced by decision trees and Naïve Bayes where the best ones for call cost forecast.

5. Results and Decision

The model results were discussed with EDA experts. After that validation it was possible to resume the following information about phone use patterns: the peak hours are between 9 to 11 and between 14 to 16 hours each weekday and there is very low use at night and during lunch time, and also at weekends and holidays. There was no seasonality between the weekdays, as they have almost the same high use. On the other hand, the month seasonal factors indicate less use at summer and near New Year. The most common call destination are for the tree bigger towns in the region, as was expected, and calls are usually under 3 minutes and between 30 to 40 cents. The special numbers like the call center number are of low usage. All the latter information is of major importance for the particular decision to support. Especially the strong seasonality identified means the equipment capacities must be planned for peak periods. From the trends estimated by the regression models, there is no evidence of increasing total duration of calls, even in peak periods, as trend lines were always non significant for the two years of data.

As was recognized by other authors (see for instance Cortes *et al*, 2001) the key criteria for decisions in telecommunication investments are the cost of the different solutions. In this way, for a final decision a cost analysis was also done using data collected from the previous analysis and simple projections, comparing the costs for the existent communication system with two change scenarios. The three options defined in this phase are based in different technical solutions defined by the EDA experts. In Figure 21 the present situation and the two changing alternatives are illustrated graphically. Option A, uses a minimum of investment using the existing lines and only buying the necessary equipments. In spite of a reduced investment, it saves the annual operation costs in 15%, but there is no expected cost reduction for the new VoIP links between

internal locations, due to low volume calls. This option maintains the two technologies presently used by the communication system until the end of equipment life: a PBx central for voice communication and VoIP, been this last one much more utilized than before.

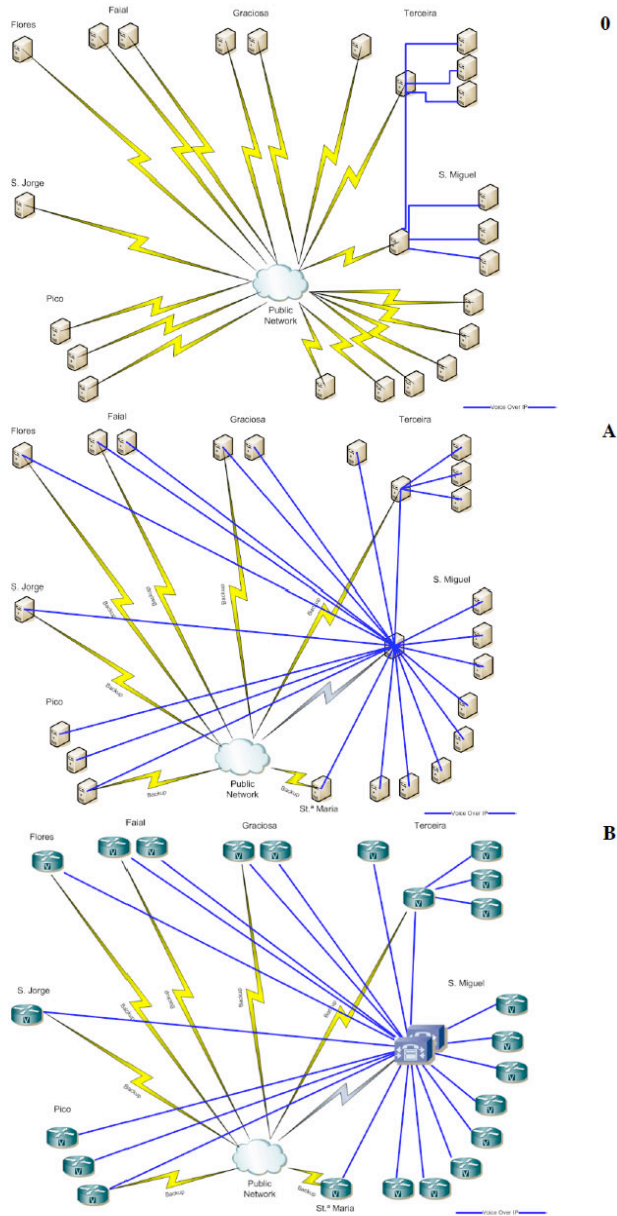


Figure 21 – Illustration of the three decision alternatives in consideration. Option 0 represents the present situation, option A, going to VoIP and maintaining present WAN equipments with minor changes and, option B, also going to VoIP but replacing all equipments.

Option B consists of replacing progressively all equipments resulting in a new telecommunications infrastructure based on VoIP Routers and Call Managers for voice and data communications. This option requires a big investment in new equipments, 7 times option A, but, when finished, will decrease the annual operation costs on 165% from the present values. The current situation (option 0) does not use any investment capital but has high operational costs. All the factors considered for that decision are summarized in Table 7. Our conclusion, from cost analysis and business intelligence, is that both new solutions look attractive as the benefits compensate the costs in the long run. The decision support group recommended the adoption of option B, as in a strategic view will have more benefits not only in money but also in preserving a “technological image” of the company and the simplification of operation activities. This recommendation was adopted by decision making executives and a project is now been implemented.

Table 7 – Decision features of the two change alternatives.

actions	costs	benefits	critical factors
Option A – VoIP connections maintaining present WAN equipments with minor changes			
Upgrade existing infrastructure; upgrade circuits bandwidth; provision of additional VoIP cards to existing equipments; Configure all networks.	High ongoing and support costs due to obsolete and mixed technologies; High cost with service operators; High operation costs if traffic increases.	Reduced investment on infrastructure; Low reduction on telephone service costs.	Age of telephonic equipment and end of life (presently with 8 years); Cost of introduction of additional VoIP links exceed the actual costs.
Option B – VoIP connections replacing WAN equipments			
Upgrade circuits bandwidth; Provision of Routers, Call Manager's, Switching and terminal equipment; Change all WAN and LAN equipments supporting voice; Configure all networks	High cost of initial investment; Change management.	Reduced ongoing cost and high reduction on support costs; Fixed telephone service; Renewed WAN infrastructure; New services introduced by IP telephony.	Long term benefits due to the reduction on ongoing costs and new services; Capability of existing service provider to implement and support the new infrastructure; Migration of existing services (Call Centre).

6. Conclusions

In this paper we describe the development of a Decision Support System, based in business intelligence and data mining technologies. These are applications very different from the personal decision support systems previously design by the authors for supporting specific decisions (see for instance Mendes *et al.*, 2006). The applications used in this work, closely linked to data servers' technologies, in spite of the fact that are mainly designed for data management, can also

be very useful for supporting specific solutions. In this work, they were found to be especially adequate to ETL, querying data, data description, exploration, and for classification.

Along with the support to the telecommunication technology adoption decisions some relevant faults and inefficient procedures were identified, as the high number of long calls not related to work activity. It was also possible to identify a miss configuration on automatic call distribution, resulting on additional external calls, which were more expensive. In fact, we could identify several terminal equipments not at all operated but with subscription costs. From these fault detection activities several terminal equipments have been eliminated and considerable ghost traffic was reduced.

But, the major and unexpected fact identified by this project was the high number of indirect calls, using human service operator, as a way around to the existing control system. Doing an indirect call, the link between the call origin and destination is much more difficult to establish. These facts lead to new rules of operation, restricting calls by human operator.

In the deployment phase we developed applications (as the OLAP cube) for use by several technicians and decision makers. We also organize workshop meetings for knowledge generation and transfer. In spite of this, we recognize that this part of the project needs more work, especially for constructing new data mining models for control and fault detection activities.

This successful project lead to a new one more oriented to fault control and optimization of processes in telecommunications and other related activities.

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Representing organizational conservation of information: Review of Telemedicine and e-Health in Georgia

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Abstract: We review a model of the conservation of information (COI) applied to organizations. Following this review, we briefly review the mathematics in support of this model. We apply the model to a review of the status of telemedicine and e-health in Georgia, which we had begun to study last year. After our reviews, we discuss future steps and draw conclusions about the model and its benefit to organizational attention and decision-making.

Keywords: conservation of information; telemedicine; eHealth; Georgia

1. Overview

In this paper, we present the background of the problem as we first discovered it. The problem was organizational attention and decision-making for which both can range in an organization from fragmented to well-focused. We discovered the problem while studying the Department of Energy (DOE) nuclear waste management program. We review the mathematics behind our solution to the problem (conservation of information, or COI). We review the status of its application to telemedicine and e-health in Georgia as part of a new project for us which we began

late last year (Stachura et al., 2009). And we provide a review of future steps and our conclusions as they pertain to the problem, the mathematics, and the particular application to telemedicine and e-health.

2. Background

We have been developing theory over the past decade for a computational model of organizations and decision-making, primarily centered around the idea of the physics of the conservation of information (Lawless et al., 2009). We began studies of this problem with studies of organizational attention and decision-making in DOE's nuclear waste management (Lawless et al., 2008; Lawless et al., 2005). Since then, the focus of the problem has become more general. The solutions and evidence we have collected indicate that the results apply to organizational models with agents of any type, including those composed of humans-robots-machines, the combination of which necessarily invokes mathematical models of organizations.

The problem is based on the type of information available to social deciders. It has often been assumed by scientists that this information is "complete" and representative of what a human agent believes at any one point in time (but below see the review by Baumeister et al., 2005 on self-esteem; and Kelley, 1991, on the failure of preferences in game theory). However, we have concluded that the information collected from an individual agent is more or less meaningless, since human agents spend their time making decisions under the forces of interdependence. How then to represent interdependence among agents and organizations? While this problem is ancient, with threads running from Aristotle on thoughts about objects to the perspective shifts of Copernicus, the duality of Descartes, and the complementarity of William James, our interest is not historical but theoretical. In this new paper, we focus on interdependence and its application to the Department of Energy (DOE), industry, and telemedicine and e-health (Stachura et al., 2009).

The problem was first recognized in social psychology by Allport (1962) who concluded that the shift from an individual to a social perspective was the major remaining unsolved problem in social psychology. Then at the end of his career, Kelley (1992), as one of the first users of game theory in social psychology, concluded that self-reported preferences did not correlate with the actual choices made when games were actually played. Lawless and his colleagues (2000) similarly found no association in multiple regressions between winners--losers in air-to-air combat and book knowledge of air combat maneuvering. And in a meta-analysis of thirty years of data, Baumeister and his colleagues (2005) found only a negligible association between self-esteem and actual performance with academics and work. Similarly, a discrepancy exists between the views of managers and the decisions made by their organizations (Bloom et al., 2007). To explain these findings, we have concluded that observational data (self-reports, surveys, and interviews) from agents can be independent of action data (e.g., individuals who are walking, driving a car, or flying an airplane; similarly, organizations during business meetings, during merger and acquisition activities, and during the search for technology partners).

States of interdependence are common in organizations (Smith & Tushman, 2005), probably because individuals multitask poorly (Wickens, 1992), but multitasking is the fundamental reason why organizations exist (Ambrose, 2001). However, organizational theory has failed, per Pfeffer and Fong (2005), possibly because social scientists have not yet accounted for the existence of illusions and incorporated them in social theory.

Adelson (2000) gives us tools to use against this problem. If human agents construct visual representations of their world with but only a small contribution from sensory data, the rest split between grouping and experience shaping processes, then cognitive and social dissonance processes operate on these representations to form world views independently of a data driven

reality. The result is a profusion of illusions that must be contended with. For example, the illusions known as "risk perceptions" have not only driven the recent collapse of the financial system in 2008-09, but they are more likely to occur under certain decision making structures (consensus rules) or during states of high interdependence (e.g., market bubbles, bank runs, and panics) than others which pursue instead risk determinations (scientific methods; majority rules; in Lawless et al., 2008).

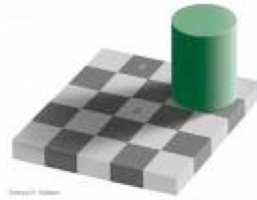


Figure 1 – The Checkerboard illusion (Adelson, 2000). The brain constructs the shadowed area in checker square B as being much lighter than is the darkened square in A. However, both are the same darkness. To confirm, print out a copy and cut out one square and slide it over the other.

3. Mathematics. Conservation of Information (COI)

We have written this paper with non-mathematical readers in mind. The more difficult aspects we have moved to footnotes. And wherever mathematics is found, we try to restate in simpler terms when possible.

A Hilbert Space (HS) is an abstract space defined so that vector positions and angles permit the calculations of distance, reflection, rotation and geospatial measurements, or subspaces with local convergences where these measurements can occur. That would allow real-time determinations of the situated, shared situational awareness in localizing the center of a target organization, σ_{x_COG} , to represent the shared uncertainty in social-psychological-geospatial terms, and σ_k to similarly represent the spatial frequencies of an organization's patterns displayed across physical space (e.g., the mapping of social-psychological or organizational spaces to physical networks). It would establish an "oscillation" between two socio-psycho-geospatial operators **A** and **B** such that

$$[A,B] = AB - BA = iC \neq [B,A]. \quad (1)$$

This type of an oscillation defines a social-psychological decision space within an organization. It is called an "oscillator" because decision-making occurs during rapid-fire turn-taking sessions that "rotate" attention for the topic under discussion in the minds of listeners or deciders first in one valence direction (e.g., "endorsing" a proposition) followed by the opposite (e.g., "rejecting" a proposition) to produce a "rocking" or back and forth process, like an organizational or social-psychological harmonic oscillator (SPHO) within an organization, or like the merger and acquisition (M&A) negotiations between a hostile predator organization and its prey target (see the example of a "rocking" oscillation in Figure 2 below, right). But these oscillations may not occur in the minds of the agents who are driving the discussion (e.g., oscillation occurs in the minds of neutral jury members as first a prosecutor's case is presented to them followed by a defense attorney's case, but specifically not in the partisan minds of the prosecutor or defense attorney, unless they are seeking a compromise; or not in the minds of a

predator organization or its prey M&A target organization but more likely in the observers more neutral to the M&A process but while not being neutral to making a profit; in Lawless et al., 2009).

A democratic space could be defined as a space where decisions characterized by SPHOs are made by majority rule (e.g., jury, political, or faculty decisions); the lack of an SPHO identifies decisions made by minority (consensus) or authoritarian rules (e.g., decisions common to military, authoritarian government or CEO business decisions) (Lawless et al., 2007).

The key to building the abstract representations necessary to construct an SPHO may be to locate opposing clusters of the shared interpretations of concepts geospatially across physical space or via a socio-psychological network anchored or mapped to physical network space. SHPOs should generalize to entertainment or stories. Similar to a decision process involving drivers and neutrals, we propose that a story or stage production, as found by Hasson and his colleagues (2004) in their study of inter-subjectivity among viewers of a Clint Eastwood movie, engages and holds an audience's attention with this rocking process. This insight suggests that the reverse engineering of terrorist organizations may be possible (Lawless et al., 2007).

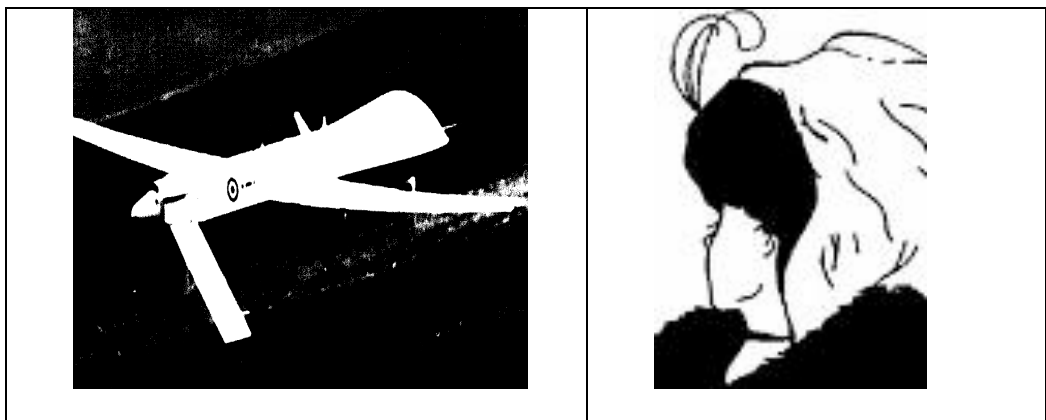


Figure 2 – Left: A "stable" outline of the armed USAF Predator UAV (i.e., MQ-1). Right: An "unstable" or "rocking" oscillation of a bistable illusion of two incommensurable images formed with the same 2-D data to produce a sketch of a young woman looking over her right shoulder or of an old woman glancing downward and to her left.

The operators **A** and **B** are community interaction matrices that locate social objects interdependently, ι , in social space (shared conceptual space) that are in turn separately anchored (embedded or situated) in geospatial or physical space. ι states are non-separable and non-classical; disturbances collapse ι states into classical information states. Two agents, one as a University President and the second as the Chair of a committee revising promotion rules, meet in an adjoining room to the President's office, the choice of seating location reflecting the relative social power of the President over the subordinate faculty member, but the second holding a skill set required by the organization that permits the two to negotiate while both are aware of their different functions and relative social ranks in the organization (Ambrose, 2001), generating bistable social perspectives that reflect the separate social constituencies that drive compromises (Wood et al., 2009); e.g., in contrast to the gridlock in the Hanford cleanup driven by its consensus-ruled Citizens Advisory Board (CAB) where compromises can be easily blocked,

compromises made by the majority-ruled Savannah River Site (SRS) CAB have accelerated environmental remediation at SRS (Lawless et al., 2008).

Per Bohr (1955), complementarity actors and observers and incommensurable cultures generate conjugate or bistable information couples that he and Heisenberg (1958) suggested paralleled the uncertainty principle at the atomic level. We have built a model to test their speculation and to extend it to role conflicts (Lawless et al., 2009). But even for mundane social interactions, Carley (2002) concluded that humans became social to reduce uncertainty. Thus, the information available to any human is incomplete, producing uncertainty. More importantly, this uncertainty has a minimum irreducibility that promotes the existence of tradeoffs between any two factors in an interaction (uncertainty in worldviews, stories or business models, ΔWV , and their execution, Δv ; uncertainty in centers of gravity Δx_{COG} and spatial frequencies, Δk ; and uncertainty in energy, ΔE , and time, Δt).

The uncertainty in these oscillations can be reformulated ¹⁴ to establish that Fourier pairs, consisting of standard deviations, are equal to:

$$\sigma_A \sigma_B \geq \frac{1}{2} \quad (2)$$

Equation (2) indicates that as variance in factor *A* broadens, variance in factor *B* narrows, and vice versa for Fourier pairs. This effect is illustrated using notional data to build three Gaussian distributions with increasing standard deviations as shown in Table 1. Notice that as the standard deviations (σ_f) for the primary functions increase, the standard deviations for their Fourier transforms decrease (σ_F), a simple illustration of COI. Also notice that the relationship for the Fourier pairs ($\sigma_f \sigma_F$) reflected in Equation (2) hold in all of the cases illustrated. And as long as we are dealing with Gaussian distributions, this result must hold (for a proof in signal detection theory, see Cohen, 1995; also, see Rieffel, 2007).

Table 1 – Notional Gaussian distributions with their standard deviations, their Fourier transforms with their standard deviations, and Fourier pairs for both. Notice in all cases that the Fourier pairs are greater than $\frac{1}{2}$.

Function	σ_f	Fourier Transform	σ_F	$\sigma_f \sigma_F$
$f_1(t) = e^{-2t^2}$	0.33	$F_1(s) = \frac{\sqrt{2\pi}}{2} e^{-\frac{1}{8}s^2}$	5.01	1.67
$f(t) = e^{-\frac{1}{2}t^2}$	0.94	$F(s) = \sqrt{2\pi} e^{-\frac{1}{2}s^2}$	2.51	2.36
$f_1(t) = e^{-\frac{t^2}{8}}$	2.66	$F_2(s) = 2\sqrt{2\pi} e^{-2s^2}$	1.25	3.33

¹⁴ Given $[A, B] = iC$, and $\delta A = A - \langle A \rangle$, then $[\delta A, \delta B] = iC$; further, $\langle \delta A^2 \rangle \langle \delta B^2 \rangle \geq \frac{1}{4} \langle C^2 \rangle$, giving the Heisenberg uncertainty principle $\Delta A \Delta B \geq 1/2 \langle C \rangle$ (for details, see Gershenfeld, 2000, p. 256). The uncertainty equation models the expected variance around the expectation value of the operators while the right hand side gives the expectation value of the commutator. In signal detection theory, the uncertainty principle becomes the Fourier pair $\sigma_A \sigma_B \geq \frac{1}{2}$ (see Cohen, 1995; Rieffel, 2007).

To summarize, a model of interdependence in the interaction of organizations must be able to:

1. Reflect orthogonal perspectives; e.g., between prosecutors and defense attorneys (Busemeyer, 2009); between actions and observations or between multiple cultures (Bohr, 1955); between USAF combat fighter jet pilots and book-knowledge of air combat maneuvering (Lawless et al., 2000); between game-theory preferences and actual choices made during games (Kelley, 1992); and to capture the discrepancy between the views of managers and the decisions made by their organizations (Bloom et al., 2007).
2. Allow rotation vectors as a function of the direction of rotation. Permit measurements between vectors and rotations.
3. Enable a mathematics of interdependent (i) bistability where measurements disturb or collapse the i states that occur during social-psychological interactions in physical space.
4. Test the proposition that information in organizational interactions can be modeled by the conservation of information.

4. Telemedicine and eHealth. Background and Rationale

Background of prior work

From our review (see Stachura et al., 2009), digital technologies are transforming many areas of human endeavor from commerce and entertainment to government and communications. Policymakers are emphasizing Information Technology (IT) for healthcare to improve service delivery, promote efficiency, educate consumers, and increase satisfaction. But other than gathering information from websites, few people are using IT to communicate online with health care personnel or to purchase medical services. This digital divide has impeded e-health's acceptance. Less well educated, lower income individuals in rural areas use the web less often for health care than better educated, higher income urbanites. To gain the benefits of IT for healthcare, it needs to become more widespread and its benefits more evident to consumers of all types across the country.

Medical care depends on physicians to collect and process patient information. But increasing knowledge requirements for patients and doctors, the need to evaluate populations of patients whether treated or not, unmet healthcare expectations, the costliness of fragmented care, and the rising demand for chronic disease care challenge traditional healthcare models that refinements alone may not solve. Healthcare IT is the best option for future medical progress. IT includes computer-aided diagnosis and treatment monitoring; telemedicine; and IT to inform the public and physicians on health and healthcare. But incorrect beliefs about IT pose a deterrent to telemedicine. Even senior healthcare executives hold beliefs inimical to the increased adoption of IT in healthcare.

In our earlier paper (Stachura et al., 2009), we also reviewed applications of Telemedicine and eHealth in Georgia from an organizational perspective. To evaluate the role of COI in organizational effectiveness, we reviewed organizational and system theory along with past applications and field and laboratory results, three case studies using Telemedicine and eHealth, a model using natural selection (machine learning), and a Monte Carlo simulation of return on investments (ROI). Theory provided us with the tools to analyze tradeoffs based on COI in eHealth management decision-making. In the three case studies, we provided an overview of a Telemedicine and eHealth network from the State of Georgia in the United States that was operating in the Southeast Public Health District (SEPHD), East Georgia Health Cooperative

(EGHC), and Island Health Care (IHC)/The Healthcare Alternatives (THA) Group. Next, we analyzed the case studies with COI and the weaknesses and strengths of our theory and approach. Finally, we close with a review of Future Trends.

Overall, indicators pointed to good progress, but a lack of uniformity in the organizational metrics exist to clearly indicate where effectiveness has occurred. At this time, not all of the data needed to model the three case studies had been provided. Qualitatively, all three case studies appear to be successful. However, we looked forward to a more in-depth analysis based on tradeoffs (COI). While too early to judge whether this combination will eventually be successful, our companion study of promoting online web-based metrics for MDRCs has been successful beyond all of our expectations as the modest system that we proposed has been picked up by DOD for all of its IRBs (Wood et al., 2008; 2009; and Tung et al., 2008; 2009). COI predicts that fragmentation will significantly reduce organizational performance and outcomes. Although at this time we cannot identify systemic problems and make recommended changes to enhance MCG's programs, that is our ultimate aim.

New Work

Traumatic Brain Injury (TBI) is the "signature wound" of soldiers returning from Iraq and Afghanistan theaters of conflict. Due to the increased use of explosive devices, although improved body armor and helmets save lives, facial exposure during combat results in symptoms of TBI in soldiers who live through trauma that would have otherwise been fatal.

Initial TBI treatment TBI aims to sustain life and prevent further injury. Chronic care requires re-habilitation and use of assistive technologies that will enable victims to live as independently as possible after they have returned to their homes and communities.

TBI victims experience a range of chronic symptoms that may include confusion, headache, fatigue, trouble sleeping, irritability, anger, depression, withdrawal, altered response, and reduced cognition. While the aim of chronic care and rehabilitation is recovery and independent living, short-term achievements that facilitate these outcomes include the ability to socialize, restoration of self-esteem, amelioration of depression and other emotional issues, re-learning to communicate, to walk, and to think functionally. Some patients with mild TBI recover completely, but others require life-long therapy.

While patients with mild traumatic brain injury may fully recover from their impairments, for others, chronic treatment for TBI will be life-long. In many cases, the type and intensity of treatment will decrease over-time as the TBI treatments advance, and as the TBI patient and his or her family learn more about how to care for and cope with traumatic brain injury.

While behavioral TBI symptoms are generally observable, physiological correlations may also be detected such as, for example, changes in pulse rate, blood pressure, and abnormal respiratory rates. Even levels of patient activity throughout the day, or the quality of nightly sleep might provide insightful. Remote monitoring (e-health) to detect these changes could offer an improved and cost-effective means for monitoring and treating TBI sufferers.

In addition, many symptoms attributable to TBI, including neuro-psychiatric symptoms, can be mimicked or modified by abnormal circulating hormone levels. Modulation of peripheral endocrine gland hormone secretion is under the control of the anterior pituitary gland, which in turn, is under the control of neuro-hormones secreted by a portion of the brain – the hypothalamus. The hypothalamus and pituitary gland are connected by a fine stalk, permeated by fragile portal blood vessels through which neuro-hormones travel from the hypothalamus to the pituitary. Thus, there are three sites, individually or in combination, at which TBI could result in abnormal pituitary hormone secretion: hypothalamus (brain), stalk, or anterior pituitary gland itself.

Finally, while initial treatment and stabilization of the TBI patient will likely occur in the controlled setting of the hospital, the true test of success will be the patient's ability to re-insert him/herself into their pre-injury lives. These long-term efforts will occur at home and in communities that may be distant from institutions staffed with the expertise to provide necessary treatment and on-going support for both the patient and the patient's caregivers – family members and significant others. Successful management of TBI victims must include the patients and their caregivers on-going access to expertise and resources to solidify and maintain initial therapeutic gains after the soldiers return home, and in the course of their normal daily activities (domestic life, work, school, and leisure) in their home communities.

Project A: "Returning Soldier Assessment and Adjustment"

Collaborating Agencies:

- General Electric Global Research Division
- US Army/Fort Gordon/Eisenhower Army Medical Center
- Center for Telehealth, Medical College of Georgia

Part A.1: Remote Monitoring of Patients with Traumatic Brain Injury to Facilitate

Diagnosis and Management.

The key objective of this research proposal is to test the hypothesis that the symptoms of TBI can be quantified using advanced remote, passive sensors and that the data captured can be correlated with medical assessments to enable a clearer understanding of disease incidence and progression in TBI.

The steps to be undertaken in our approach to achieving this key objective include: (a) Identification of the key symptoms and clinical pathways of TBI; (b) Mapping disease symptoms to standard, physical and behavioral, clinical models; (c) Development of a sensor informatics system that measures relevant activities and behaviors; (d) Deployment and validation of the system in Warrior Transition Battalion (WTB) barracks; (e) Testing of the central hypothesis that the system and model can explain the symptoms associated with TBI and that it fits relevant behavioral models; and (f) Perform additional clinical studies that will explore potential treatment pathways, and allow the development of management recommendations.

Part A.2: Contribution of Neuro-Endocrine Abnormalities to Manifestations of TBI.

The key objective of this research will be to screen for pituitary hormone abnormalities in warriors hospitalized for the treatment of TBI.

The pituitary gland is part of a neural/hormonal axis (hypothalamus, hypothalamic-pituitary portal blood system along the pituitary stalk, anterior pituitary gland) responsible for maintaining physiologic metabolic balance. *Brain injury* that damages neural—hypothalamic—ability to exert control over the anterior pituitary gland can disrupt normal hormonal cycles that vary according to the time of day (circadian, diurnal), in month-long cycles (menstrual), or in response to the individual's metabolic status (feedback). Hypothalamic hormones that regulate anterior pituitary hormones travel down the portal blood vessels of the stalk. If the *pituitary stalk* is damaged (as in whiplash injury) and the flow of these brain influences is interrupted, the anterior pituitary loses important regulatory direction. Stalk interruption results in loss of cyclic

hormone production, and decreased anterior pituitary hormone production in general, among which the consequences are the inability to respond to stress. Damage to the *pituitary gland* itself results in decreased production of all anterior pituitary hormones, again with the reduced ability to respond to stress or make other metabolic adjustments.

At a critical and specific time of day, we will obtain a single blood sample from each TBI victim and measure the level of a panel of hormones in an attempt to identify hormone levels or patterns of hormone levels that differ from those of individuals not afflicted with TBI.

Project B: "Telehealth Psychological Service Delivery to Patients with TBI"

Collaborating Agencies:

- Center for Telehealth, Medical College of Georgia
- Charlie Norwood VA Medical Center

A growing literature suggests several promising directions for both the assessment of, and treatment for, individuals with mild to moderate TBI during acute and post-acute rehabilitation. For example, cognitive behavioral therapy (CBT) has been shown to be effective for treating the psychological and behavioral consequences of TBI, including depression, anxiety, sleep disturbance, and pain. As the longer-term implications for adjustment to injury and quality of life post-TBI are just now beginning to be realized, it is clear that efficacious, cost-effective, non-stigmatizing and even novel post-acute interventions are needed. It is essential that these new approaches must take into account access to mental health care because definitive treatment is seldom completed in hospital and active duty soldiers and veterans are often discharged to their homes or to other care facilities that have limited access to the healthcare systems most able to provide the required effective interventions.

In the past decade, telehealth technologies have emerged as efficient and effective service delivery tools to bridge geographical barriers. Telehealth service delivery models, especially those incorporating web-based telehealth technologies available in the home, provide a solution to the problem of access by allowing health care professionals to provide mental and behavioral health care to patients living in, and attempting to reintegrate themselves into, communities where access to provider experts is not readily available.

This research examines the effectiveness of such telehealth service delivery models for veterans and active duty soldiers who have sustained a mild to moderate TBI. We plan to use a three-arm randomized control trial to test the hypothesis that evidenced-based CBT for TBI patients, delivered via videoconferencing technology ("Telehealth") will be at least as effective as traditional ("In-Person") CBT delivery for improving psychological functioning, and that both CBT service delivery modes will be superior to "Usual Medical Rehabilitation Care." Consented participants are assigned randomly to one of the three treatment arms (consented means those subjects who have freely given their consent to participate). Our methods allow the direct comparison of each service delivery mode's effectiveness in terms of two categories of outcome variables: (1) clinical outcomes, including symptom severity and overall psychological functioning as represented by symptoms of depression and anxiety, sleep disturbance, and pain; and (2) process outcomes, such as treatment adherence, session attendance, attrition, patient perception of treatment, and patient acceptance of technology facilitated treatment delivery.

Demonstrated efficacy of telehealth-delivered CBT for patients with mild to moderate TBI will allow for the development of remote service delivery and chronic support programs that do not require patients to travel repeatedly or to travel to distant hospitals for outpatient treatment. Our ultimate goal is telehealth-delivered CBT in the home in order to provide long-term access to high quality treatment by, and support from, trained mental health providers when and where that

treatment and support is needed, to reduce stigma associated with mental health treatment by military personnel, and to promote both optimal recovery and successful community reintegration.

Project C: "TBI Caregiver On-Line Needs Assessment and Resource Access"

Collaborating Agencies:

- Charlie Norwood VA Medical Center
- Center for Telehealth, Medical College of Georgia

In 1998, the Family Caregiver Alliance estimated direct and indirect costs of TBI to the US health care system, to patients and to their families at \$48.3 billion annually, with survivor costs of \$31.7 billion annually. Lifetime costs for one individual can total as much as \$4 million. TBI can seriously affect cognitive, physical, and psychological skills. Physical deficits can involve ambulation, balance, coordination, fine motor skills, strength, and endurance. Cognitive deficits of language and communication, information processing, memory, and perceptual skills are common. Psychological status is often altered. And adjustment to disability issues during treatment is frequently an important factor for all concerned.

When a TBI victim returns to the bosom of her/his family and community, she/he has been changed from the person they once knew. She/he has support needs with which they are unfamiliar and inexperienced. Unfortunately, there is not now in place a mechanism for these caregivers to understand and articulate their own needs for developing competence in the support of their damaged loved ones, and there is no systematic way for them to learn of and gain access to the resources required to assist them in that effort

The purpose of the study is to develop an online assessment questionnaire and resource center for caregivers of patients with TBI. The study is based on the Resiliency Model of Family Stress, Adjustment, and Adaptation and the Life Patterns Model to form the conceptual framework for the effort.

In the initial phase of the study a needs assessment questionnaire for lay caregivers of individuals afflicted with TBI will be developed and refined. The subsequent study phase will include placing the questionnaire on a selected website for use by actual caregivers and other interested parties. A series of branching programs will be developed to link questionnaire results to relevant educational and related resources. In addition to resources with general relevance and accessibility, a long range goal will be to include support references and resources that are not only specifically relevant, but also locally available.

5. Future Steps

It is too early in the studies we have proposed in this paper to observe oscillations, but we fully expect to discover them geospatially between treatment at regional centers and with telemedicine; between total treatment costs and timeliness without and with e-health; and between worldview self-reports of those who have been treated in large centers and those in family and home-town locations (we will consider Dawes and his colleagues, 1989, who stressed the importance of demographic data with questionnaires as more reliable and valid data). In the future, we also plan to collect comparative data to test with panels for the existence of social and psychological oscillations. And we plan further progress reports.

6. Conclusion

Social and psychological oscillations are common to human existence. We have built a mathematical model of these oscillations which shows significant promise theoretically and with applications in the field. Regarding its application to telemedicine and e-health, it is too early to draw conclusions. But we can state unequivocally that the telemedicine and e-health research agenda proposed in this paper is exciting and, hopefully, promises to uncover more questions that we can possibly answer.

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Organizational Decision Support Systems

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Abstract: This paper presents a notion for developing Organizational Decision Support Systems (ODSS). The lens used is to see ODSS as a specialization of Social Decision Support Systems (SDSS) and a generalization of Group Decision Support Systems (GDSS). A *unit decision process* can be raised by any person in a organizational whole, the organization itself or some sub-organization. The decision process can use a given formalism coherent with the idea that as the contributions from people in the decision process expands, so does the space of available perceptions (P), the space of available actions (A), strategies (S), and options (O), the space of available criteria (C) of valuation of options (V), leading to decision. Atomic decision processes link in the *global decision process* of the organization. Potential benefits, shortcomings and needed technologies are indicated as well as prospects of development.

Keywords: organizational decision support systems; social decision support systems; collective intelligence; decision support systems; collective decision-making.

1. Introduction

Information and communication systems substitute and enlarge human capabilities. One striking aspect of such enlargement has been the development of automatic control devices that substitute people in decision making. Another, the development of information systems for decision support, covering several aspects of decision processes (Power, 2002).

Turoff *et al.* (2002) introduced the notion of a Social Decision Support System (SDSS) as a type of information system, with first objective “to facilitate the integration of diverse views into a growing knowledge base”. Other related approaches include Rodriguez and Steinbock (2004), Rodriguez *et al.* (2007). One can enlarge the concept of a SDSS to include the support and taking of some conceivable decision by some conceivable population. Iandoli *et al.* (2007) report field tests for an actual application to climate change.

In such generality of possible applications, one stands out of special interest: *organizational decision*. Among social groups, organizations distinguish themselves by the stable recurrence of people and common functional goals. Being widespread is one of the reasons that make one suspect that their success is of crucial importance to the well-being of human societies. It is natural to suspect that properties of the decision process each uses are of crucial important to its success. The specialization of the notion of SDSS, to fit the characteristics of organizations, appears as an evident step to get into the notion of Organizational Decision Support Systems (ODSS). An account of previous research in the subject may be found in Garrido and Faria (2008).

Obvious advantage can be gained in seeing such a move as companion to a dual move of generalization of Group Decision Support Systems (GDSS) (Huber, 1982) (Turoff and Hiltz, 1982).

The notion of ODSS presented here, being as general as possible, acknowledges primarily *the role of conversations among people* in organizational decision processes. If conversations do not occur, organizational decisions are taken in an absolute individual fashion or are taken by automatic devices. These no-conversation modes can have their usefulness, but it is hard to deny that, from some level up, conversations among people are necessary for good decisions, if not only for decisions, and *that people's practice expresses such necessity*.

One can see conversations as having another role besides being a tool for deciding: often they spot the need to trigger other decision processes. This is the same to say that often decisions originate in conversations about decisions. In this way, *decisions connect forming chains, trees or loops*.

This notion of ODSS sees decision processes in an organization as constituting, through co-existence and integration, the *global conversational decision process* (GCDP) of the organization, henceforth *global decision process* (GDP), for short. ODSS should help to better the GDP by making it explicit, through the mapping and interconnecting of *unit conversational decision processes* (UDPs) and suggesting its analysis.

An ODSS should be able to connect to other decision support and information systems of the organization in order to ease and speed the flow of information among them. In this way, the ODSS will become a hub organizing decision, and the flows of information to and from decision.

Given the above characteristics posited, I think the organizations that can benefit first from this notion of ODSS are those whose leaders and, desirably, the decision-makers and all participants:

- i) recognize that conversations among people are a necessary and effective component in a vast class of required or possible decisions (usually the more important ones), and
- ii) want to explore and exploit the potential benefits of supporting such decisions in an integrated way along the organization based on information systems.

A framework for the support of UDPs is presented in Section 2. In Section 3, the framework is extended for the integration of UDPs in the GDP of the organization.

Section 4 reviews potential benefits and shortcomings and identifies issues for design and development not addressed in this paper.

2. Unit conversation decision processes

I consider here a unit conversation decision process (UCDP), or unit decision process (UDP) for short, to correspond to a well defined organizational whole or set of people. Inside an organization there can be many such wholes as the organization itself or their sub-organizations (divisions, departments, project groups, for instance). A UDP should usually output a stream of decisions either internally or externally motivated. The people in the whole to which the UDP corresponds are supposed to be potential contributors to the decisions in the stream.

Inside a whole some people will be in charge of taking decisions, some will not. For short, I will use the term "decisor" for someone in charge of taking decisions. Depending on the decisions, at one extreme only one people in a whole will be a decisor, at the other extreme all the people will be decisors. Also depending on the decision protocol for decisions, some will be taken individually and some will be taken collectively. In any case, a period of conversation potentially enlarged to all the people in the whole is supposed to happen before the decision is taken, and one of the core functions of an ODSS is to facilitate and support this period.

Why would one take a decision with *support* from a conversation? In other words, which benefits can a person taking a decision get from receiving inputs or advice from other people? This appears a good question for any people in the whole when s/he must take a decision, either being the only to take the decision for the whole, or participating in the collective decision taking protocol. If all the people in the whole are called to a collective decision, they still do not escape to make an individual decision, the collective decision being some composition of individual decisions.

The obvious answer to the questions above is that receiving inputs from other people may help in arriving to a decision that generates outcomes better *for the individual decisor* and *for the whole* than would be the case if the decision would be taken alone. This is a “make individual sense” condition. For the condition to be maintained in the long term it is also necessary that the people in the whole do perceive the sequence of decisions taken as generating outcomes better for them. If that will not be the case, the decisor will not find willingness of the people to give inputs and his or her potential gain will become impossible. To have “ n heads think better than one” it must be clear for each of the n that there is a personal and a collective gain in the thinking. The personal gain may fail to happen at each decision but should be positive along the sequence of decisions the person perceives, as far as the person is able or interested in perceiving. I think that the more this conscience and its consequences are taken in account by decisors (and by non decisors), the more an ODSS can be useful to the people in an organization.

2.1. Formalism for supporting unit decision processes

A more refined and insightful answer to the questions above can be obtained if we take a formal analysis of the decision process and use this analysis to conceive the support an ODSS should make available to decision processes with conversations. The following formalism is a classical one, with elements from Simon (1976), Newell and Simon (1972). It is presented as a possible example to base implementations.

Let us consider a person that must take a decision alone. To decide, the person disposes of a set of perceptions P_1 . This set encompasses, necessarily, perceptions about the environment or state of affairs, S_1 that does not meet some reference criteria R_1 . If the criteria reduce to one only criterion, one will write r_1 . The *issue* of taking a decision is raised in first place by the perception of the criteria not being satisfied, and the judgment that something could be done or not done with respect to it. This creates a goal g_1 , which could be:

- Assessing the solvability of the problem of satisfying the criterion to be met;
- Given the solvability, accessing the relevance or urgency of doing so in the frame of other decisions of the whole;
- Given both above, to select from different courses of action or options, that which expectably will lead to satisfying the criterion.

In any case, the person will perceive or conceive of a set of available actions A_1 , from which a subset must be chosen, forming an option. This formulation allows defining the set of options O_1 , as all possible combinations of taking or not taking the actions in A_1 , the power set of A_1 .

Using a set of criteria C_1 , the person will valuate the consequences of each option, creating a set of valuations, $V_1 = C_1(O_1)$ from which the decision should follow. Note that C_1 should include R_1 .

By asking other $n-1$ people to contribute through conversations, the person can potentially *enlarge* the set of perceptions s/he disposes to a set P_C . Formally, one can view such set as the union of perceptions of each person:

$$P_C = P_1 \cup P_2 \cup \dots \cup P_n \quad (1.1)$$

There will be a potential gain in terms of a better decision for the decisor if P_C strictly includes P_1 : $P_C \supset P_1$. Otherwise, the decisor gets no new inputs and her or his decision cannot be different from taking the decision alone. In this case, s/he (and the organizational whole) may incur effectively a loss by the costs inherent in the conversation from which the contributions arose. However, in this case, a subjective gain may be considered either enlarged confidence on the decision or a warning on the decision capabilities of the whole.

Enlarging the set of perceptions may be the result of enlarging the set of perceptions of the state of affairs, the set of available actions, and the set of criteria. As with P_C , one can view formally such enlargement as unions:

$$\begin{aligned} S_C &= S_1 \cup S_2 \cup \dots \cup S_n \\ A_C &= A_1 \cup A_2 \cup \dots \cup A_n \\ C_C &= C_1 \cup C_2 \cup \dots \cup C_n \end{aligned} \quad (1.2)$$

Because of (1.2) the set of options and the set of valuations also may grow:

$$\begin{aligned} O_C &= \text{powerset}(A_C) \\ V_C &= C_C(O_C) \end{aligned} \quad (1.3)$$

The analysis and formalism above suggest that an ODSS should support UDPs through collecting and registering contributions in a way that makes evident the statement of the issue or goal for initiating the decision process, the information about the state of affairs, the possible actions and the criteria, consequent options and valuations from each contribution.

2.2. Flow of the decision process

Let us imagine roughly how a UDP with conversation would go. Say that an *issue* has been raised. This means that, at least, a description S_1 of a state of affairs and an applied reference criteria R_1 providing evidence for / establishing the necessity of deciding doing something else about it (other than what has been done) have been presented through the ODSS. Possibly, actions to take, options and their valuations may have been presented, all through adequate forms. Then, other people can contribute enlarging the first presentation of the issue. After some time the decisor seems appropriate, for example, because no real enlarging on any of the sets is observed or just because of time constraints, s/he takes the decision.

Let us note the following. It is recognizable that the decision process implies a flow, and it seems a good idea to require that ODSS provide states and transitions between states to formalize the flow. Say that an issue has been raised by a non-decisor. It may make sense that it is recognized as worth examining to enter the decision process. If recognized it may also make sense to prioritize it. States of *raised*, *recognized*, *prioritized* are possible descriptions. When the decision is taken, the issue may be said to be *decided*. Upon getting confirmation that the decision worked it may be said *closed*. Transitions between states should be the responsibility of the decisor in charge. This implies that a decisor may pose an issue in the *recognized*, or *prioritized* state from the beginning. It can even make sense that a decisor poses the issue as *decided*.

Any potential benefit from conversation in decision process comes with the cost of involving more people in the process, which means that they must spend time and energy to think or research about their aspects and the contributions of others, and to transmit to the system the results of their thinking or research. Because of inherent costs, decisors always face the problem of establishing a trade-off in allocating resources to the decision process. Stating an issue as decided (without conversation) may be the best course of action in many cases. The notion of ODSS presented here targets enlarging behavioral possibilities of people inside an organization, not restricting them.

2.3. Polling and voting mechanisms

Supporting decisors through conversation or any other contributions does not entail that the decision itself should be taken by other people than the decisor. If i) a decisor consistently arrives to good decisions in the sense that people in the organizational whole perceive that in the long term decisions are beneficial to them and ii) people in the organizational whole understand that their contributions are necessary for good decisions, then it is expectable that they contribute without conditioning their contributions to these being accepted or the decision being mandatorily collective – that is being arrived at by some voting process.

However, the existence of polling or voting mechanisms at each organizational whole level in a ODSS is a must, or at least, a distinctive advantage. On one hand, a decisor may want to know what the result of a poll is on some aspect of an issue or on the whole issue – and eventually decide accordingly. On the other hand, voting may be mandatory for some decisions and it may be useful to have such possibility in the ODSS.

3. The global decision process

In an organization, many decision processes occur recurrently and simultaneously. The decision processes are dependent and, often, strongly inter-related. I envisage the function of an ODSS as giving support to the *global conversational decision process* of the organization, *global decision process* (GDP) for short. It is the union and composition of unit decision processes.

In this paper, I consider four issues in conceiving such support. Sub-organizations and the address space of each person, the linking of decisions, the explicit map of decision processes and implementation aspects.

3.1. Sub-organizations and the address space

Organizations have sub-organizations. These have been referred above as wholes of people to which decisions respect. It is clear that one cannot expect much usefulness from raising issues to people if they are unrelated to their interests – or if the people cannot contribute to their decision.

Mathematically speaking, if an organization has a set of m people, it is possible to conceive of 2^m subsets of people. In practice a few of all these possible subsets will correspond to sub-organizations or wholes – the organization itself being one of them and the largest. Some subsets are included in other, for example, a department may be included in a division, some not, for example, a project group with people from several departments. Some are more stable, some more transitory.

It follows that it seems a good idea that an ODSS supports the definition of sub-organizations and the attribution of people to them. In each sub-organization, it is to expect that decision processes recur, occur simultaneously and are inter-related as they are in the organization as a whole. For this, I mean to require that the ODSS will allow for mapping the configuration of sub-organizations inside the organization, each sub-organization being supported in their decision processes as such.

Along a set theoretical reasoning, a person necessarily belongs to more than one subset of people or sub-organization. Say that s/he belongs to sub-organization X . Then it also belongs to any sub-organization Y which set of people includes the set of people of X , in particular s/he belongs to the universe of people of the organization. Furthermore, it can belong to other sets for which the Y inclusion relation does not hold.

Should a person be allowed to raise decision issues to any subset of people or sub-organization? In other words, as information overload should be minimized, which should be the address space of each person to pose decision issues? A seemingly natural criterion seems to define such possible address space as the set of all subsets of people in the organization to which the person belongs. Say that a person belongs to department X , of division Y of organization U . Then she can pose decisions either to X , or to Y or to U . Such arrangement expectably will preserve relevance of issues posed, participation of people, and promote clear thinking about decisions.

3.2. Relating and linking decision processes

Linking and relating decision processes in the global decision process of an organization can be seen to happen at a whole level (inside a sub-organization and independently of others) as well at a multi-whole level (say from a division to a department and then up again).

Two possible relations of decision processes, which gave naturally rise to linking, are sequencing and nesting.

I will say that decision process D_1 will be in sequence with D_2 if D_2 has been triggered by D_1 , but the completion or closing of D_1 does not depend on D_2 . I will say that decision process D_1 will nest D_2 if D_2 has been triggered by D_1 , and the completion or closing of D_1 does depend on the completion of D_2 .

If an ODSS allows for the tagging of decision processes in terms of their sequencing and nesting relations (and the associated implementation of decisions) it will be possible to develop visualizations and analysis of the unfolding of the global decision process, a seemingly most useful possibility.

Other possibilities of relating and linking are of interest. Decision processes can be classified by type. Assuming that an ODSS will keep the records of most (if not any) decision processes in the organization, such information can be explored to look for similar decision problems, best solutions, or to develop facilitators for people to raise or pose issues.

3.3. Explicitly mapping decision processes

The conceptual architecture for ODSS presented raises the possibility of explicitly mapping the global decision process and their constituent processes in several ways, for example through textual or graphical visualizations.

I think this is a most advantageous possibility to consider, explore and exploit. Such mapping would allow for a clear conscience among people in the organization (or the organizational whole) of the issues at stake, their relative importance, the existence of decision processes and how these could be changed and made more efficient.

In this view, one can view ODSS in a learning perspective: they are devices through which people learn to decide in better ways either alone or collectively.

3.4. Implementation aspects

A straightforward implementation of a ODSS could use a web or intranet server configuration. Depending on the size of the organization, the ODSS could be partitioned through several machines or software instances. Linking of the instances becomes an important facility as well as connecting the ODSS to other information systems in the organization.

Such an implementation configuration would allow support for synchronous (actual or virtual meetings) or asynchronous interactions among people and between people and the ODSS. Asynchronous interactions have interesting sparing time prospects as eliminating (unnecessary) meetings or facilitating meeting preparation.

4. Review, conclusions and perspectives

This paper has presented a notion for Organizational Decision Support Systems (ODSS). Several ideas converge in this notion. If one considers the ubiquitous role and practice of conversations in many decision processes, and the character of top-level of these¹⁵, then it seems a good idea to explore the possibility of substantially improving decisions quality in organizations by taking the “support of conversations” as the main “tool” to arrive at decisions.

The notion presented sees an ODSS as mapping in itself the configuration of sub-organizations of the organization. It becomes natural that the interface with users be framed through such a map, each user addressing or relating with decision processes occurring in the sub-organizations or organizational wholes s/he belongs to.

The notion also supposes that some formalism for decision processes is to base the interaction among users, or the collecting and communication of users’ contributions. Users may be decisors or non-decisors, but, in principle, all are deemed as potential contributors to decisions, including raising issues to be decided.

To exploit further the potential advantages of an ODSS, this should allow perceiving decision processes as state transition flows, with associated devices to enable polling and voting on issues, linking and classifying decision processes. This raises the possibility of mapping through the ODSS the global decision process of the organization, making the interaction of such an information system a space for organizational learning.

4.1. Potential benefits and pitfalls

At the individual decision level, the basic fact giving a potential gain for decisors and the organizational wholes is that an ODSS can ease or facilitate:

- To perceive potential relevant issues for decision as any member can raise an issue.
- To get an enlarged perception about the issue to be decided upon, that may at least translate in a better decision under the current frame of thinking. In an even more favorable outcome, it may translate in a better frame of thinking to consider the issue.

One may expect that the greater the diversity or variety (Asbhy, 1956) of contributions, the more probable is the potential gain. Assuring such diversity – in particular, preventing groupthink (Wikipedia, 2009) and “organizational silence” (Morrison and Milliken, 2000) – is a major concern. In an ODSS, anonymous contributions should be enabled in a way that people trust.

On the other hand, some issues raised may be irrelevant or the perception created by the conversation process may not enlarge the perception of the issue, or give rise to a better decision that an issue’s presenter had in mind when presenting it. Human time costs incurred in the decision process would be then unproductive. This problem *in se* can also occur without using an ODSS, and using an ODSS could inflate it. This potential pitfall prompts for three necessary steps of understanding:

¹⁵ Being top-level means they are not conducted by machines nor are approached in a individual basis by decisors.

- That an ODSS as a support system *aims at greater automation* of the decision processes but it *cannot substitute* people thinking and judgment.

- That using an ODSS *entails a period* of individual and organizational learning.

- That the general principles for an ODSS stated above can be *implemented in many flexible ways* desirably matched to the reality of the people in the organization and their current processes.

In particular, the possibility that all the people contribute to decision *does not entail* that all people decide. Additionally, it also *does not entail* that people are obliged to contribute with extra effort for the organization.

At the global decision level, the basic fact giving a potential gain for the people in the organization is the possibility of mapping the global decision process of the organization in very flexible ways, able to support meaningful communication to and from people.

4.2. Future research

Any decision process has a cost in itself, and going for an ODSS as described will have inherent costs, both in investment and operating costs. Profitability hinges on synergistic factors some of them I will indicate as being:

- Improved decisions quality;
- Improved motivation and satisfaction of people;
- Improved efficiency of the global and the local decisions processes of the organization;
- Organizational learning.

All these in turn should translate into more added value *per capita* produced by the organization. To get estimates of the value of the increase is a difficult task, given that a not-yet-tried concept is being proposed and given that locally unpredictable, relevant gains to expect, may come from non-linear effects of interaction among people an ODSS may enable. However, logically deriving bounds from a set of reasonable assumptions may give a first map of possibilities.

Having established the interest in implementing an ODSS, the following questions to address relate to how one must design the ODSS so people using it start to produce better decision processes with minimal learning. Design should also aim i) smooth integration in the culture and established ways of interaction among people and ii) effective integration in the global information system of the organization. In requiring smooth integration in the culture, one does not mean that this culture will not change as a result of the organization adopting an ODSS.

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Contextualized Ubiquity: A new opportunity for rendering business information and services

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Abstract: Ubiquitous information and services means that they are available anywhere and anytime. The development of mobile-devices with wireless network-access capabilities, together with the decrease in network-traffic costs and the proliferation of free wireless hotspots, makes the use of mobile-devices, as Internet access tools, increasingly common and attractive. With novel forms of presenting information and to provide new ways to interact with consumers, new business strategies can be boost, in Customer Relationship Management (CRM) and E-Commerce. This paper describes a different approach to the relationship between customers and business-providers, based on contextualization mechanisms, located in user-consuming real-world objects. A Wine Integrated Management System, called SIGPV, is presented as a proof-of-concept, enumerating some of possible major business and CRM benefits.

Keywords: ubiquity; mobile-devices; context-aware; electronic-services; tags.

1. Introduction

Electronic information and services organizations today are still centered on the Personal Computer (PC) as an access vehicle. When mobility is required, several issues arise, namely: availability, suitability-of-use and usability. Ubiquitous computing model aims to break with the traditional PC-centered interaction model and to give end-users the opportunity to interact with the digital world, through their surrounding environment elements, at any time, using any device (Han et al., 2004). To achieve real ubiquitous computing, it is necessary to address several open issues and challenges, outlined by many researchers (Satyanarayanan, 2001; Kindberg & Fox, 2002; Saha & Mukherjee, 2003), such as users mobility in geographic spaces, the integration of physical and virtual spaces, contextualized interactions, among others.

While currently common mobile-devices, with Java and web connectivity support, are progressively trying to solve the mobility and heterogeneity issues, contextualization is still in its

early stages, which is mainly in Global Positioning System (GPS). However, besides this being only an outdoor solution, generally available in more expensive mobile-devices, the geographic position is just one of several attributes of context-aware, thus not allowing a full integration of physical and virtual spaces.

One approach to overcome these limitations is to use context elements such as: barcodes, visual tags or radio-frequency tags. Although radio-frequency tags, namely Near Field Communication (NFC), are already used in closed dedicated applications, such as security and access control, they are not yet suitable as a widespread contextualization mechanism for elements in the surrounding environment, due the need of a proper decoder, which is not yet embedded in common everyday devices (in fact, in Europe only Nokia 6212 Classic NFC has NFC support and it is only available in some countries) and also NFC tags, when compared with barcodes, would be an expensive solution.

Table 1 shows a comparison between common context elements. Visual tags can be easily and inexpensively embedded in real-world objects and their decoding systems are based on image recognition. Because of their ability to handle more data per tag area, visual tags are replacing the well-known EAN13 barcodes. A common everyday device that can perform this kind of decoding is a mobile-device, like a cell-phone with a built-in camera. Putting together barcodes with information storage capabilities and mobile-devices as decoding systems can represent a natural approach as a reliable mechanism to quickly look up information or initiate a object-specific action. In fact, visual tags and mobile devices are already used in some activities.

A traceability system (Seine et al., 2004) was developed to secure the safety of fishery products, and was implemented in Japan. In this system, visual tags are used because they are the cheapest and they perform better in water environments, comparatively with other identification (ID) technologies. Also, their decoding can be made using widely available mobile devices, which gives consumers access to the products information, therefore increasing their confidence. Site-specific access to services, such as virtual queues in restaurants, interactive advertising and vacations browsing, are introduced in (Toye et al., 2005). This approach makes static, de-contextualized and non adapted information or services more friendly and interactive, and is able to provide user-specific contents. Finally, usability and classroom communications research are described in (Chaisatien and Akahori, 2006).

Visual tags can also provide an attractive and transparent way to enable user access to product-oriented contextualized information and services, which allows the creation of innovative interface between enterprises and customers: new CRM and Business-to-Consumer (B2C) tools. In order to present and study the business potentialities and applicability of this approach, a framework for wine-related electronic services, called SIGPV, as been developed. It is an integrated system that uses contextualization mechanisms, such as visual tags or NFC in Douro wine bottles and mobile devices as an easy-to-use transparent access to a business services and information repository. This represents the creation of a business mechanism founded over the availability of product-contextualized information and services, such as: wine characteristics, consumer feedback, and easy access to e-commerce platforms, among others, namely related to tourism.

SIGPV represents also an effort to bring technology, promote innovation and business-cooperation in the oldest demarcated wine-making region of the World: the Douro Demarcated Region (DDR).

2. Using mobile devices to decode ID-tags

Mobile devices, mainly cell phones, are embedded in daily routines and represent the most common and widely used technology today. As such, educational level is not a serious barrier to their use. Studies have shown that in Portugal, at the end of 2007, the cell phone/person ratio is 126,9%, which is 12,5% above the European Union average (ANACOM, 2008). As a rule, “everyone carries at least one mobile device”. This wide availability makes them an ideal tool for interacting with information technology and on-demand services. This idea is reinforced by the current evolution trends in mobile devices, which suggests an enormous potential that can be tapped to support enterprise information and services platforms, making them the key technology to access data services and support ubiquitous frameworks.

2.1. Tag-based identification technologies

Tags, as a machine-readable representation of data (Gao et al., 2007), have been largely used to represent data and to link objects to digital information. There are several tag-based ID technologies, such as barcodes and radio-frequency identification (RFID) tags. The combination of 2D visual tags with an easy-to-use on-the-fly decoding system yields an effective, powerful and innovative way of providing real time contextualized in-field information and on-demand services. This section briefly discusses and compares the different types of tags that can be used for this purpose.

Found almost everywhere, 1D barcodes or simply barcodes are a tag-based identification technology that have the capability to store and represent data through parallel lines of different width. They are massively used in retail commerce, linking products to databases, making automatic management and accounting systems possible.

Two-dimensional or 2D barcodes represent another early step in the tag systems technological evolution. They have emerged as the natural way to encode large quantities of alphanumeric data and to link objects to web-based information and services, through the encoding of an URL (Toye et. al, 2005; Parikh et al., 2006; Rekimoto et al., 2006). Table1 shows a comparison between different types of tag-based identification technologies.

Table 1 - Comparison between common tag-based identification technologies.

	Barcodes	2D Visual tags	RF Tags
Strengths	Printable; Low-cost; Suitable for visual decoding.	Printable; High data store capability; Low-cost; Suitable for visual decoding.	Automatic non-visual reading; Can be de-coded while inside objects.
Weaknesses	Low data store capability; Decoding in dirty environments.	Decoding in dirty environments.	Not printable; Cost; Reading problems; RFID portable decoder.

The decoding of 2D visual tags is usually performed in a cost-effective way by automatic decoding systems known as industrial visual inspection systems. But the current trends in the evolution of mobile devices have made built-in cameras increasingly more common; as a result, it is possible to turn many currently available mobile devices into portable decoding devices, transforming a low-cost widespread consumer electronics device into a visual inspection system.

2.2. Decoding tags

The decoding procedure of EAN13 barcodes is based on well established infrared technology. Although barcode readers are widely available and can be considered low-cost, they are not widespread among the general public, and it is unlikely that they can be brought into day-to-day operation. On the other hand, considering that RFID technology is very promising, the incorporation of RFID tags or tag readers in mobile devices remains unlikely in the near future (Toye et. al., 2005; Seine et al., 2004).

By contrast, the decoding of 2D visual tags can be accomplished by mobile devices with a built-in camera and Java support, being this the consensual approach (Rohs, 2004). Java software for coding and decoding 2D visual tags, such as QR Code and Semacode, already exists. The use of a mobile device as a decoding platform effectively makes 2D visual tags usable worldwide and almost for any purpose.

3. Context-aware framework

The proposed framework intends to overcome the difficulties in access a service oriented platform. Our approach is based on a service-indexing element as a part of a contextualization mechanism, used to supply static information and/or to interface with context-based dynamic information and services. In this context-aware framework (CAF), depicted in Figure 1, a mobile device is used as the decoding device and, simultaneously, as the ubiquitous tool to access on-demand information and services, that are supplied by a cooperative knowledge-based system.

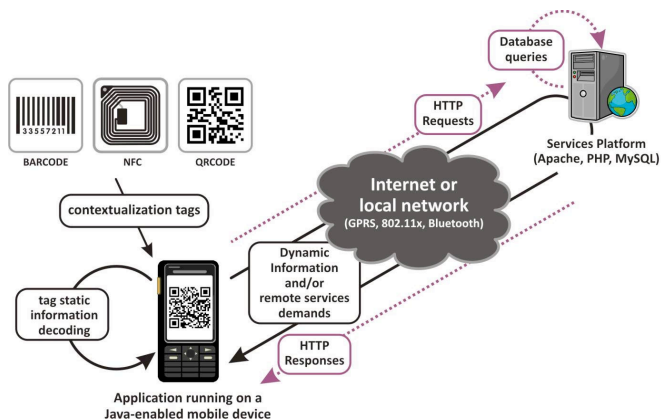


Figure 1 - Context-aware framework as a service platform that is invoked dynamically by an application running on a Java-enabled mobile device. Each service is contextualized by using distinctive mechanisms, covering a wide range of targeted products.

Ubiquitous support is accomplished by using widespread wireless networks support such as General Packet Radio Service (GPRS), Universal Mobile Telecommunications Service (UMTS) and 802.11x hotspots that are progressively increasing in urban environment.

3.1. Using Visual Tags as a contextualization mechanism

Although other technologies may, and might be used concurrently, we have chosen the QR code open standard to encode data into 2D visual tags.

The bridge between a site-specific action and the information system that provides the on-demand services is accomplished by the QR Code, placed in the targeted objects. Data encoded in QR Code can be used in a static or in a dynamic approach. Helpful and static information about could be directly obtained from the tag by a simple decoding procedure. Dynamic information based in context or even user profile cannot be accessed through the static data contents encoded in the in tag. Instead an element specific parametric URL is encoded, which renders all other possible element references, making information and/or services access automatically element-contextualized.

3.2. Mobile device application

The mobile device application of the CAF Framework was developed to run on users' mobile devices, with an embedded camera. This client software performs three primary functions. The first one is to decode the visual tags; the procedure is quite easy and an user can decode the tags by simply pointing the device's camera at a visual tag and pressing the capture button. The second function is to locally decode the static content of the tag, if available. Finally, the third function is to access a dynamic site-specific service, where the user must establish a connection to the CAF server. Besides, information management and general-purpose data entry capabilities are also provided, as part of the interaction between the customer and the CAF.

The client software was developed as a Java Micro Edition Platform (Java ME) application. Java ME Platform stands for an open solution for building mobile applications and, as a key advantage, allows portability between platforms and reuse of applications, being supported by almost every mobile device.

Mobile Media Application Programming Interface (MMAPI) or simply Java Specification Request 135 (JSR135) supports developers' access to native multimedia services. JSR135 support is available in almost all mobile devices with a built-in camera. Figure 2 shows the decoding procedure of the developed application. If JSR135 is not supported in a specific device model, the application can load a previously captured photo, and decode it (offline decoding). When JSR135 exists, the application will capture a photo (containing the 2D visual tag) and decode its content (online decoding). If the decoded content is static information (text or message), it will be showed on the mobile device display. Otherwise, if the decoded contents represents an URL, other type of dynamic information and services may be available to the in-field element represented by the QR Code. As a result, the application retrieves, through the mobile device native browser, web-based element-contextualized information and services, from a central repository.

3.3. Services platform

The service platform, depicted in Figure 3, has a broker interface in order to enable an uniform query mechanism to access a multitude source of services provided by cooperative partners.

This web-based platform builds upon a MySQL database and uses PHP-based services running under a Apache web-server, to enable a platform-independent, open-source framework, mainly conditioned by the web-browser availability.

The operation follows the traditional client-server architecture. After the authentication procedure, incoming HTTP requests are received and processed by the Apache interface, which handles the indexing parameters such as service identification, tag identifier and other service parameters, if present. The invoked service will then build the appropriate queries to the MySQL database and generate the appropriate HTTP response.

This platform has an intrinsic spreading that is assured by the capability to add new service modules, which can also cooperate with other service repositories. Although being primarily developed for mobile devices, where usability issues were a concern, this service-oriented, web-based platform can also be used as an office back-end interface to CAF.

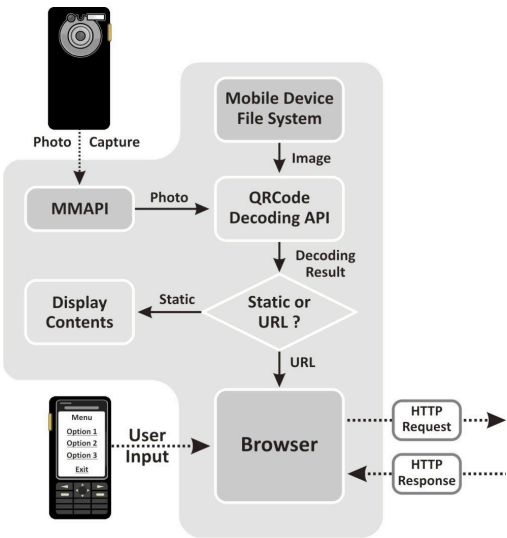


Figure 2 – Mobile application decoding a visual tag (barcode or QRCode) and for accessing the remote services platform.

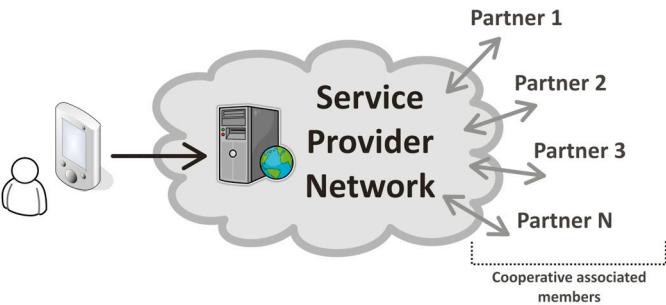


Figure 3 – Services platform as an integrative and uniform interface for a cooperative associated member's network.

4. SIGPV Prototype

As a proof of concept, we ventured into the development of a mobile-based framework for wine-related electronic services, denoted SIGPV.

Wine is the common product between tourism-related services in DDR, making this region a privileged place to materialize the SIGPV Framework. Using a globally renowned brand, like Douro wine, as an interface to a service-oriented e-commerce platform, where winemakers and tourism agents may promote both their products and services, which are the founding pillars that sustains SIGPV Framework philosophy.

Using a camera-equipped mobile device together with a specific software application, which decodes QR Codes placed in wine bottles, one can easily and automatically gain access to product-related and tourism related information and services. Real-time feedbacks and further replies among consumers, for instance, during a restaurant meal regarding a given type of wine, is also provided by the very same framework. As a result, the decision of purchasing a given type of wine in DDR e-commerce stores, which are connected to this platform, is indeed very much dependent of the expected positive reviews which become a progressively determinant factor in such matters. Tourism-related services, such as a typical Douro weekend or a gastronomical route, can also be acquired through a Douro wine bottle – Figure 4 shows the SIGPV Framework overview.

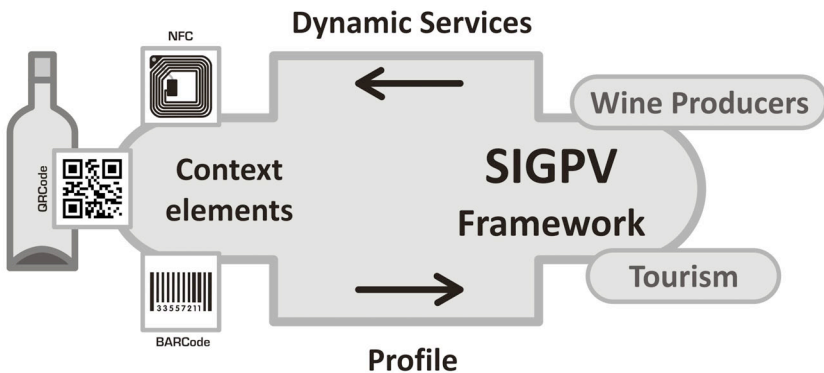


Figure 4 – The SIGPV Framework web services, linking the consumer, through context elements, and wine producers and tourism actors, in a broker platform.

These services are an example of what a simple technology introduction can do to carve an unique and positive boost in such a strategic region, whose economical and social importance is ever more demanding:

Winemakers are offered access to an integrated, visible and innovative publicity platform, as well as the possibility to obtain real-time feedback about their products and to offer consumption-related suggestions, namely gastronomical side-dishes and typical places where one can enjoy the wine, while relating with the DDR unique environment.

DDR Commerce acquires a solidly privileged contact with clients, namely through the Douro wine bottle interface, potentiality capable of improving wine sales. Furthermore, this very promising interface is likely to enhance the availability of other DDR products like wine, agri and gastronomical tourism. Finally, SIGPV can be a privileged vehicle to take products publicity and tourism activities to a vast audience, without any added costs.

Wine consumers are provided with a simple and attractive way to get information and product-related services using their everyday mobile-phone. They can insert and obtain a given - Figure 5, type of wine reviews from other consumers, but also consumption tips – either gastronomical or touristic – directly from the producers and other DDR typical products, which can be publicized using the SIGPV platform.

Targeted publicity campaigns taken directly to the consumer, associating a client profile when consulting wine reviews, a region with an innovative and technological image and new tools to promote commerce and e-commerce are some of the benefits to the DDR brought by the SIGPV framework.



Figure 5 – The SIGPV Framework web services running on a mobile device, enabling the upload of wine tasting notes.

5. Results and discussion

The Framework developed and, in particular, the prototype that has been implemented has shown great potential to support a context-interaction between consumers and business operators.

This approach represents a contribution that enables organizations to rethink their paradigms of B2C and CRM - in a future based on the increasing necessity of approaching the consumer to business agents.

SIGPV demonstrates how a bottle of wine can become a gateway to a much wider range of services that directly relate to the wine. While in the DDR there is a clear symbiosis between wine and tourism, we believe that the framework presented may be applied to a large number of other business areas. We also believe that the advantages and applicability of this approach are transversal and as far as consumers are concerned, they will enable an ubiquitous and contextualized access to services, allowing as well that business actors have a way to interact and develop new relations of proximity with their end-customers in an innovative way.

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Information management process in Continuous Improvement area at worldwide steel company

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Abstract: This article aims to present specific features concerning information management in the Continuous Improvement area of the Americas Long Carbon sector in ArcelorMittal. The aim is also to learn what the informational resources related to continuous improvement area and describe how the process of managing information actually happens. The study was based on theoretical models of Davenport (1998) and Choo (2006) and tried to understand how the efficient management of information can aid in decision making at organizations. The result of the documentary research revealed the existence of initiatives throughout the different units in the Americas and also revealed corporate tools for information management. The field research results indicate the need for a structured and formalized model of information management that responds to users in adequate time, while alert to the need for policies that encourage the sharing of information related to the improvement of processes, products and services.

Keywords: Information Management, Continuous Improvement, Improvement of Processes, Products and Services, Steel Company.

1. Introduction

To say we are in an economy based on knowledge or information has become a habit. However, until today just a few organizations integrate knowledge and strategies. There are several possible explanations for this phenomenon. The more likely one might be related to the fact that the use of the information strategies is much harder than to simply talk about it. (McGee & Prusak, 1994 p.17) For Drucker (2000, p.10), the companies have no choice but to become a company based on information.

Prahalad (1997) believes that a company actually controls its destiny when it has the ability to predict, uniqueness related to its business and ability to share. The companies that have flexibility to react to market changes are more likely to last. Having access of information is not enough. It is necessary to know how and when to use it.

It seems to be becoming increasingly the feeling that world events are rapidly converging to shape a world that is unique, integrated and which influences economic, cultural or any other traditional cross borders very easily. The implications of these changes are significant and affect all spheres of life, providing new challenges for all organizations (Parker, 1998, p.400).

An example of such changes is impacting the whole economy is the steel industry, which had been growing and according to Lopes (2007) would grow more.

In this optimistic scenario, in October 2006, Mittal Steel took over the majority of the shares of Arcelor and the company became ArcelorMittal, the largest steel group in the world.

It is necessary to emphasize that this study was conducted in an environment of growth and optimism in the steel market. Nevertheless, as of September 2008 the world economic scene has changed dramatically and all sectors of the economy have been affected. The economic crisis caused a drop in steel prices worldwide, reduction of new applications and more factories stopped production for a few weeks to reduce inventories. In this scenario, the year of 2009 will be crucial to redesign the way not only of steel industry, but the world economy.

The main objective of this study is to find out the characteristics of the appropriate model for the information management exclusively for the continuous improvement area in ArcelorMittal Long Carbon Americas.

2. Referencial Theory

2.1. Continuous Improvement

We must return to the concept of quality to speak about continuous improvement within the organization and the context of this research.

For some authors, quality can mean the fit for use. For audit process it means meeting the requirements of standards. In the business environment, the concept is tied to meeting the specifications of the products required by customers. To Garvin (1992) (apud Cruz, Rodrigues and Nagano 2007), it can be defined in four stages of quality:

1. Phase of inspection (reactive): Focus on the verification of compliance with the specifications of the pre-defined product;
2. Phase of the statistical process control (preventive): Focus on ensuring the uniformity of the product;
3. Phase of quality control (preventive): The focus comprises the tasks and the process beyond the products.
4. Phase of Total Quality Management: At this stage the focus is on overview of the organization, seeking to integrate different technical processes, operational and administrative, to the continuous improvement of management in the organization.

Campos was one of the main advisers of the cycle of PDCA (Deming Cycle), which stands for Plan, Do, Check and Action. According to Campos (1992), continuous improvement is related to two types of management: maintenance and improvements. Further, for the same author, are obtained through the PDCA and are maintained through the cycle of SDCA: Standard, Do, Check, Action.

ArcelorMittal has started the quality movement in different ways in each country. In Brazil, for example, it started in 1989 with Prof. Vicente Falconi Campos and has been developed nowadays. In Brazil, all units have an office of quality which is responsible for maintaining management model.

Within the company management model the improvements can come from a chronic problem or from an organization guideline through the strategic deployment.

2.2. Information and Knowledge

It has been very difficult to delimit the borders amongst the meanings given to data, information and knowledge. Davenport (1998, p.18) presents some characteristics of the three terms in order to make the distinction between them clearer.

Table 1 - Data, information and knowledge

Data	Information	Knowledge
Simple observations about the world state	Data endowed with relevancy and purpose.	Valuable information from human mind
Easily structure	Requires unit analysis	Hard to structure
Easily obtained by machines	Requires agreement of the meaning	Hard to capture from machines
Often quantified	Requires necessarily human measurement	Often tacit
Easily transferable		Hard to transfer

Fonte: Davenport ,1998, p.18

According to Nonaka and Takeuchi (1997, p. 64), information is a stream of messages, being the organizational knowledge created from the flow of this information and anchored in the believes of the knowledge owner.

For authors such as Drucker (2000, p.13), information is any data given with relevance and purpose. Data conversion into information requires knowledge. According to McGee and Prusak (1994), information is a key strategy in the organization, a strategic resource equivalent to labor, technology or capital.

2.3. The Intelligent Organization

Why do we speak so much about smart organizations? How could we determine whether an organization is smarter than another? Could we perhaps classify them according to its profitability?

According Gregory¹ apud Choo (2002, p.11), there are two meanings for intelligence: having the knowledge and create it.

Moreover, Garvin (2000 P.54-72) believes that successful organizations manage efficiently their process of learning. According to the author, a smart organization is an organization that learns and is able to create, acquire and transfer knowledge.

According to Edmondson (2008), most executives believe that efficient execution of their processes by production at the right time and in time delivery of products and services is the best way to achieve customer satisfaction and financial results. The reality is a little different. Even the most perfect performance can not assure enduring success in the knowledge economy.

The author proposes four stages for execution with a focus on learning: to provide guidance to the process, to provide tools that allow employees to collaborate in real time, to collect data and to establish a process of disciplined reflection.

According to Leonard-Barton (1998, p. 20), the departure point for a company to manage its knowledge is to understand its strategic skills, which represent a competitive advantage that is not easily imitated. They can provide a permanent advantage over competitors.

Choo suggests that the survival of businesses depends on their ability to process information about the environment and transform them into knowledge that enables them to adapt to change. This skill to adapt is a smart organizational characteristic and it is the key to have an intelligent organizational behavior in an environment of rapid changes. (Choo, 2002).

2.4. Information Management

Only when the information management is done knowingly and seen as a natural process, the organization will actually be based on information (McGee & Prusak, 1994). For these authors, information must be mapped, identified, categorized, and finally released. Firstly it must be identified what to be collected.

There is no right or wrong style, but the style most appropriate to the time the organization is experiencing. In one organization, several types of information management can co-exist.

Davenport (1998) described a generic process of managing information. According to him, each organization can set its process in a different way, with different stages.

1. Determination of requirements: The determination of the information requirements is a difficult problem, since it involves the perception of managers or employees involved in the process.
2. Capture: The acquisition of information is a system of continuous acquisition. It has three different activities: exploration of the environment - the required information is located and collected. Classification of information - the information must be categorized using criteria previously established. Format - The structure and format of information must be pleasant to the user. Distribution: It is necessary to define which and to whom information will be sent and choose the most efficient way for distribution.
3. Use: The use is the final step in the information management. Until it is used, it has no meaning. It is like a very efficient medicine in the closet or used inappropriately: it does not make the desired effect.

According to Davenport (1998) in order to improve the management of informational processes, we must emphasize the need for constant improvement of people and inter-related processes.

Choo (2006, p. 403-404) sees the process of managing information as a continuous cycle of six related cases. According to Choo (2006), information management should be viewed as the administration of a network of processes that acquires, creates, organizes, and distributes the information.

The efficient use of information is what Choo (2006, p.404) calls for adaptive behavior: a selection of actions directed at specific objectives.

Choo (2006) analyses each case from the perspective of the information administration whose responsibility is to plan, develop systems, services, processes and information resources.

1. Information needs identification: information is needed to reduce the ambiguities that indicate changes in the environment.
2. Information acquisition: it requires a plan to collect and share information by the organization sources.
3. Storage and information organization: it reflects how the organization notices and represents its environment.
4. Products and services information: it must meet the need of information of the organization members.

5. Information Distribution: The way information is disseminated and how it will be in the right place, right time and right hands.
6. Information Use: It is a result from the sense building, knowledge creation and decisions. In each case, the use of information is a social fluid and reciprocal process.
7. Adaptive behavior: the Company reactions interact with the other companies' actions and thus generate new signs and messages, keeping new cycles of information use.

The organization needs not just to interpret the environments, in which it is inserted, but to create, acquire and transfer new knowledge, changing the behavior before the decision-making process. "The key to understanding the organizations as information systems is to recognize the two anomalies that face all organizational activity: uncertainty and ambiguity" (CHOO, 2006, p. 417).

3. Research Methodology

The research was conducted by quantitative approach. It was applied and descriptive. Descriptive is proposed for further description of the real company area by studying the information management products and processes in this area. Applied is proposed to study a specific problem, the information management in the continuous improvement area in ArcelorMittal Americas.

To conduct this research, aware of the high geographical dispersion of the target population and the wide availability of information concerning key personnel of each unit in relation to information management, it was decided to hold a non-probabilistic sample. Thus, the search for this sampling plan was as follows:

Population: CEOs (Chief Executive Officer), Coos (Chief Operating Officer), VPs (Vice Presidents), Managers and Continuous Improvement professionals involved

Sampling framework: Continuous improvement and development area's employees of the Americas Long Carbon units.

It was adopted in this research: survey method, documentary research and bibliography search as data collection techniques.

The research instrument selected was the self-administered questionnaire, the questions were arranged to ensure no induction of certain patterns of response.

To ensure reliability of data, the questionnaires were made available through an internet site created specifically for this study. There was no identification of the interviewee whatsoever and the data was treated in total confidentiality.

After data collection, data were coded, categorized, classified, tabulated and had distribution of frequency defined. After entering data in the software and tabulation of these, descriptive analysis is followed by tables. We used unvaried analysis, by variable and analysis of associations between the variables.

3.1. Company Characterization

With strategically located plants, ArcelorMittal is present in 60 countries with over 330 thousand employees, an annual production capacity of 130 million tons of flat, long and stainless steel, which represents more than 10% of total steel manufactured in the world. In 2007, sales were over 30 billion euros and leadership in main markets: automotive, construction, appliances, packaging and industry in general, especially in the research, development and technology.

The research focused in the study of information management at the Americas ArcelorMittal long steel segment (LCA Long Carbon Americas) continuous improvement area.

The main objective of this area is to diagnose process, product and services' opportunities as well as to develop projects targeting on production increase or cost reduction.

4. Results

During the documentary research, several management information initiatives among Long Carbon Americas units were detected. Each plant is looking for the best way to manage its information using the tools available or creating new tools.

One of these initiatives is the Corporate Information System Management ArcelorMittal Long Carbon Americas (SIGA). It is the management information system used by the LCA that allows the monitoring of companies performance within LCA in Brazil, Argentina, Costa Rica, Mexico, in Trinidad and Tobago, Canada and the United States from its monthly management reports.

Worldwide the company uses BPM software (Business Performance Management), but for some specific reasons LCA works with the information in the SIGA before sending it to BPM. With SIGA system deployment there was an integration of all the information tools and systems, before dispersed in different systems and reports. The software now works as the main information repository on LCA management and it is used by all LCA units.

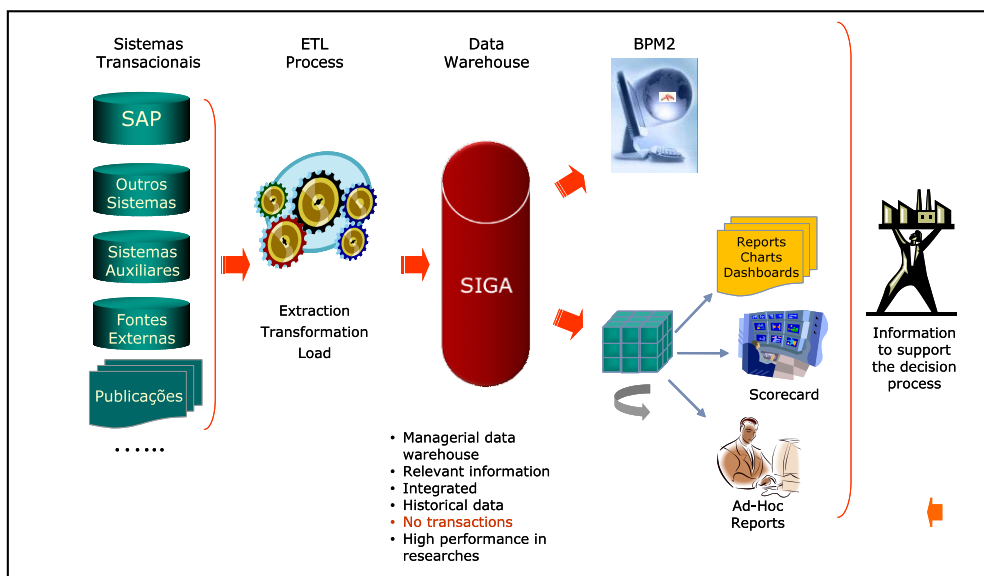


Figure 1 – Scenario of the management information after SIGA deployment. Source: provided by LCA Performance and reporting manager.

Other initiatives are the Global Cost Benchmark - GCB and Global Technical Benchmark - GTB. The objective of both databases is to standardize, collect, analyze and distribute comparable information across all units in the company. The first is focused on costs and the second on technical indicators.

The GTB uses the same kind of platform the GCB does, but besides the GCB tools, the GTB team developed SHARE, a problem solving software. SHARE, unlike the SIGA and the BPM, is oriented to the monitoring of technical indicators.

When SHARE was created various analysis tools were introduced in the program, which made the software automatically inform the user what project would provide the greatest impact on improving desired. At the same time the software indicates which benchmarking companies is available for contact. The SHARE analysis function allows studying the indicators interdependence so the user can best discern the problem.

SHARE's main function is to support the units to carry out technical benchmark, identify the indicators that have greater process impact. Data from SHARE respect the same taxonomy, measure units and calculation methods. The units are encouraged not only to feed their data into the system, but to use the software for procedure analysis, and use the data as a platform for planning their performance improvement.

SHARE relies on an assistant program that analyzes the data and presents a pareto graphic with a descriptive statistic summary. The software is a technical information repository as SIGA is a management data repository.

Another initiative is a corporate community called KMP - Knowledge Performance Management, which acts as practice community or as large groups to exchange best practices. There are groups or KMP communities formed to discuss the various metallurgical processes. These groups have representatives from all ArcelorMittal units and they have meetings periodically. The papers presented during these meetings are published in the KMP SharePoint. The SharePoint concept is that knowledge is only valid when it is available. SharePoint, GTB and other information repositories are concentrated in a single portal called Global Knowledge Management Program.

The survey was conducted from September 11th to October 7th 2008 with professionals linked to product, process and service improvement from LCA. Ninety invitation letters were sent out by e-mail with a link to a questionnaire on the Internet. The response rate was 57% (51 questionnaires). This rate was satisfactory considering the motivational efforts made and the occupational level of the people selected to enroll the survey.

Regarding the spot check, 61% of respondents are between 36 and 45 years old, 90% are male and 63% have an academic background in engineering.

The perception of 65% of the respondents is that the company has a formalized process as far as strategical information management. However, the answers point that the information management process is emerging and has some improvement opportunities.

This study adopted the Davenport (1998) generic information management model; it was used as a basis for the questions formulation and the grouping of responses.

4.1. Determination of the information requirements

The data indicates a difficulty in defining which are the information clients' demands. About 51% of respondents characterized the process of determining of information demand as informal or nonexistent. 49% of respondents characterized this process as structured and 60% of respondents agreed that people who generate the information are aware of their target audience and objective.

4.2. Capture of information

After you have set what the information needs are, the next step is to get them. The information obtaining process requires time, skill, insight and continuity. The research results show that in

LCA, the search for information related to processes, products and services improvement is conducted in an unsuited manner. Approximately 57% of respondents rated as inappropriate for the time spent collecting information.

The result of research shows that 83% of respondents are aware of whom to look for when information is needed. However 55% do not recognize the existence of organized file information. Therefore, we can infer that a large proportion of the information files related to improving production processes and services are scattered in the personal files. 75% of respondents rated as high or medium the level of difficulty for information recovery. The existence of an organized file is a variable that impacts the evaluation of efficiency of information management.

To learn where to find the information is very important although not enough to get it. A process for efficient search and retrieval of information begins by defining the terms of taxonomy, classification and archiving to enable rapid and efficient consultation for users. At the junction of the variables only receive the necessary information and the awareness of which to search for information, statistics were not significant. 70% of respondents disagreed with the statement that they only receive useful information.

4.3. Distribution of information

After setting, finding, sorting and formatting the information, you must deliver it to its destination. Getting the right information, at the appropriate time and the user who needs it are the steps to optimize the use of information. A well-prepared information in the hands of those who do not need it, it is a waste of time and effort.

Approximately 86% of respondents do not recognize a policy direction for the distribution of information. Data from research shows that the management information efficiency is linked to the existence of management information practices.

According to Choo (2002) the ultimate goal of distribution and dissemination of information is to facilitate its sharing. Data from research shows that the respondents recognize the need to share information within the unit and among units, but 75% of respondents have from very small to medium degree of willingness to share information ranging. The data research however, does not allow us to identify the cause of this phenomenon, but it suggests that some factors may contribute to the low interviewee's availability to share information, such as low efficiency in the provision process, products or services improvements in the unit, lack of encouragement policies to information-sharing and no lay-out to promote information exchange.

It is even interesting that medium or high availability to share information tends to agree that the company is using the knowledge already existing in the group. Thus, we are led to infer that even those with a willingness to share information, only would do it if it was internally.

4.4. Use of Information

Until the complete and efficient information is inert if not analyzed and used by the user. It is at this stage that the information comes alive, or rather, it gains sense and helps those who use it in the decision making process.

Although 82% of people agreed that there is the formal implementation of actions to improve the use of information, 70% of respondents identified personal contact as the main way to get the information necessary for these process improvements. The data does not allow us to conclude the reason why they prefer the personal contact. Meanwhile, another data revealed that 94% of respondents agreed that a centralized system for the exchange of best practices would facilitate the work of all.

With a centralized system or not, the company needs to make the information flow and find the best path to an effective use. The data showed statistical significance of the research associated to the variables efficiency of information management and the existence of procedures for the managing information process. What allows us to conclude that an important step in LCA information management process is define procedures for its operation. The system will only be characterized and noticed by users as structured and formal, then the process of standardizing the management and dissemination of new procedures to its users.

From the correlation analysis, four new variables combined were generated. However, it appears that the two most important variables combined carry about 64% of the information of the original system. This indicates that the relationship could reasonably be translated through these two new variables, reducing the size of the original system of four to two.

According to the analysis it was found that the characteristics associated with higher overall efficiency of a managing information system for the interviewees are the speed of response and formalization of the structure.

The use of knowledge and the file organization appears as issues related to both standards, efficient and inefficient, however were not decisive for the classification system of information management.

5. Conclusions

The research's main goal was to set out what are the features of the appropriate model for the management information at the continuous improvement area in ArcelorMittal Long Carbon Americas.

The research data showed that management information to processes, products and services improvement efficient in LCA has two main features: it is a formalized process and it must have quick response in information search.

Despite several initiatives towards the information management nowadays, most respondents do not have a clear vision of where to get the necessary information; they recognize the rework and have medium level of willingness to share information. Data from research shows that although the respondents still prefer to share information internally, they are willing to share information as long as the system is structured and formalized.

SharePoint is the initiative with the greatest potential to become a global ArcelorMittal tool for official information management activities. For the SharePoint to become something more than a information repository, research data allows us to conclude that there must be a structured process of information management as a whole. The process must be formalized, standardized and official with clear procedures which should be disseminated throughout the company.

Research data also showed that respondents use personal contact as main source of research and information exchange, having e-mail as their most used tool.

These figures lead us to conclude that for technical information to be disseminated, personal contact is very important. A tool that can help the dissemination and sharing of information is the practice community where the members can meet regularly in person or through video conference.

To lay out all the information available for improvements that are being or will be developed is still an idea that may not please people involved in the development of new products, for instance. Thus, the community members should be accepted by the responsible member, and his stay may be subject to its contribution for the group.

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7. Notes

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Collaborative, Networked and Virtual Organizations

Lifecycle Supply Chains: Net-Concerns' Value Added Appraisal

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Abstract: The product-service provision is eco-protection demand, requiring innovative entrepreneurial organisations, in which the on-duty conformance-to-use preservation and certification and the end-of-life take-back, with compulsory recovery targets play critical relevance. The required competences appear *externalities*, by respect to the *internalities* of the old manufacture practice, and the networking options provide winning technological aids. The paper analyses alternatives, at different facility/function levels of integration, outlining a procedure for their effectiveness appraisal. The scheme is centred on the bottom up series of checks, to evidence of the return on investment form below, so that the partnership is permanent motivation spur, fostering competition through the properly established facility/function trading.

Keywords: Product Lifecycle Management; Reverse Logistics; Product-Process-Environment-Enterprise; Ambient Intelligence; Virtual enterprise.

1. Introduction

The ecology demands are dramatic changes in the industrial economy trends. The affluent society paradigm, based on the manufacture efficiency, transforming raw materials, into mass products, fast increasing pollution and waste, is facing imminent limitations, to safeguard the future mankind. It is difficult to accept the today populations' absolute privilege of exploiting the earth resources, when the entitlement is the fact of being the first to get their possession. The impending eco-regulation is entangled question, presently made rather critical, in times of economic recession, as the mandatory restraints are seen severe charge, forbidding full access to immediately spendable riches.

In the note, we try to outline the knowledge entrepreneurship way out (Michelini, 2008), based on the value added in intangibles, assured by two main opportunities:

- the resort to product-service deliveries, imposed by the lifestyle manufacturers' responsibility;
- the net-concerns' efficiency, obtained by clustering facility/function fit-for-purpose capacities.

The issue is technology-driven construct, offered by the information and communication aids, to aim at advanced entrepreneurial settings. The emerging net-concerns have to incorporate the ICT, as instrumental business support of the lifestyle supply chains. The technicalities cover a series of prospects, such as:

- design, manufacture, trade, service and bookkeeping fusion;
- net-enhanced product-service deployment organisation;
- forward/backward logistics information flow integration;
- resource productivity management and imbalance recording;
- customers' relationship and certification establishment;
- supervisors' accreditation and eco-vaulting administration;
- entrepreneurial project and partnership clustering appraisal;
- facility/function market and broker negotiation/incorporation;
- interoperability ruling and in-progress achievement assessment;
- networking value added and return on the collaborative course.

The technicalities are necessary prerequisites. They are not sufficient for the listed issues' success, unless the eco-rule and trade guidance oblige selecting innovative business organisations, where the prospected ICT opportunities are crucial instrumental aid.

The advanced enterprise challenge, consequently develops on three successful occurrences:

- the compulsory lifestyle transformation of the manufacture entrepreneurship;
- the ICT pervasiveness, and the networking agility, leanness and return potential;
- the profitably transparency of the co-operative production and business projects.

The analyses moves from series of studies, recently carried to explain the strict correlation, tying the durable growth, with the service engineering and reverse logistics, because of twin fall-off: the maximally intangible value chain; the complete visibility of the tangibles' productivity. The closing remarks suggest hints for short-term accomplishments.

2. The Product-Service And Eco-Provision

The lifestyle provisioning is deemed to be standard issue of future industrialism, foreshadowed by the «externalities» to «internalities» interlacing of the supply chains, where the *net concern* settings become forced solution, in view of incorporating the facilities and functions, to make the delivery feasible. The analysis aims at defining the metrics, to compare the related performance, in terms of intra-organisational ties, since the legal, administrative, etc. aspects indifferently allow reaching the enacted bylaws (Acaccia et alii, 2007a), (Michelini & Razzoli, 2007).

The analysis, on these grounds, does not look at technology-driven guesses, rather at factual set-ups, requested by the manufacturers' responsibility, each time the product is put in the market. The lifestyle entrepreneurship is, presently, motivated at two levels (Michelini & Razzoli, 2004a&b):

- the on-duty conformance-to-use certification, after proper maintenance and regulation, basically, ruled by means of voluntary agreements, binding the suppliers to the purchasers;
- the end-of-life take-back and recovery (reuse, recycle) accomplishments, according to the enacted compulsory targets, fulfilled and recorded by the authorised treatment facilities.

Both levels entail externalities, namely, actions outside the point-of-sale, when the items are fully enjoyed to the buyers' profit, but their lawful operation needs to satisfy the eco-protection acts. The environmental safeguard requires choices, taken at the design step, and series of accomplishments, which are standard completion of each provision, suitably detailed into the PLM, *product lifecycle manager*.

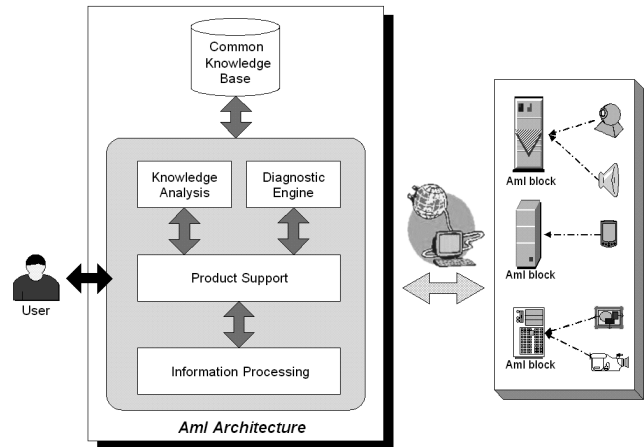


Figure 1 – The PLM-SE set-up, managed by advanced enterprises

The eco-defence exemplifies the main externalities, as compared with the earlier internalities of the manufacture business. It portrays engagements taken by the consumers (producers and users), to be allowed withdrawing the given natural capital, namely, borrowing raw material, transformed in pollution and waste. The consumers' debt is ambiguous (fraudulent?) affair, because the sponged off natural capital is downgraded (with entropy increase), and the damages are, up now, left vague, even if the overall appraisal is performed by independent third parties (governmental authorities or notified certification bodies) (Michelini & Razzoli, 2007). The eco-protection, as a result, is emerging activity, needing regulation, enacted by the national authorities, according to EU directives, and harmonised, to assure worldwide equivalence. The promising business will profit of co-operative nets, according to different schemes:

- the manufacturers keep in charge the all service: provision, lifecycle conformance and disposal deeds, so that the trade regulation depends on single indentures;
- independent actors profit by the safety rules and environment acts expansion, to become service dealers, with technology oriented qualification and infrastructure-based organisations.

The schemes exploit suitable PLM information aids, service-engineering oriented, i.e., PLM-SE, in the first case, or *reverse-logistics* oriented, i.e., PLM-RL, in the second one. The entrepreneurial set-up involves several competencies, however, the lifestyle supply chain asks for the suited design pre-setting, as necessary manufacturer's task. The company without proper know-how is compelled to out-source major duties, lowering its competitiveness, in front qualified opponents.

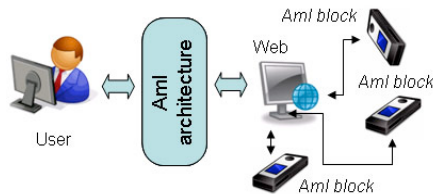


Figure 2 – The Aml aids functional modules in real-life mission

The eco-protection is growing domain, with number of impending bylaws. As preliminary glance, we might quote (Acaccia et alii, 2008), (Michelini & Kovács, 2002):

- the conformance-to-use preservation and certification, rightfully assured by voluntary agreements, to guarantee the buyers through self-consistent product-service delivery;
- the end-of-life take-back, today included in the manufacturer’s responsibility for given durables, to accomplish the enacted recovery (reuse, recycle) compulsory targets.

The situations, in the existing industrial contexts, are well exemplified by advanced enterprises, in which the lifecycle *externalities* are part of the business mission, Figure 1, turning the company’s skill, to the lifelong service delivery (Anufriev et alii, 2007), (Kopàcsi et alii, 2006). The remote service duty is highly enhanced by resourceful and friendly interfaces, which incorporate ambient intelligence, AmI, aids, Figure 2, to support users’ pleasant access (Michelini & Razzoli, 2008a). The ability of taking profit of the existing technologies, and transforming the eco-defence acts, into business assignment, is challenge, tacked by innovative and motivated companies, ready to draw focused contracts, and to widen the conventional trade course.

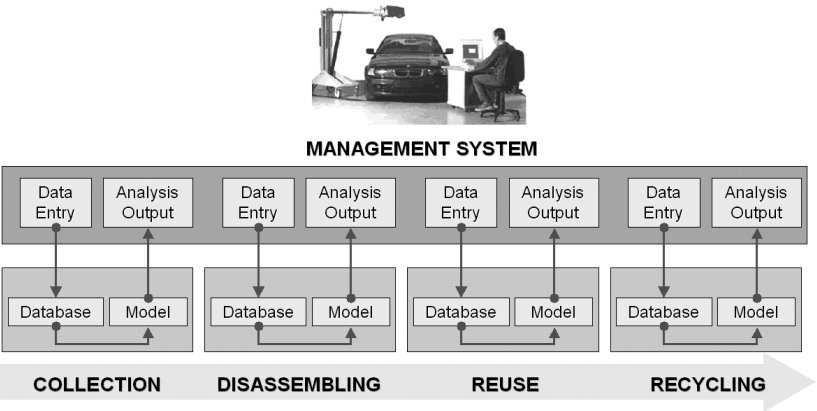


Figure 3 – The knowledge build-up in the ELV reverse logistics

In front of mandatory bylaws, the chance to remain in the market obliges strict policies, where the added commissions have to play the enacted role, should or not the company equips accordingly. In first instance, e.g., the reverse logistics is beyond the conventional manufacture capabilities, Figure 3, and the (conservative) carmakers might prefer concentrating efforts on the core activity, and leaving the *end-of-life* vehicle, ELV, treatment to external organisations.

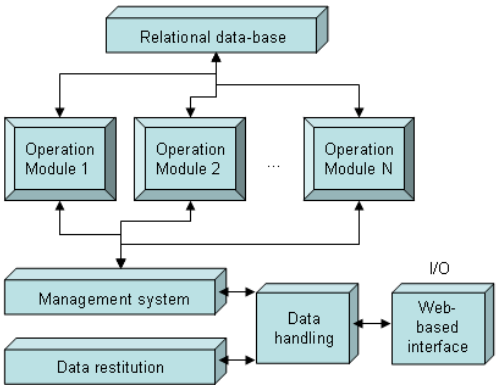


Figure 4 – The reverse logistics flow simulation/appraisal tool

The choice is not without risk, whether the competing carmakers will confront with offers,

having dissimilar overall (call-back included) cost. The producer's responsibility leaves little respite, once the actual charges' visibility cannot be disguised into local administrative inefficiency. The critical instance deserves careful analysis (Acaccia et alii, 2007b&c), combining material and information flow efficiency, by the negotiation, incorporation and exploitation of the special facilities/functions, each time necessary. The knowledge management, Figure 4, broadly profits by networked operation nodes, sharing the *product-service* data-base, linked, to aim at the optimal processing effectiveness of the industrial efficiency.

The eco-charges' transparency is primary enabler of the business effectiveness. The capability of creating entrepreneurial organisations fully encompassing the lifestyle *externalities*, within standard business *internalities*, is challenge to come, in front of the pervasive eco-acts, impelling to shift into business models, whose return shall maximally depends on the knowledge management aids, due to the embedded information and communication technologies.

3. Function-Facility Assembly Incorporation

The mentioned example set-ups are consistent with *controlled* collaborative net-concerns, linking suppliers and clients, for value added chains, which make the *product-service* course transparent to the certifying bodies, through checks and conformance assessments. The all might be appreciated as extraordinary job creation mechanism, with, however, different possible issues:

- the *governmental agencies*, opting for the administrative ruling, without free competition;
- the *net-concerns*, aiming at opportunistic task arrangements, under third party overseeing;
- the *virtual enterprises*, performing the duties under the service ruler, on self-consistent bases;
- the *extended enterprises*, keeping the duties, as firm's lifestyle provision accomplishments.

At the project range:

- *knowledge dissemination*: the information flow and decision-support tools acknowledgement and evaluation are managed, in order to appreciate the networking effectiveness;
- *operation programming*: the business is stated, setting the partnership strength and acceptance interest, to fix the set-up details, duty schedules, node responses, audits plans, and the likes.

At the concern range:

- *net-concern participation*: the negotiation and setting of the listed series of accomplishments are run, to account for the individual intra-organisational requirement;
- *co-ordination acceptance*: the assessments, advices and guidelines of the collaboration frames are dressed, to guarantee the pertinent integration sharing.

At the node range:

- *involvement obligations*: the task allotment, given the supplier/receiver and inner/outer lists, is applied, to verify all the involved nodes competencies and provisions;
- *audits/reviews schemes*: the audit/review schemes are acknowledged, to establish the periodic and emergency measurement schedules and on-duty acceptance tests.

Figure 5 – The networking association effectiveness

The first does not include enterprise's risk, and pricing is chiefly affected by political biases. The efficiency, with the second, is confined at the networking options, above all, because of the process visibility. The subsequent ones profit by computer technology aids, though, at different integration levels. The *virtual* enterprise (Michelini, 2008) is distributed assembly of

facilities/functions, linked by the common project, to expand the business and to enhance the partners' profitability. It operates as single company, when the *externalities* are viewed by the clients, without, however, full interplay with the producer's *internalities*. The *extended* enterprise is the step ahead, if the *product-service* is entirely conceived and timely delivered by the main manufacturer, with resort to pertinent partners, assuring the complement competencies.

- The standard product data: physical representation; producibility; operation running, quality, cost and affordability; lifecycle requirements; use and maintenance directions; dismissal instructions;
- The standard manufacturing data: materials procurement and processing, assembly and disassembly; quality testing and conformance assessment; packaging; re-manufacturing;
- The standard environment data: voluntary agreements for low pollution and high remediation; mandatory targets to rule recovery (reuse, recycle) and safe dumping;
- The standard enterprise data: business functions: trading strategies, finance/resource management, etc.; operation functions: facility and job management, scheduling and planning, etc.; other project data.

Figure 6 – Knowledge manager: characterising data-bases

The networking advantage, Figure 5, is complex issue, with overall prerequisites at the project range, due to the involved knowledge. At the partners' co-operation level, the roles require feasibility and leanness checks. Then, each participant has to acknowledge the team's relationships. Dealing with the eco-defence, the project knowledge covers, Figure 6, the product, the process, the environment and the enterprise, the **2P2E** frames, with the extension of the old **2P** simultaneous engineering practices, taking in the lifestyle *externalities*, to incorporate the needed service-oriented facilities/functions.

- Co-operative development of the technical construction files, with resort to virtual prototyping, to predispose the lifecycle overseeing, call-back and recovery duties;
- Decision support during manufacture, by simultaneous engineering, aiming at scope economy for buyers satisfaction, on-duty and end-of-life service included;
- Facility/function up-dating, suitably driven by the lifestyle product-service eco-footprint control, all along the supply chain emerging requirements.
- On-duty observation for control, diagnostics, maintenance, repair, etc., through conformance-to-specification checks, functions assurance and impact assessment;
- Monitoring help for the supply chain eco-management, with data transparency of provisioning, maintenance, recovery, recycle, reclamation and dumping;
- Off-process ascertainment channels, to measure the resources consumption and the remediation requirements on the all (forward/backward) supply chain.

Figure 7 – Characterising capabilities of the extended enterprise

The net concerns pertain to the new technologies, with many stakeholders: users, networkers and developers, service-providers, equipment manufacturers, software producers, access managers, etc., all actively engaged in conceiving new options and issues. The intangibles' provision, directly and indirectly, co-operates to the value added increase. The indirect features help modifying the users' habits all over the supply chain, to add transparency to the allotted goods and functions, and related eco-impact. The consumers start recognising the differences in the competing alternatives; visibility becomes the spurring for conservative choices. The net organisation permits to cover three areas:

- the inner cluster, to link nodes collaborating to manufacture and to manage the product-service;
- the outer lines, for the buyers' assistance and conformance appraisal at the point-of-operation;

- the selective bonds, for the overseeing bodies access, and the eco-certification/accounting duty.

The first area affects the suppliers' infrastructures. The other two are *service* features, at present, ruled by *voluntary agreements* or by *mandatory functions*, in the producers' *lifestyle* responsibility schema. The *extended* enterprise, Figure 7, typifies by self-sufficient information frames, with unifying context, to fulfil the *product-service* delivery. The example characterising capabilities are crucial in achieving suited eco-conservativeness, through fully structured entrepreneurial profitability. They help explaining why the net organisation is necessary technology.

- Varying-geometry boundaries, to expand over every view specifying the *products-services*;
- Embedded simulation-emulation tools, to allow virtual behavioural experimentations;
- Co-operative infrastructure, to support problem-solving issues, open to multiple-domain experts;
- Automatic propagation of changes, with consistent updating of the super-model data-frame;
- Straightforward evaluation of alternatives, trends, risks, etc., based on reliable relational schemes;
- Rapid producibility, affordability, etc. analyses, performed via intelligent decision support;
- Fast and accurate exploration of lifecycle occurrences, to broaden concept-to-production figures;
- Efficient archival of globally accessible knowledge-bases, readily available in the current activity;
- Ubiquitous service through the *extended* enterprise, enabling effective, inter-operable tools;
- Any similar opportunities of advanced PLM surroundings, that the present IT tools can provide.

Figure 8 – The product-service lifestyle knowledge infrastructure

The benefits of interactive communication nets, out of the function of linking people, anywhere in the world, come from their capability to grant the job «visibility», enabling the direct control on the organisation efficiency and the transaction real usefulness. Both aspects were in the shadow in most of the bureaucratic accomplishments, leading to hide productivity, if the cost is, simply, transferred to the citizens, through fiscal measures. The knowledge society, from this standpoint, is qualifying progress, at least, at the operation transparency and instrumental neutrality.

The knowledge infrastructure, Figure 8, characterises by a set of aspects (Michelini & Razzoli, 2008b), having unifying motivation in the business project, even if enforced by mandatory bylaws. On such premises, the advanced enterprise's solution is achieved after incorporation of all *externalities*, into suited company's accomplishments. For sure, the usual manufacture making does not yet cover the SE and RL duties, ending at the *point-of-sale*, not to be involved in *point-of-service* and *end-of-life* tasks. The *extended* enterprise challenge, thus, is bet worth to be investigated.

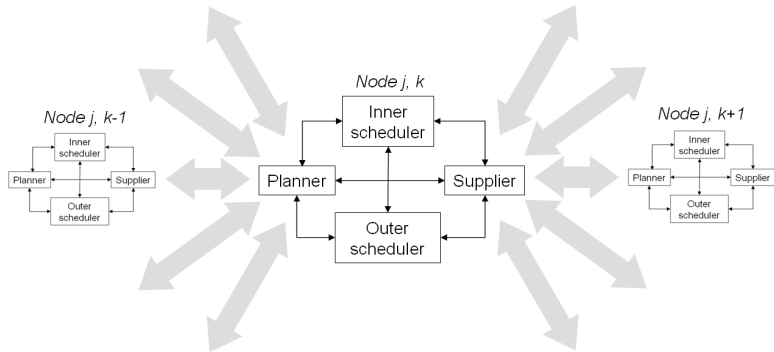


Figure 9 – The two-port local planner/supplier node, with inner/outer scheduler

The idea is to distinguish the technicalities, namely, the facilities/functions timely needed by the *product-service* delivery, from the factual corporate assembly. The «buy or do» axiom suggests the extension to look at the «enterprise's capability» as dynamic allocation of facilities/functions, to be developed into the **2P2E** frames, ceaselessly modified, depending on the lifestyle demand. The **2P2E** integration is just the step ahead of the earlier **2P** practice. The advanced enterprise, so, develops as cluster of nodes, interfaced to fulfil the each time arising business project demands. The partnership exploits balanced scorecard, to fulfil the information *planner-to-supplier* cross-flow, with the local-to-global perspectives planning, Figure 9. The local tier plans the *two-port* cross-flow, using the *inner-outer* scheduler, in view of the intra-organisation prospects.

With focus on the *planner*, the job handles the input requests. The case reverses for the *supplier*, which has to deal with the subsequent nodes, assuring their right satisfaction. Every local tier sorts out many-to-many relationships. The node fixes its inner setting, amalgamates the planner/supplier work-flow, and generates the schedules for the aggregation duties. The net concern allows:

- the team partner: to establish the value delivery flow; to create the mission-driven service change; to explore the self-mending measurements; to ensure the behaviour accountability and recording; to allow the allotted tasks negotiation; to help defining trends and detecting out-of-bound threats; to retain liability for calling and running the reviews and executing any decisions; and the likes;
- the business ruler (dominant trader): to intervene when the nodes run into problems; to ensure the consistency of the overall assessments; to define the policies and to decide corrective actions; to negotiate the contracts; to establish any general rules, assuring the project progression.

- The *transition* fixes the local tier behaviour, giving the *planner/supplier* schedules, conditioned by the *inner/outer* perspectives;
- The *inner* perspectives, showing the local performance, through standards, taken from the shared measures list, to express the assessments after cross-examination;
- The *planner* schedules, giving the joint assessments of the node and each of its feeders, eventually averaged, through measures drawn from the standard performance measures list;
- The *supplier* schedules, providing the integrated output interface, jointly weighed with each client, using the shared performance measures list, from the averaged cross-flow raw data;
- The *outer* perspectives, adapting the pooled requirements, drawn from the shared performance measures list, to give the output affecting the involved net-concern nodes.

Figure 10 – The node behaviour in the bottom-up collaborative network

In abstract, the business ruling means to manage the supply chain, transmitting the rising deeds to the partners, and enabling bottom-up collaboration, Figure 10, aimed at fulfilling the business project. The *net-concern* value added appraisal is established in the deliberate self-ruling frame, by timely specifying the supply constraints, raising at the stage of project between co-operating partners, or at more structured stages of *virtual/extended* enterprises, with lawful responsibility on the delivered *products-services*.

The performance assessment permits understanding the networking value added. The appraisal, at the unstructured stage, of course, makes sense at the node level only. The remarks that follow, even so, suggest using a method consistent with the surroundings *complexity*. At the *virtual* or *extended* structured stage, the bottom up appraisal permits distinguishing the each partner's benefit, out of the overall project profitability. The method is sketched in the following, to promote the entrepreneurial spirit towards the advanced enterprise's solution, once assessed the return on investment.

4. Business Infra-Organisation Appraisal

The assessment method is based on two assumptions (Cunha & Putnik, 2006), (Michelini, 2009):

- the existence of the appropriate facility/function market, from where picking up the partners, each time assuring the requested competences and capabilities;
- the availability of lawful and smart negotiation, assemblage and management aids, through which the dynamic corporate up-dating becomes standard option.

For explanatory purpose, we distinguish three infrastructural levels:

- the networked affiliation, the linked (independent) partners co-operate without sole and permanent bonds, with the value added of the information and communication technology tools;
- the virtual enterprise, the net-concern builds on the unique business project, with partners' bonds, enduringly oriented at the product-service provision, under tying legal constrictions;
- the extended enterprise, the net-concern establishes under the responsibility of the manufacturer or equivalent representative, who keeps the product-service provision total liability, (Michelini & Razzoli, 2005).

At the node range:

- *assessment aids*, the facilities set-up evaluation avails of decision support tools, to deal with the feeder/receiver and inner/outer perspectives;
- *impact certification*, the eco-consistency is assessed, and the conformance-to-use checks are assigned to (third-party) accredited bodies;
- *issues monitoring*, the co-operation (cost, time, conformance, quality, etc.) is granted full visibility, and the predicted compatibility is shown;
- *shared metrics*, the nodes standards are taken from agreed measurements list, with the accord to establish, revise or cancel out the metrics.

At the concern range:

- *control and govern*, each node operates in autonomy, performing decision keeping and issues communication, to allow on-process interaction;
- *deployment trend*, the ability to create 'value' goes behind the performance measurement, by training/learning aids, based on up-graded net-concern setting;
- *duty organisation*, clear-cut responsibility manages allocation, co-operation, achievement, etc. tasks, specifying goals and clout, to develop and manage the business;
- *integration modes*, the facility/function market is accessed, to find out, negotiate and assemble the partner cluster that grants enhanced deliveries.

At the project range:

- *policy and objectives*, the business consistence and appropriateness are analysed as overall outcome, using market-driven cost/benefit figures;
- *strategy choice*, the performance figure is dealt with for the strategic resetting, guaranteeing the involvement (and assent) of all (active) partners;
- *tactical setting*, the current facilities/functions steering is done by the business ruler (dominant trader), according to the chosen policy and objectives;
- *up-grading planning*, the net concern is thought with evolving structure, through new partners and facility/function incorporation.

Figure 11 – The node self-evaluation prospect

The bottom up performance measurement deals with node and network properties. The node is the unit service having the responsibilities to formulate, detail and distribute the information concerning the locally allotted directions and requirements of the co-operating partners. At the lowest stand, the efficiency depends on the networking virtues (out of the all product-service

conception and ruling), permitting the value added deployment. The examination covers a set of accomplishments, used as self-assessment check of the business profitability, Figure 11. The weigh and rank of each (twelve) self-assessment tests depend on the application, and change, when the policies and/or objectives modify. The overall figure is important to assess the networking value added, notably, when the eco-service duties are performed within administrative regimes, under governmental authorities.

At the node range:

- *efficiency*, the entrepreneurship value is affected by the information hurriedness, completeness and reliability exchanging/managing among the business partners;
- *involvement*, the partnership aims at co-designing, co-producing, co-selling, co-supporting the delivery to customers' satisfaction and third-parties' protection;
- *partnership*, the net-concern nodes are, or not, linked hierarchically, dominated by the market objectives and co-operation abilities;
- *technologies*, the core-competency compatibility allows the organisation effectiveness, by net and decision tools, to make the integration work.

At the concern range:

- *collaboration*, each one treats the other as business partner, allowing and accepting the other requests, in view of the chosen business;
- *duration*, within the project scope, the nodes share unified vision, and work to accomplish the product-service delivery;
- *integration*, the business ruler (configuration manager or dominant trader, only) resorts to brokers' help for facilities/functions negotiation and incorporation;
- *ruling*: the decision-making aims at best-use of the partners' competencies, with account of the scheduled common goal, subscribed at the cluster setting/resetting.

At the project range:

- *communication*, the information sharing, on-line and in real-time, needs to grant in-progress collaboration up-dating, between autonomic units;
- *drivers*, the supply chain complexity, covering multi point-of-service engagements, requires the manufacture and provision clustering comparable sophistication;
- *size*, the setting occurs among the nodes and across the value chain, dynamically adapting the partnership to the on-progress supply chain;
- *structure*, the fitting will take the form of net-concern, where each partner is a node (with one or more input and output links).

Figure 12 – The virtual enterprise value added checks

The assessment procedure is above all important for partners operating within *virtual* enterprises, to fulfil the analysis by respect of competitors, Figure 12, in view to adjust the cluster «instantiation», up to the most effective functions or facilities incorporation. The evaluation of the entrepreneurial know-how becomes instrumental to derive and propagate the new forms of network-based industrial organisations. The eco-duties, fixed by administrative bylaws, aims at infra-organisational settings, with organisational managers and integration brokers (Michellini & Razzoli, 2008c).

At the node range:

- *involvement*: the service provision is standard duty, because the right facility/function competencies inclusion is fully defined by the ruling manufacturer;
- *partnership*: the three-party scheme binds the suppliers (product/service dealers), the buyers and the certifying body (for the results overseeing and recording).

At the concern range:

- *integration*: lifelong responsiveness admits business assistants, out of the main manufacturer, operating under proper accreditation;
- *ruling*: the provider's commitment is fixed through voluntary agreements with the clients and, when requested, compulsory achievements with the governmental authorities.

At the project range:

- *drivers*: the stipulation covers the product lifecycle, fully engaging for the conformance-to-use service and end-of-life take-back, with account of the enacted eco-regulations;
- *structure*: the net-concern has to reach self-consistent lay-out, confining the «virtual» setting, to brokers/agencies, only, for facilities/functions choice and appraisal.

Figure 13 – The extended enterprise value added checks

The lifestyle provisioning requires a responsive trader, allied with all pertinent partners, in view of optimising the business opportunity, at the buyers' satisfaction and the environment protection. The networking effectiveness, Figure 5, depends on the interplay with the control agency, Figure 11, or on the service integration of the supply manager, Figure 12. The project overall betterment needs series of accomplishments, at the intra-organisational setting, ruled, typically, by the main manufacturer, Figure 13, when the network configuration manager overseen the all product-service value chain.

The transition from the net-concern and *virtual* setting, to *extended* enterprise, involves revising the business integration at the entrepreneurial level, now, based on the overall supply chain unified responsibility, with incorporated *externalities*, carried within *internalities* scopes. Being permanent achievement, the *extended* enterprise has the company ruler, managing the necessary facilities and functions, in view of optimising the unified provision and the eco-protection duties.

The permanent supply of on-duty and end-of-life eco-services needs obviously to turn towards the *extended/virtual* enterprise levels, as the government administered level has hidden cost, not easy to remove. The *virtual* vs. *extended* enterprise choice depends on the local entrepreneurial context. If no advanced enterprise develops, the factual replacement is encouraging outcome. The efficiency in this dilemma requires distinguishing the internal viewpoints, where the self-assessments are carried on the bottom up base, from the external viewpoints, where (by the top-down project/concern/node logic) the single partner ranking is accomplished, to appraise the all infra-organisation value added, Figure 14. The evaluation, additionally, discerns the *extended* and *virtual* enterprise cases, in terms of intra-organisational features, along with the above outlined checks.

At the project range:

- *brokerage aid*: the business ruler and the on-the-market facilities/functions intermediation can be carried by a domain broker or forced by the governmental agencies;
- *function/facility market*, the core-competencies to be incorporated by net-concern are accessed from the facility/function market, after specific enquiry;
- *facilities assembly*, the entrepreneurial assembly will identify the (stable) *extended* enterprise, either address the current supply chain *virtual* set-up;
- *re-setting rules*, the supply chain servicing and end-of-life call-back imply incessant up-dating of the net-concern partnership, to include the pertinent facilities.

At the concern range:

- *information system*, the scope and organisation are ranked by competitive comparisons, using benchmarking indices;
- *business ruler*, the business opportunity is made-up to entail worldwide leadership, having vision of the sought market share;
- *net management*, the productive lay-out, support services and business processes are sustained and ruled by the transparent partners co-operation;
- *strategic enhancer*, the timely included core-competencies are ranked by the innovative jobs synthetic figures and by the resulting net-concern complex outcomes.

At the node range:

- *local leadership*, manufacturer's responsibility requires defining the reference dealer, even if specific/shared charges are managed according to contract rules;
- *notification duties*, the environment protection, is subjected to the enacted mandatory targets, and the issues are notified to the overseeing authority;
- *operation achievements*, the on-duty monitoring and conformance-to-use assessment are co-operation demands, to make transparent the responsibility ascription;
- *customer satisfaction*, current and final approval is ruled by voluntary agreements protocols, in extension to the enacted compulsory targets.

Figure 14 – The networked organisation overall effectiveness

The external viewpoints are helpful indicator, to estimate the intra-organisational entrepreneurial deeds, listing the business integration main features, Figure 14. Dissimilar lists are possible; the choices are suggested, based on the selected economy of scope policy. The combined top-down/bottom-up networking value-added benefits evaluation shows the potential of the partnership build up. This is important from the 'node' standpoint, to appreciate the temporary aggregation/merging, to answer a given business project. The process is deemed to evolve bottom up, as the single function/facility provider is supposed to have self-sufficient autonomy, and to negotiate the partnership, after that the advantages are properly weighed up.

The bottom up performance appraisal needs to comprise all the measures made between the group of *planners*, and the ones between the group of *suppliers*, with the overlapping risk, which, always, affects the complex structures. The value added measurement at the tier's cross-flow depends on the local viewpoints, and shall be smartly balanced, Figure 9, by the intra-organisational prospects. The top down finding is less sensitive to complexity drawbacks, but cannot exploit sharply defined metrics. The devised procedure, anyway, provides preliminary guesses.

The partnership dynamic negotiation, integration and up-dating are wholly linked to the ongoing *product-service* delivery. The business does not end at the point-of-sale; it expands at the points-of-service (for control, maintenance, conformance assessment, restoration, etc.) and includes the take-back of the end-of-life items (for recovery-reuse-recycle targets and waste damping duties). Today, the manufacturers' affairs, mainly, end at the point-of-sale, with the tiny exception of the operation instructions and maintenance data sheets, given by the product

lifecycle management, PLM, aids.

The net-concern new business opportunities largely go beyond the traditional manufacture duties. It permits linking partners co-operating within the common project, assembling the single expertise, to add the matching capabilities, whether required. The function/facility assembly, to allow lifestyle supply chains, is efficient answer, keeping the core activity even when non proprietary abilities are involved, and the accomplishments are enforced by law. The business project leads to competencies addition, to be built around (closest as possible to) the supply chain, for the buyers' satisfaction and the environment protection. The networking, at the concern range, implies effectiveness through the information infrastructures, by series of opportunities in the data-base management, communication transparency and collaboration ruling.

The evolution from the *networked* affiliation, to the *extended/virtual* enterprise organisations will develop, when the technology-driven actors exist, having the suited ICT competence and capability, on the further condition to be the economically sound answer of proper socio-political requests. The framework will settle up the pertinent function/facility market, with annexed backing and brokerage aids, to make possible assembly the complementary organisations. The assessment procedure is just a step of the interplay, is critical in showing the return on investment.

The example cases discussed in the investigation suggest to separately tackle the *on-duty* backing, where advanced enterprises could eventually deploy, based on efficient PLM-SE tools, drawing up, on *voluntary agreement* basis, the lifestyle business. The *end-of-life* duties bring to rather different situations; here, the specified recovery (reuse, recycle) targets are enacted compulsory bylaws. The administrative ruling by governmental agencies happens to be heavy burden, with the huge opacity in the cost build up, only slightly mitigated with resort to *networked* affiliation nodes. The *extended* enterprise solution maximally depends on the manufacturers' capacity to fit in the full *externalities*, as current economy of scope accomplishments. The *virtual* enterprise alternative is transitional step, to be carefully appraised on the reached profitably.

5. Conclusions

The «service» value added in the times to come is important, to turn the wealth build-up towards «intangibles», following the «to de-materialise» axiom, by which, in lieu of «material goods», the trading exchanges «functions». Here, the opportunity is moved a pace ahead, looking at the market changes, promoted by the extended manufacturers' responsibility, requiring their involvement in the lifelong supply chains, for the provisions conformance-to-use certification and end-of-life recovery (reuse and recycle). These changes entail aiming at the networking advantages, hence, with account of the outlined study, at the different possible outcomes: *governmental agencies*, *net-concerns* and *virtual/extended* enterprises. The evaluation of the cost/benefit ratio, each time, achieved is relevant requisite, both, for immediate course, and for longer terms fall-out.

Explanatory hints are obtained, considering the regulations, foreshadowed by the EU directives. The eco-protection for the on-duty common durables (cars, home cauldrons, etc.) requires periodic conformance-to-use checks, charged to the users, as the producers' responsibility ends at the point-of-sale; the fee is fixed at the administrative level, incorporating the governmental tax. Recently, the *free* take-back of *end-of-life vehicles* and of *waste-electrical-electronic-equipments* is obligation to put in the market the items, with mandatory recovery (reuse, recycle) pre-set targets. The assembly of accidental *net-concerns*, eventually assuring the on-duty conformance-to-use certification, is here out-of-date, and for, e.g., the *end-of-life vehicles*, three issues come out:

- the deposit-refund scheme (Sweden model), the cost is fixed by the governmental agency, which oversee the lawful accomplishment of the compulsory reverse logistic demands;
- the visible-fees scheme (Dutch model), the duty is ruled by the area foundation, active as broker to engage the right partners, taken from the existing function/facility market;
- the extended enterprise scheme (German model), the product-service provision includes the end-of-life call-back, since the carmakers guarantee the reverse logistic duties.

The charge analysis is instructive. The above recalled first and second schemes, pretty likewise, address the *virtual* enterprise setting, with rulers outside the manufacturers; the big disparity of the costs shows the administrative lack of efficiency, with large users penalty. Anyway, the all charges are even bigger, when no overseeing ruler exists, and the reverse logistic is managed on fortuitous arrangements, adding the administrative taxes, to impromptu reclamation businesses. This situation, quite often, brings to the unlawful rejection of wrecks, with the (actual) consumers' profit, and the community damage. The *extended* enterprise scheme internalises the reverse logistic costs, and the choice fosters the producers' competition, to optimise the all *product-service*.

In any case, the pre-emptive appraisal of the lifestyle provisioning is fundamental requisite. The route, here suggested, combines the bottom up procedure of the nodes' self-assessment (to clearly show each partner's benefit), with the stepwise appraisal of the networking, Figure 11, the *virtual*, Figure 12, and the *extended*, Figure 13, partnership's value added. The evaluation is further done into standard contexts, Figure 14, by top down rule, to provide third party rates. The *extended* enterprise, Figure 7, has the chance of the optimal *product-service* delivery, fixed at the design stage, through the coherent fourfold interplay of the **2P2E** frames.

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Virtual Enterprise Network Solutions for Virtual Product Development in the SMEs

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Abstract: Today, development teams involved in the product development are often geographically and temporally distributed. There is a high level of outsourcing in the actual product development efforts. It is then possible to say that enterprises give rise to a special type of virtual enterprise, in which each company maintains the greatest flexibility and business independence. This paper presents a vision of next generation engineering working environments and describes a core information technology which future systems can be built on. Cooperative processes are not the automatic results of implementing collaborative, real-time communication technologies, but the result of a carefully designed and systematically maintained virtual team development plan. This paper discusses the critical issues of the virtual product development and builds a general architecture of an experimental platform for training, research and consulting in the new digital economy, located in the PREMINV center from "Politehnica" University of Bucharest.

Keywords: virtual enterprise network, virtual enterprise, virtual teams, cooperative systems, Internet/Intranet/Extranet, outsourcing.

1. Introduction

Under the concept of a global economy, enterprises are assigning design and production environments around the world in different areas. A serious issue of information exchange emerges as companies use traditional hardware and very distinct software appropriate to their field of expertise. To overcome the problem of low productivity due to the interruption of information, the concept of simultaneous engineering and concurrent design becomes very significant. Currently, the biggest problem for virtual networks is that the companies which need them the most are not becoming members. If one monitors the activities of companies involved in international trade on the Internet, one would notice rather quickly that many of the most active companies are very small. We would never speak badly of very small companies, being one ourselves. However, it is probably these companies more than any other who has the most to gain by joining virtual networks. Unfortunately, many of these companies either can not afford or are unwilling to pay for a WWW presence, which is usually a prerequisite for joining an active virtual

network. There is also usually a membership fee and in some cases the fees are slightly expensive when one considers that the organizations are very new and have no proven record of success.

Some proponents of the Internet have stated that its real benefit in the current situation is that it will allow small and medium sized companies to be competitive with large multinational enterprises (Guran, 2008). We do not completely agree with this position. We argue that the market power of large multinational corporations is so great that it dwarfs SME's in comparison. However, we would also point out that SME's using a strategic alliance methodology can achieve greater success in market penetration in global markets thereby affording them new business opportunities. So, while we do not view the Internet as giving SME's greater power in head to head business competition, we do see the potential of the Internet as an evolving global marketplace. The importance of the virtual network can not be over emphasized in this context. The ability of companies to form global networks on the Internet will transform the way that we do business in the future. Our view is that the future of global networking is very promising. The recent corporate downsizing which is happening in many countries means that new industries will have to provide employment opportunities in order for consumer demand worldwide to grow (Dragoi, Cotet & Rosu, 2007). We believe that the Internet will provide the means for companies to associate themselves with one another in virtual networks and begin to develop new business opportunities for each other in global markets. Furthermore, we believe that many companies who are now considered small will exert tremendous market power with the help of global networks. The ability to share information and resources gives even very small companies an opportunity to pursue larger projects, knowing that other members of a network will provide support and also participate as partners (Fink & Ploder, 2007). Finally, local or provincial government agencies will be able to assist their local business community by joining virtual networks. The ramifications for local economic development are quite significant. By accessing a virtual network, your agency can now reach more companies and enhance your business attraction promotional activities. The term "virtual enterprise" has been used in articulating the strategy for the 21st century global manufacturing enterprises. One of the key requirements is to develop an Information System infrastructure to integrate and control the interoperability of the distributed, heterogeneous and concurrent systems in the participating organizations. This article presents an innovative Information System infrastructure and its Networking Solution to help describing global information technology support for inter-organizational enterprises with the background of modern information and communication technology in the PREMINV platform for SMEs.

2. E-economy paradigm

Whether we consider one enterprise or a holding, for survival, it is necessary to learn from the past, supervise the present and plan the future. An important factor for the enterprise in the products and services development is to know, to establish, to translate and to define the customer requirements using quality methods, tools and techniques (see Figure 1).

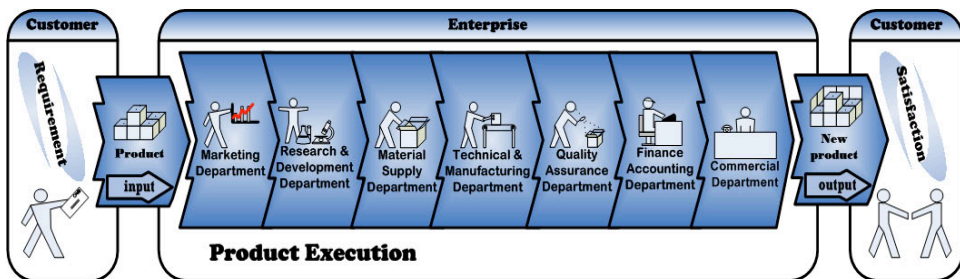


Figure 1 – Process model for customer requirements satisfaction

The enterprise uses ITC support to attract, retain and cultivate relationship with customers, streamline supply-chain, manufacturing, procurement systems and automate corporate processes to deliver the right products and services to customer quickly and cost-effectively (see Figure 2).

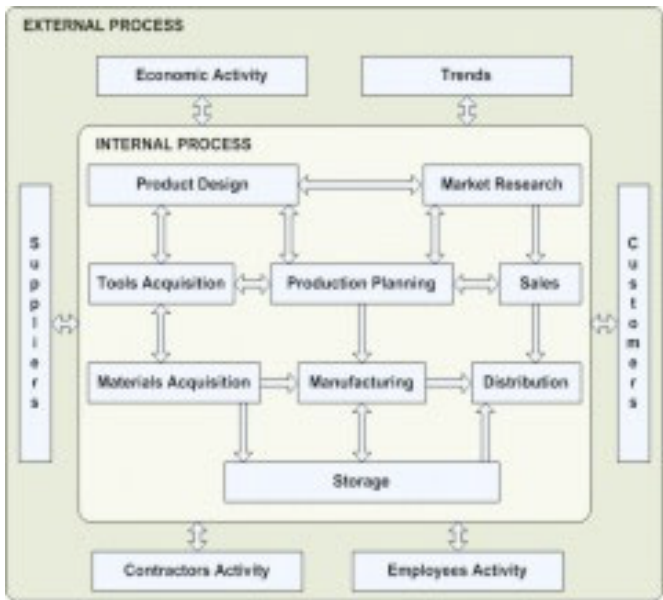


Figure 2 – Internal and external enterprise processes

In this new era of information, the fundamental sources of wealth are knowledge and communication, and not natural resources or labor work (Rosu, Dragoi & Guran, 2009). Today, one can differentiate three classes of elements as:

- **Data** – a discreet and objective group of facts of a certain event;
- **Information** – a message containing an originator and a receiver and whose meaning involves a new interpretation based on a group data;
- **Knowledge** – a mixture of experiences, values, contextual information and intuition, forming a framework in a person's mind that enables him/her to evaluate and to obtain new experiences and information's.

The global market today increase the need for common and collaborative processes and sharing information seamlessly between companies involved in extended enterprise. All forecasts predict very rapid growth in e-commerce as part of e-business and e-services that attract

increasing attention because of the impact of new information and communication technologies on firms, markets, employment, and development. There are fundamental effects on the organization of business flows and processes, transaction costs, the creation of new business models, and changes in the boundaries of firms across sectors. All these effects are defining the new digital economy perspectives on business, products, individuals and technology. Today, digital economy encompasses e-business, e-commerce, and e-services as services or resources that can be accessed through people or businesses, using network technologies (see Figure 3). For business, e-service is going to be a new way to save money, to revenue growth, and faster development model. For end-users, e-services increase productivity and simplify life, take advantage of more sophisticated and specialized services on an as needed basis. At the level of production dedicated enterprises, e-services are (see Figure 3): Business-to-Business (B2B), Intra-Business (IB), and Business-to-Customer (B2C).

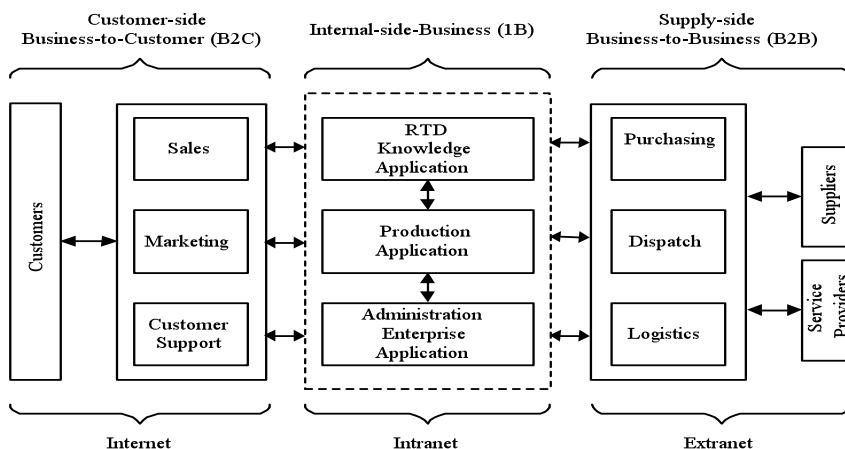


Figure 3 - The exchange of information services and goods through networks

In a real meaning, an e-business is any business that uses Internet or Internet technologies to attract, retain and cultivate relationships with customers, streamline supply-chain, manufacturing, and procurement systems and automate corporate processes to deliver the right products and services to customers quickly and cost-effectively, also to capture, explore, analyze, and automate corporate processes information on customers and company operations in order to provide better business decisions. For the future, e-services and e-business, as were defined, require the enterprise re-thinking and re-modeling, with the system and applications design for an efficient use of new network technologies. The perspectives of this kind of manufacturing and economy, named shortly new digital economy, we can see the product perspective (holistic product view, product life-cycle, value-network integration etc), business organizational perspective (new organizational form, customers and suppliers integration, collaborating organization etc), the technology perspective (technological building blocks, infrastructures, interoperability etc.) and the individual perspective (skills, workspaces, collaborating individual, different roles: worker, consumer, citizen). As a general requirement for an infrastructure to support virtual enterprise it can be underlined that the companies must be able to inter-operate and exchange information in real time so that they can work as a single integrated unit, although keeping their independence/autonomy (Dragoi, Cotet & Rosu, 2007).

3. PREMINV e-Platform: a Virtual Enterprise Networks Solution

Usually, a virtual community, e-community or online community is a [group](#) of people that primarily interact via communication media such as [newsletters](#), [telephone](#), [email](#), online networks or [instant messages](#) rather than face to face, for social, professional, educational or other purposes. If the mechanism is a [computer network](#), it is called an online community. Virtual and online communities have also become a supplemental form of communication between people who know each other primarily in real life. Many means are used in [specialized software](#) separately or in combination, including text-based chat rooms and forums that use voice, video text etc. Significant socio-technical change may have resulted from the proliferation of such Internet-based [virtual networks](#). The importance of the virtual network can not be over emphasized in this context. The ability to form global networks on the Internet will transform the way that we do life in the future. Service-oriented computing is becoming the prominent paradigm for leveraging inter-personnel information systems to complete higher-order information transactions at the heart of the modus operandi of the virtual network.

This system describes research aimed at supporting the formation and operations of virtual network through the setting-up of service-oriented workspace environments. Virtual collaboration for networked virtual teams is a complex and challenging activity in which there are major important components to be accounted for (Coppola, Lomuscio, Mizzaro & Nazzi, 2008).

3.1. Virtual Team's for Virtual Product Development in the PREMINV Platform

Also, today, what do you want in an e-teams with multidisciplinary optimization? First, for your enterprise: low risk, low cost, single point of support; reap benefits as soon as possible, ready for unpredictable demand and growth, future capabilities. Secondly, for your customers: excellent response time, ability to build competitive advantages from a wide variety of applications (use specialized products for unique features, integrate them for seamless customer support etc), ensure optimal customer experience to build loyalty, customer trust (security features build trust: validate who is doing business with whom; secure financial transactions, protect internal assets, halt spread of viruses, protect against hackers), high availability etc . Virtual Enterprise operates as nodes in a network. A different architecture, engineer and construction organization, a fresh virtual team, is needed every time for every new project (see Figure 4 and see Figure 7).

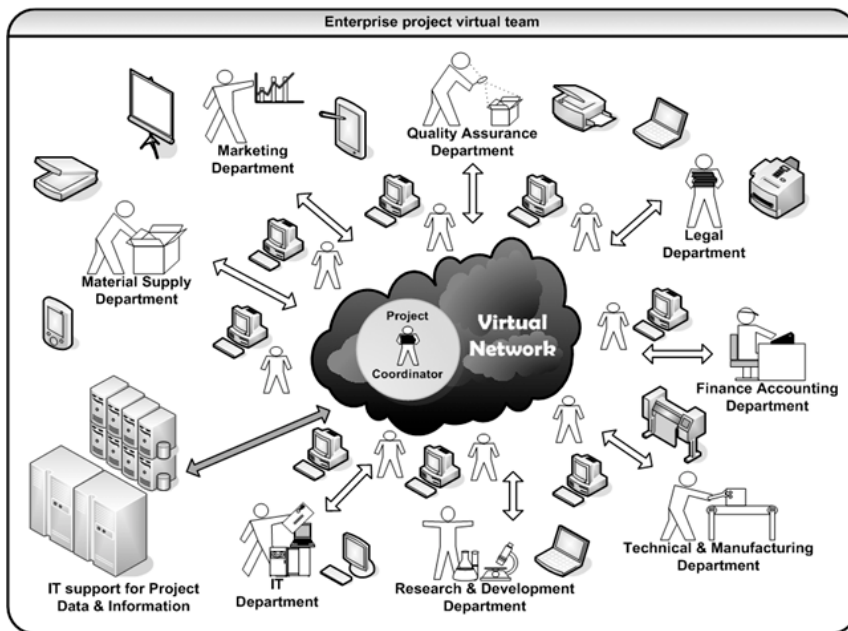


Figure 4 – Enterprise virtual teams for project development in the PREMINV platform

Innovative techniques to co-ordinate and manage information, resources and documents need to be developed to integrate successfully and reduce lead times, increase quality and keep within budget constraints. Consequently, the partners in the virtual enterprise need to exchange legacy data and migrate with other systems outside their own secure corporate boundary. In order to achieve collaboration between different actors in the Virtual Enterprise, there needs to be common processes supporting the distributed product development process.

Virtual teams do not operate like traditional physical teams, as their requirements reflect a whole new way of communicating, working collaboratively, sharing information and mutually supporting other team members. The new technologies and approaches required to achieve this are completely alien to most of our present organizational culture. And this is why they fail. Cooperative processes are not the automatic results of implementing collaborative, real-time communication technologies, but the result of a carefully designed and systematically maintained virtual team development plan. A virtual product development by the virtual teams in a virtual enterprise is a temporary alliance of teams that come together to share skills, abilities and resources in order to attend a project opportunity and whose cooperation is supported by computer network and adequate tools, competencies and special application software (see Figure 4).

We purpose in the PREMINV platform (see Figure 5), a general architecture for an industrial holding or SMEs, geographically dispersed, in order to achieve collaboration between different actors in the Virtual Enterprise, there needs to be common processes supporting the distributed product development process (Rosu, Dragoi, Guran, 2009).

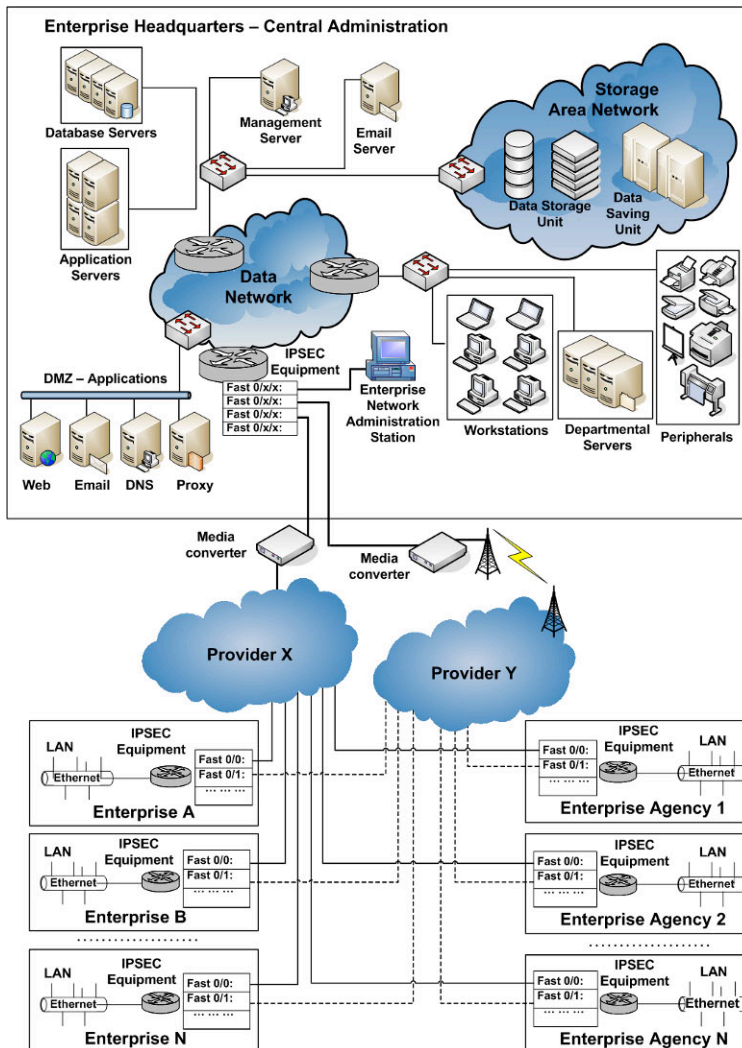


Figure 5 – PREMINV e-platform: VEN solutions for enterprise/SMEs geographically dispersed

The Internet is a world-wide conglomerate of different networks that communicate among each other via a common protocol, independently of the hardware type used. Various network services can be used by everyone, either supplying or demanding those (Heinrich & Lehner, 2005). A large range of distribution, the platform independence, an big number of user friendly services that are easily accessible through the World Wide Web as well as the open standards used and free or budget-priced products (such as browsers, html editors, software updates) have lead to a high and continuously growing proliferation of the Internet (Shakya, Takeda & Wuwongse, 2008)

The advantages offered by the e-platform for covering the information needs are held to be the following (Dragoi, Cotet & Rosu, 2007):

- Reduction of local barriers by means of world-wide information offers;
- Reduction of time barriers by means of permanently available information;

- Reduction of (transaction) costs by way of automation of information processing on the supply and/or the demand side;
- Improved coordination and cooperation with external partners using an integrated information and communication platform (i.e. platform independence, information exchange without media ruptures).

However, the application-to-application communication problem still exists. Businesses have needed a standardized way for applications to communicate with one another over networks; no matter how those applications were originally implemented (Ward & Peppard, 2002). Web Services, the latest evolutionary step in distributed computing, represent exactly this solution by providing a standardized method of communication by means of which different applications can be integrated together in ways not possible before. Different applications can be made to call on each other's resources easily and reliably, and the different resources that applications already provide can be linked together to provide new sorts of resources and functionality. Moreover, the application integration becomes much more flexible because Web Services provide a form of communication that is not tied to any particular platform or programming language.

3.2. Virtual Enterprise Network Solutions

Also, what is a virtual enterprise network (VEN) solution?

- A way for businesses to achieve virtual scale enabling them to operate as if they had more resources and capacity than they actually have;
- Allowing them to operate with all the resources and reach of a large enterprise but without sacrificing their speed, agility and low overheads;
- Enabling them to compete for bigger more profitable contacts with higher innovation and design elements with bigger customers who are prepared to have strategic partnerships with their suppliers (Thuraisingham, 2003).

A Virtual Enterprise Network needs its own Private Member Collaboration System to communicate and develop its projects and bids. It needs its distinctive Network Business Applications such as Capability Aggregation and Tender Matching to enable it to function effectively as a co-operative in both pre-sales and contract operations. It also needs a Public Web Site to manage its interactions with potential customers and new members.

A hierarchical network design model breaks the complex problem of network design into smaller, more manageable problems. Each level, or tier, in the hierarchy addresses a different set of problems so that network hardware and software can be optimized to perform specific roles. Devices at the lowest tier of the hierarchy are designed to accept traffic into a network and then pass traffic up to the higher layers. The core of the network has one purpose: to provide an optimized and reliable transport structure by forwarding traffic at very high speeds. In other words, the core layer should switch packets as fast as possible.

Devices at this layer should not be burdened with access-list checking, data encryption, address translation, or any other process that stands in the way of switching packets at top speed. The distribution layer sits between the access and core layers and helps differentiate the core from the rest of the network. The purpose of this layer is to provide boundary definition by using access lists and other filters to limit what gets into the core. Therefore, this layer defines policy for the network. A policy is an approach to handling certain kinds of traffic, including routing updates, route summaries, Virtual Local Area Network (VLAN) traffic, and address aggregation. You can use policies to secure networks. The access layer feeds traffic into the network and performs network entry control. End users access the network via the access layer. As a network's "front door," the access layer employs access lists designed to prevent unauthorized users from gaining entry. The access layer can also give remote sites access to the network via a wide-area

technology, such as Frame Relay, ISDN, or leased lines. A reliable and available network provides users with 24-hours-a-day access. In a highly reliable and available network, fault tolerance and redundancy make outages and failures invisible to the end user. The high-end devices and telecommunication links that ensure this kind of performance come with a steep price tag. Network designers constantly have to balance the needs of users with the resources at hand. Multicast traffic can also consume a large amount of bandwidth. Multicast traffic is propagated to a specific group of users. Depending on the number of users in a multicast group or the type of application data contained in the multicast packet, this type of broadcast can consume most, if not all, of the network resources. As networks grow, so does the amount of broadcast traffic on the network. Excessive broadcasts reduce the bandwidth available to the end users and force end-user nodes to waste CPU cycles on unnecessary processes. In a worst-case scenario, broadcast storms can effectively shut down the network by monopolizing the available bandwidth.

Two methods can address the broadcast issue for large switched LAN sites:

- The first option is to use routers to create many subnets and logically segment the traffic. This scenario can create a bottleneck in the network.
- A second option would be to implement virtual local area networks (VLAN's) within the switched network.

A VLAN is a group of end devices that populate multiple physical LAN segments and switch ports; they communicate as if they were on a single LAN segment. One of the primary benefits of VLAN's is that LAN switches (by creating VLAN's) can be used to effectively contain broadcast traffic and manage traffic flows. The Virtual Local Area Network (VLAN) is the best support for the virtual enterprise network or the virtual teams.

The interconnection of VLAN's is realized on the level two (ELAN – Emulation Local Area Network), and on the level three (MultiProtocol Over AT –MPOA). MPOA Client (MPC) and MPOA Server (MPS) are obtained the configuration by LECS (LAN Emulation Configuration Server). The virtual networks MPOA is named IASG (Internet Address Summarization Groups).

In this case a virtual team is formed with members located at different geographic locations. A virtual local area network is created for each project in the PREMINV platform (see Figure 6).

In addition to the team's full-time members, the team also includes contributing members who are recruited for specific components of the project. As such, a core group is responsible for leading the project and a sub-group is involved in specific components of the project. While the full time employees form the central core of the team, experts in the different problems of the project (control systems, mechanic systems, electronic systems, programmer's etc.) are also team members. Today, in order to survive, whether organizations are composed of one or many enterprise (holding) or organizations are small, medium or large, it is necessary to learn from the past, supervise the present and plan the future. Professional qualifications, personal experiences, capacity to transform information's in knowledge constitute the individual resources. Patent acts, models, concepts, enterprise culture and management form the group resources. Individual and group resources totality represents the enterprise internal resources.

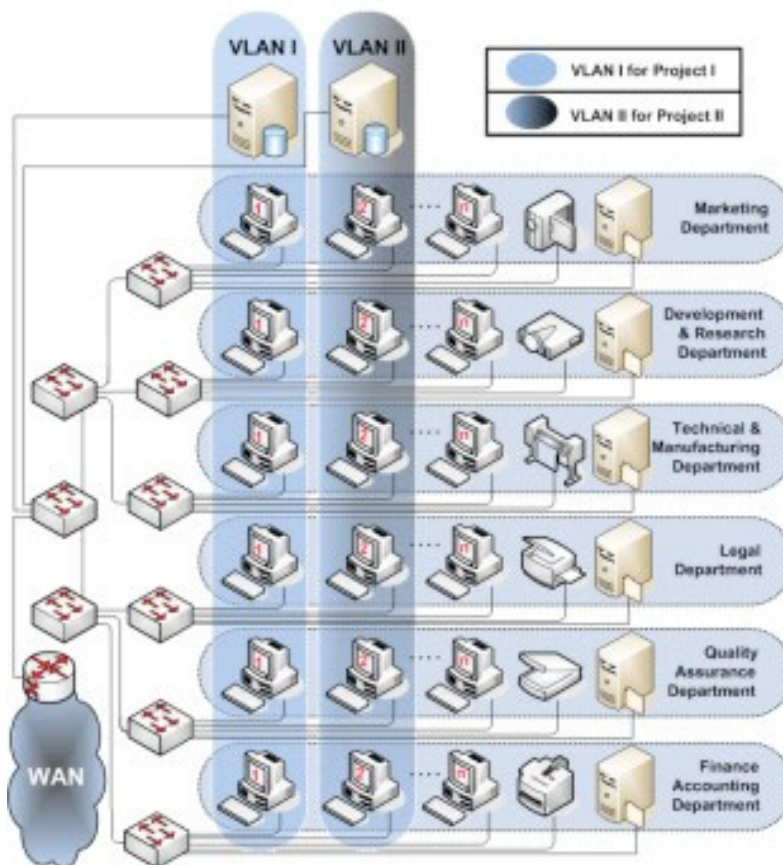


Figure 6 – General architecture of a VEN for an industrial holding or SMEs

Relations set of external resources with client, suppliers and partners, product and services credibility, offering quality. Tacit or explicit knowledge transfer between these resources and knowledge conversion from a resource to other determines value creation.

4. The PREMINV Platform

A central point of future product development is therefore collaboration and communication. We are implemented in the PREMINV platform a solution based as a virtual network concept (see Figure 7). This is based on consistent, integrated data sets and on tools that support the collaboration (Dragoi, Cotet, Rosu & Rosu, 2007). As a general requirement for this infrastructure support is that the companies must be able to inter-operate and exchange data, information's and knowledge in real time so that they can work as a single integrated unit, although keeping their independence/autonomy. A complete redesign of an existing enterprise to converged or virtual enterprise would represent a big effort, not justifiable in market terms as companies are not replacing easily their running systems. A better strategy is to try to separate the internal

functionalities from the network-related ones and develop the necessary mappings to legacy systems, to correspond to the new aggregator model for modern electronic system.

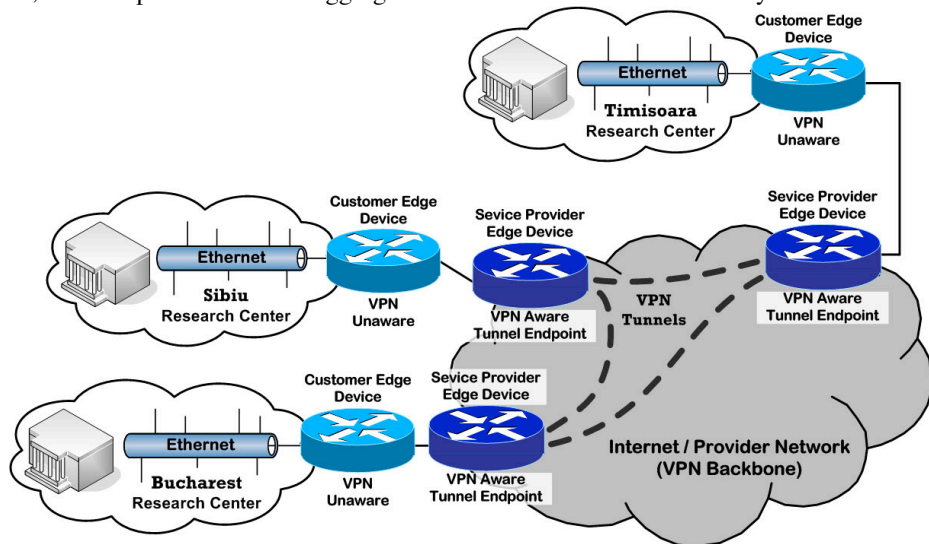


Figure 7 – General architecture of VEN in the PREMINV e-platform.

Traditionally, only data about the designed product are stored, made available for the product development team and archived for later product development projects. With product lifecycle management, information coming from all product lifecycle phases is to be integrated, including sales, operation and service data about sold/installed products. Product data management technologies are extended to manage more complex and more dimensional data. Upon this data management, tools used by different people throughout the product lifecycle are integrated, including requirement analysis, reverse engineering, production planning, resource planning, logistics and traditional design and simulation systems. Traditional applications in the enterprises, mainly related to ERP (Enterprise Resource Planning), DMS (Document Management System) and CRM (Customer Relationship Management), are using massive amount of data on operation and customers that are unused in data warehouses. To turn that stored data into valuable information, companies are now questing *knowledge applications* (KApps). The product development process has become an intensive process of knowledge application and it consists of a process of transformation of information. The business advantage in having KApps, lies in the ability to analyze large amounts of data from any business model, determine the personalized preferences of all potentially customers, than rich them with relevant information, wherever they may be. These serve as the driving force for new generation of applications. To take the full advantages for knowledge and information-based business models, there is a need for an integration framework that can tie together the various classes of KApps. To create an integrated decision framework (Rosu, Dragoi & Guran, 2009), we have to implement a number of KApps built on a platform (see Figure 8) that is composed of three layers: *E-business decision* (support solutions that include the ability to deliver views and queuing, reporting, and modeling capabilities that go beyond current offerings), *Enabling technologies* (data mining, query processing, and result distribution infrastructure, which mean the ability to store data in a multidimensional cube format (On-Line Analytical Processing – OLAP), to enable rapid data aggregation and profound analysis), *Core technologies* (as data warehousing, and data markets, that get all company data working together so that user can see more, learn more, and make the

organization to work better). Because information access and control drive business competition, it is obvious to consider the lack of boundaries in modern business and that fact that corporations and consumers became interconnected via private networks and Internet.

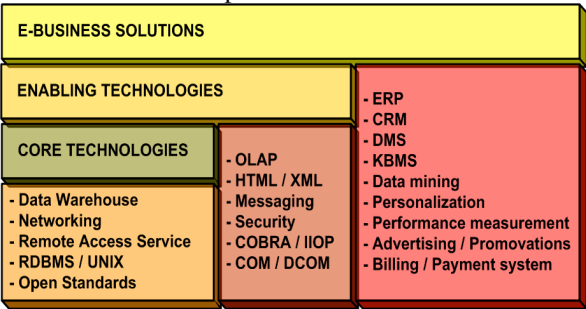


Figure 8 – Knowledge based applications architecture

These increasing interconnections are facilitating development of KApps in three phases (see Figure 9): *Corporate Intranets, Extranets, Commercial, Internet Applications*.

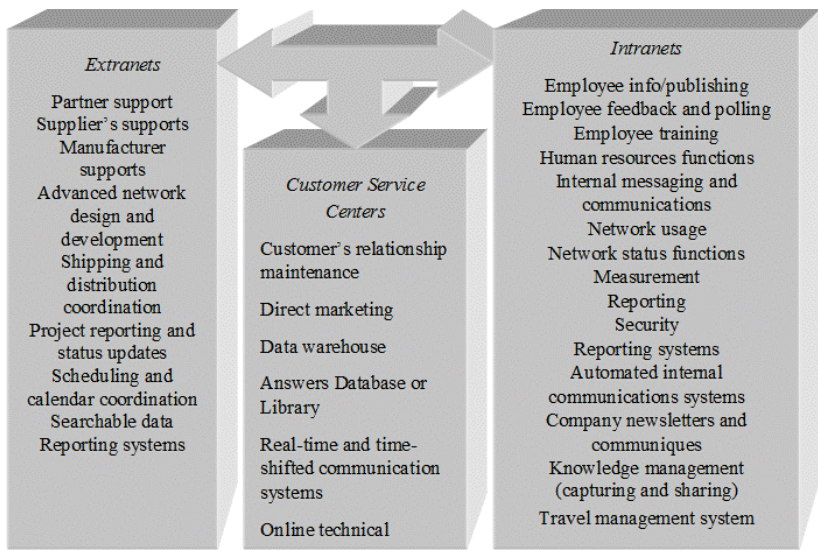


Figure 9 – Knowledge based applications architecture

Corporate Intranets, in which the companies are creating complete and uniform linkage of information and knowledge resources distributed through the organization. For the knowledge creation to occur, data aggregation needs also data analysis. Moving from departmental solution, in which data and reports are, developed for small, specialize communities of users, to corporate intranets, opens up data resources to a broader base of users, by using the browser as a standard interface. **Extranets**, that are focusing on supply chain partners, in the conditions when the companies are moving parts of the internal corporate information infrastructure, so that suppliers and trading partners can access them (through fire-walls). The key business drivers are: fast access, customized data, and responsiveness. Standardized reports and interfaces are minimizing services requirements imposed by the management of huge data volumes, cross-platform coverage and support, response time speed, and a broad range of interface choices. **Commercial**

Internet Applications, which focuses on new business models, created for capturing, consolidating, and reselling consumer information, business transaction records, and financial data. At the present, most companies and corporate strategy is in phase I, with the emphasis on creating the ability to imitate decision-making through all levels of an organization. Nevertheless, they are facing the challenges of performing complex computational analysis on collected data and of disseminating the information and knowledge not only to employees, but also to customers, suppliers, and business partners.

4.1. Partner's Evaluation Using Knowledge Based Systems

The partner's evaluation methods can be based on one criterion or more criterions. Assessment of partners based on only one criterion (e.g. price or delivery terms) are used infrequently because of the limited modeling of reality. In practical work should be considered more influence. Analysis based on one criterion may be insufficient or even false. For example, offers the most favorable price can generate some problems in processing the resource in question, which involves other costs. For practical work there are a number of assessment methods based on more criterions such as: Note system; a method of assessment point (table-Scoring); Process with rates; Process with indices; determining a profile; a three-dimensional analysis, etc. Of these we will discuss the notes evaluation method. In case of the notes system, evaluating the performance of partners is with note (e.g. enforcement activities necessary to achieve project - considering the final product of the enterprise as a project of quality, of course price). Note resulting average taking into account the criteria chosen provides a unit of measure to assess partners. The simplest method corresponds with the three levels system at which the evaluation criteria is based on attributes.

Verbal descriptions are replaced by points. Advantage of this system is that it is very easy to use. Critical points of the assessment relates to the importance of parameters and the high degree of subjectivity. The method is used to evaluate qualitative criteria, to which: is not possible to accurately measuring the degree of fulfillment of objectives; the evaluator can observe systematically different dimensions of partner characteristics. We analyze this partner evaluation method and elaborate a knowledge-based system implemented in VP-Expert (expert system generator - VP-Expert version 2.1, by Brian Sawyer, Educational Version, distributed by Paperback Software International) and Prolog which effectuates the partner evaluation based on notes system method. Production rules form the knowledge representation model used in this work. In the *EVAL.KBS* knowledge base (KB) there is *if-then* structure rules excluding the rules for inference engine operations (Figure 10). Knowledge Base includes a series of rules relating to the partner's evaluation criteria. Partner shall make more assessments - in terms of *deadlines*, *communication capacity*, *price*, *flexibility* and *quality products*. For each evaluation criterion partner get a score. Depending on the value thereof and rated the partner is awarded a grade (Rosu, 2009).

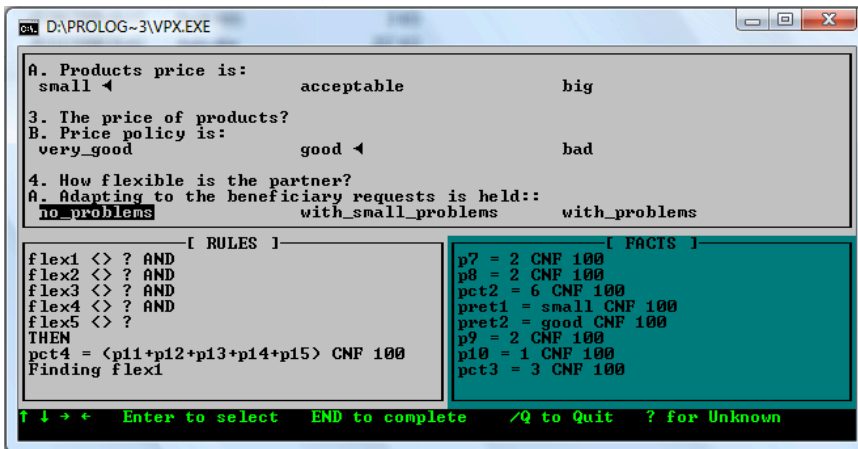


Figure 10 – The EVAL.KBS interrogation

For each of these evaluations partner be awarded a grade. Finally, depending on the score partner receives final assessment. Partner can be classified as *GOOD*, *AVERAGE* or *UNSATISFACTORY*, depending on the total score obtained at the end of the query (Figure 11).

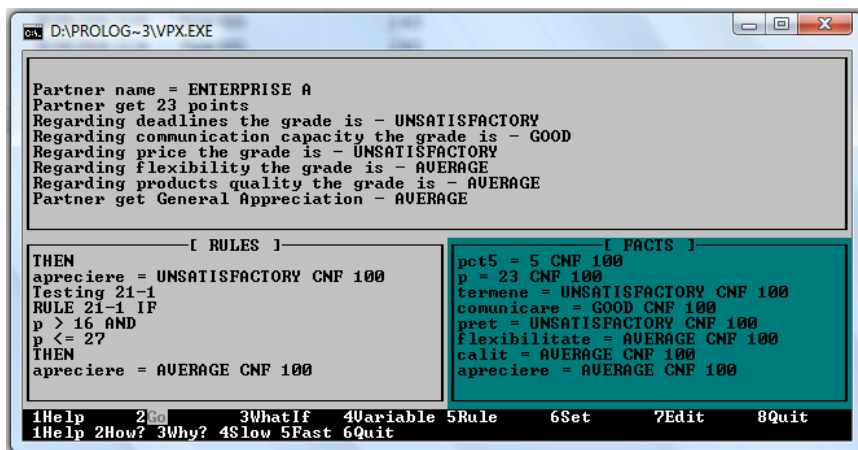


Figure 11 – A partner evaluation – show results.

In case you have several partners who obtain the qualification *GOOD* choice can be based on the number *GOOD* grades obtained in the assessment criteria.

5. Conclusions

Collaborative design is based on the simulation of scenarios. The key elements of a scenario are the desired product, the targeted environment, the lifecycle processes and the people involved in the processes. It is widely understood that successful design is often a highly collaborative team based activity. To be effective, a virtual team must be able to communicate, collaborate and

coordinate, all at distance. Though some corporation are practicing a form of distributed design, a documented procedure for conducting distributed design and product development has yet to be created, tested and distributed. However, the same set of skills that guide design teamwork for a team where all members are in one location is different from that set of skills needed to lead virtual team. The paper proposes a solution used in the PREMINV e-platform to support virtual product development, based on the main internal and external SMEs knowledge resources used during the product development process and business strategies elaboration. Specific interfaces have been designed for different types of users and other applications to activate functions that are provided for them by the integrated platform, i.e. engineering change management or search for needed information. The developed service and methodology have been tested in pilot projects carried out in the design process. The results of the testing process showed that the traditional approach to the integration of engineering data between different systems can be improved by using the new technologies. Finally yet importantly, the paper presented how a knowledge base can be built at the SMEs level to support an enterprise department activity. This work realized at the UPB-PREMINV Research Centre, in University "Politehnica" of Bucharest, is focusing on a university - SMEs partnership. The validation of this solution by a case study in the ORGVIRT & PROGPROC research projects is to determine the new organization type for integrating the virtual enterprise medium and to outsource shared resources from UPB-PREMINV research centre to industrial partners. We intend that our future work in this area includes building other knowledge bases to support eventually all SMEs departments' activities. The benefits of using Web Service technology as a core IT platform for the PREMINV have been identified. They comprise minimized processing times and costs and the improvement of the following features: **functionality** (system supporting and/or fully automating product development); **process**; **integration** (system to (internal or external) system communication); **usability** (effortless communication between the human user and the system); **security** (protection of the enterprise knowledge); **flexibility** (easily adjustable to a fast-changing business environment). The purposed decision support system includes two main modules: an information classification and retrieval module; a decision inference module. These modules implicitly guide users to follow systematic decision procedures to structure a problem, collect information, develop a model and analyze a decision step by step. The input/output interface provides an interactive mechanism for communication between users at the client sites and the other components in the system. The database manages the domain knowledge embodied in the system. The overall developed system infrastructure was based on object-oriented and agent technology. Every agent can communicate with other software agents to smooth out the decision process. When an agent conducts a decision support activity, it consults the knowledge base located in various sectors of a platform.

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Advanced Planning System (APS) for Non-Hierarchical Manufacturing Networks

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Abstract: The focus of manufacturing planning and control has gradually expanded from (in-house) production activities towards all manufacturing and logistic activities in the supply chain. Planning of in-house operations is still very important, but the trends towards increased use of outsourcing and mass customisation require that customers and suppliers are able to exchange information frequently to cut down costs and lead time while quickly adapting their manufacturing and logistics operations to market/customer requirements. Many vendors offer systems to plan and control in-house operations, whereas only a few large vendors (such as Oracle, SAP and I2) offer supply chain planning systems. This limits the ability for SMEs to exploit the supply chain planning options. This paper discuss current supply chain planning solutions and presents a more simple and adaptive concept to be used in both SMEs and larger enterprises. The research presented in this paper is funded by the EU Union via the EmpoSME and ValuePole projects.

Keywords: Manufacturing network; Supply chain management; Planning and Scheduling; APS; ERP.

1. Introduction

Most manufacturing companies face strong competition, continuous changes in market and customer requirements. Planning are frequently affected by the actions of suppliers and customers in their supply networks such as changes to orders that are already in production or re-planning caused by lack of components or resources. Often, decisions have to be made without having a complete, real time overview of possible options and associated consequences. The result is typically excess inventories, too long lead times, too low customer satisfaction and poor resource utilisation.

Supply networks are dynamic and hard to define, and a single company is often part of several different supply networks simultaneously. An increasing level of customisation combined with demands for high quality, low costs, short and precise delivery times, and high flexibility represents a significant challenge to managing operations in networks.

Although these challenges will apply to companies of all sizes, they are particularly true for SMEs due to the following characteristics:

- The network are typically non-hierarchical

- They have limited resources available for specialist roles in planning and decision making
- They typically have very limited use and knowledge of APS (Advanced Planning Systems) solutions
- They require flexible tools which let them exploit the advantage of typically being flexible and easier to manage than larger enterprises

Observation shows that information exchange is often limited to order placements without any kind of information visibility or other communication between network partners. Thus network effects of individual decisions are often not possible to neither intercept nor predict. This implies that planning and control at any network partner is currently executed with incomplete information about status among the other network partners and without the possibility to see the full consequences of decisions being made. Additionally, the planning and control task will vary with regards to scope and complexity challenging the traditional planning and control approaches, and existing methodologies, tools and knowledge.

The paper briefly discusses three major areas for manufacturing in non-hierarchical networks. After this a more simple and adaptive alternative approach to existing APS solutions is presented, and finally the approach is positioned in a broader perspective titled “Work Bench Concept” to be used in both SMEs and larger enterprises.

2. Collaboration in Non-Hierarchical Networks

Typical for SMEs is that they operate in non-hierarchical networks, characterised by power being distributed among members, and the absence of one or several dominant actors that dictate plans or impose a centralised planning perspective (Harland et al., 2001). In such networks each member participates in multiple supply chains, manufacturers are equal in status, operate as partners and no one has the power to dictate the others (Jagdev and Thoben, 2001). Coordination and collaboration between the companies is vital in such networks.

Collaboration refers to the activities and environment related to the “joint planning and execution of supply chain activities” (Ayers, 2006), and is therefore an essential element in planning activities in a network perspective. Collaboration is using cooperative efforts in order to meet mutual goals, exchanging information, developing improvement in partnership (Ayers, 2006). A manufacturing network is fully coordinated when all decisions are aligned to accomplish global system objectives (Sahin and Robinson 2002); of course when this occurs decisions have already crossed the company’s boundaries, meeting articulated and complex contexts (Danese et al., 2004). Several collaborative models for coordination networks activities have been developed. The aim of models such as collaborative planning, forecasting and replenishment (CPFR), vendor managed inventory (VMI) and automated replenishment programs (ARP) is to achieve seamless inter-organisational interfaces by specifying control principles and operations models for the flow of materials and information (Holweg et al., 2005).

Collaboration in the network is decentralised and each actor performs individual planning, with the aim of optimising operations in a local perspective. Companies in non-hierarchical networks face challenges that make collaboration difficult. Firstly, the networks themselves are dynamic and hard to define, and a single company is often part of several different manufacturing networks simultaneously. The focal company and other network members frequently face situations with conflicting interest and trade-off situations. A typical scenario is when orders from different networks compete for scarce resources and deadlines and delivery times are short. Frequently, these requirements cannot be fulfilled because there is a lack of information about the current state of the production and network processes. In addition, customers might request

changes to orders that are already in production, making it difficult to make quick decisions based on a complete, real time overview of possible options and associated consequences. Secondly, products are becoming more and more sophisticated and intelligent, with service and value added elements embedded in the products themselves. Further, with an increasing level of customisation, and demands for high quality, low costs, short and precise delivery times, and high flexibility, the management of the operations in the networks represents a significant challenge.

3. Manufacturing Planning and Control

The essential task of *manufacturing planning and control* is to efficiently manage the flow of materials, the utilisation of people and equipment and to respond to customer requirements by utilising the capacity of suppliers and internal resources to meet customer demand (Vollmann et al., 2005). *Planning* across non-hierarchical networks is a complicated and complex task due to conflicting objectives and continuously changing demand. In such a case, the planning and scheduling issues will have to face the challenge of coordinating systems that do not fully share all relevant information between companies (Alvarez, 2007).

Distributed planning in non-hierarchical networks has to be performed in a setting where relevant information from several IT systems are integrated and up to date, and can be accessed in real time from anywhere in the network. This information visibility depends on the exchange of critical data required for the efficient management and control of the flow of products, services and related information between members in the network (Handsfield and Nichols, 2002). Each node should ideally be able to see the real time situation in the network, downstream as well as upstream, from boardroom to shop floor, enabled by *automatic data acquisition*. Although *information visibility* and *system integration* are regarded as keys for enabling collaboration, very few networks have successfully achieved this (Quinn, 2003).

The dominating techniques and systems for planning and control (e.g. Enterprise Resource Planning - ERP, Manufacturing Execution Systems - MES) do not support the need for a network perspective. They have a single-company focus and mainly support centralized production and planning and control (Alvarez, 2007). This makes network planning difficult and inefficient. This amplifies the need for supply chains to rely on flexible, adaptable and responsive planning and *decision support tools* across the entire network (Özbayrak, 2006).

4. Advanced Planning and Scheduling

Advanced Planning and Scheduling (APS) systems introduced the benefits of constraint-based planning and optimization to the business world and enabled companies to optimize plans according to financial and other strategic objectives. APS seeks to find feasible, near optimal plans unlike traditional Enterprise Resource Planning (ERP) systems (Stadtler & Kilger, 2005). APS takes into account constraints at enterprise level as well as at plant level. Materials and capacity issues are considered simultaneously, and manufacturing, distribution, and transportation issues are integrated. Many ERP and APS systems make it possible to include suppliers and customers in the planning procedure and thereby optimize a whole supply chain on a real-time basis (Wortmann, 1998; Vollmann et al., 2004; Kennerly & Neely, 2001).

APS aim at automating and computerizing the planning processes by use of simulation and optimization. Still, the decision-making is done by planners with insight in the particular supply chain and know how on the system constraints but likewise important: a feeling for feasibility of

created plans. Thus, APS aim to bridge the gap between the supply chain complexity and the day-to-day operative decisions. This requires, however, that planners are able to model and setup decision rules for the planning and optimization.

According to Petroni (2002) there are several problems involved in using planning software such as high complexity, lack of training and knowledge among managers and personnel, low-data accuracy, and lack of support from the software vendor. Early adopters of APS report significant reductions in cycle time, resource and inventory load (OM Control, 2001; Schell, 2002; Hess, 2002). A study by Funk (2001) however, showed that only 20% of the APS installations investigated were successful (based on a threshold of achieving 70% of projected gain to become a success).

In spite of the supply chain functionality, most APS implementations are limited to a single organization or a single manufacturing site. A few cases can be found in literature on successful supply chain implementations. Gupta et al. (2002), for example, describe a decision support system which helps Pfizer to plan their distribution network. Another study from the Vita Group show an increase in delivery accuracy from 79 up to 99% while reducing lead time from 5-7 days to zero and reducing the planning resources by 30% (Works Management, 2008).

5. The Work Bench Concept

The Work Bench Concept is an alternative approach to supply chain planning where decentralised planning decisions are made with regards to individual company operations – but with a network perspective. The main functionality is to operate and manage existing SMEs manufacturing networks. The work bench comprises components for integration of information systems, visualisation of the planning and production situation, communication to enable cooperative decision making under uncertainty, optimisation of plans and simulation of the decisions, network diagnostics and performance monitoring among others. This involves a number of challenges such as providing members access to network-wide real time information (Wang and Wei, 2007), enable visualisation of the available information (Boyson et al., 2003), secure the interaction between advanced ICT based decision support tools and human decision making (Barthélemy et al., 2002), and creating a coordinated and collaborative environment (Deek et al., 2003) for planning and decision making. The state of the art, major challenges and identified requirements are listed in table 1 below.

Table 1 – State of the art, challenges and requirements for future Supply chain planning solutions.

State of the art	1. Collaborative practices and methodologies have been developed for coordination between long term supply chain partners. Examples include Vendor Managed Inventory and Collaborative Planning, Forecasting and Replenishment (Holweg et al., 2005). 2. Predominant manufacturing planning and control techniques are based on centralized production control, with infinite capacity, constant lead time and fixed routings in the single company (Alvarez, 2007). 3. Decision support tools for network planning and execution are based on optimisation and simulation such as Advanced Planning and Scheduling, Strategic Network Planning etc. (Turban, 2007)
Challenges and conflicts	Existing collaborative practices and methodologies: Are not supported by low cost ICT-systems

	• Have a single-company perspective, fail to provide collaborative planning for the network and fail to include the non-hierarchical perspective • Are restricted to centralized planning and control, and lack flexibility and real-time information. • Are out of reach for most SMEs due to the centralized control, high complexity and high cost • Assume centralized control in hierarchical networks and consensus between stakeholders • Furthermore, the tools does not: • Address uncertainty and risk adequately • Support a more diversified classification of tasks to enable improved planning results based on a more holistic view. • Enable effective human interaction in decision making • Include presentation and real time information from network • Support an "individual" real-time plan generation
Requirements	1. Planning and control techniques and principles with the capability to handle conflicting objectives, dynamic networks and distributed decision making 2. Techniques for solving distributed and dynamic planning. 3. Full integration with dashboard solutions, allowing real-time decision support with advanced what-if capabilities and graphical, interactive planning boards 4. Simple ICT-supported collaborative methodologies for non-hierarchical network collaboration which: • Consider new manufacturing planning and control techniques for non-hierarchical networks • Explicitly address operational (and selected tactical and strategic issues) as well as operational uncertainties and risk, and cope with the dynamicity and complexity of manufacturing systems • Automate routine tasks, leaving human schedulers to concentrate on exceptions handling

In the following section an supply chain planning approach to solve requirement 2 (Techniques for solving distributed and dynamic planning) is presented.

6. A new Supply Chain Planning Approach

Whilst the planning and optimisation procedure used in Advanced Planning and Scheduling systems is the current state-of-the-art for a single company or a hierarchical supply chain/network, planning among individual companies belonging to several non-hierarchical networks require other solutions. The reason for this is quite simple: an APS system need to have a joint goal and clear constrains for the planning engine to work, and this is not obtainable when dealing with several non-hierarchical networks. We therefore present a relative simple solution based on individual ERP or APS plans in the respective companies followed by improvements in between partners. It is assumed that requests from customers (customer orders) have been accepted as far

as possible by the ERP/APS system, possibly based on customer priorities (see below) in case of resource or materials shortage. However, such a plan is normally based on standard customer lead-times to allow the individual ERP-plans to create realistic plans at the first attempt. The option of optimising the joint plan is therefore primarily based on the difference in between standard customer lead-time and actual lead-times in the company.

The outmost simple solution is therefore to allow partners to (manually) view the (production) plan and based on this utilise/request the available “free space”. A more far-reaching solution would be to allow customers to also move low priority jobs in order to create extra “free space” and thereby make way for more orders. This solution requires that jobs and customers are segmented and assigned a given priority such as illustrated in table 2.

Table 2 – Job and customer priority rules

Jobs: Customers:	High priority (red)	Medium priority (yellow)	Low priority (green)
High priority	Orders are unlikely to be moved (customer requests change)	Orders might be moved (customer requests change)	Orders can be moved (customer initiate change)
Medium priority	Orders can't be moved	Orders are unlikely to be moved (customer requests change)	Orders might be moved (customer requests change)
Low priority	No access to view plans		

Assigning customer priority is a manual task. Job priorities need to be assigned automatically to allow the system to work without consuming extra resources. High priority jobs are typically related to bottleneck resources or customer orders with little or no slack. Low priority jobs could either be related to customer orders with slack or it could be stock orders. Cancellation or reduction of stock orders (jobs) might lead to higher costs depending on the details (in case of high setup costs the ERP-system might generate a stock order in connection with a customer order to reduce the total costs).

The planning approach could work in a more or less manual version where the customer-initiated changes are updated manually, but a more integrated approach would be more beneficial for all parties but also more costly. In both cases the production plan needs to be generated individually for each partner, allowing him to only view details of own orders/jobs whereas other orders/jobs only appear as a coloured (red/yellow/green) anonymous job.

One might ask why any company should allow customers to make changes to current production plans and the answer is quite simple: to be attractive and flexible and thereby increase their competitiveness for high- and medium-priority customers. A simple comparison with our own diary would immediately create an understanding of the potential of segmenting and colouring our appointments - avoiding that we are left out of important meetings/activities because of minor/moveable arrangements.

7. Conclusion

In the highly competitive market that most companies find themselves in it is vital to organise the manufacturing and supply chain operations in the best possible way. The first step in this

development process is to organise the internal operations in an appropriate and fruitful way, but for most companies there are similar improvements to be made by involving supply chain partners in the planning process. Information access and visibility, new planning and control principles, collaborative mechanisms and new information tools have to be developed in order to meet the particular challenges of SMEs in non-hierarchical networks. The paper discusses the current state of the art applications and outline a new approach titled "Work Bench" to further improve the planning with special focus on non-hierarchical networks. Especially a simple approach to align production plans is presented.

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A Responsive Pricing Model for Communication Services in Small and Medium Enterprises

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Abstract: Small and medium enterprises (SMEs) typically don't have the necessary IT (Information Technology) resources to deploy, integrate and manage their communication services. For that reason, they need preconfigured, fully integrated equipment that can be easily installed, used and maintained by non-IT experts. The applied pricing mechanism for those communication services should dynamically change with users' needs regarding quality of service (QoS) if economic and network efficiency are to be achieved. In this paper we propose that SMEs deploy the bandwidth management server (BMS) in order to optimize the price they pay for communication services in accordance with desired bandwidth for each service. We have developed BMS that automatically performs calculations in short time intervals, considering network congestion and network capacity utilization, desired bandwidth and maximal price the user is willing to pay.

Keywords: Small and medium enterprises; Communication services; Pricing mechanism; Quality of service; Bandwidth management server.

1. Introduction

High speed Internet access and advances in network technologies provide new opportunities for small and medium enterprises (SMEs) to become more efficient and competitive by interconnecting sites, deploying collaborative applications, increasing access to data inside and outside the office (telecommuters) and integrating heterogeneous telecommunication services. Next generation Internet must allow the continuity and interoperability with existing networks and at the same time enable the implementation of new capabilities (ITU-T, 2005). Pricing scheme should enable optimization of available network capacity and effective network resource utilization to Internet service providers (ISPs) who tend to maximize their revenues while providing users the required service quality at acceptable price. Pricing is the process of determining tariffs, i.e., cost per unit. It is based on particular pricing model and controlled by a pricing policy. Quality of Service (QoS) differentiation introduces a clear need for incentives to be offered to users to encourage them to choose the service that is most appropriate for their needs. In commercial networks, this can be most effectively achieved through pricing. NGN (Next Generation Networks) must be flexible enough to enable the use of different pricing models. Pricing model should fulfill a trade-off between providing satisfying user's utility and

provider's revenue, still preserving implementation efficiency and feasibility. User's utility can be expressed as a function of the amount of available network resource offered to a user which indicates a user's sensitivity to changes in QoS. QoS is negotiated between the provider and the user for each traffic flow and this process results in the contract called Service Level Agreement (SLA). During SLA negotiation, the provider estimates resource usage according to the required traffic profile. During the service provisioning interval, the usage-based traffic monitoring should be applied, but only with respect to deviations from contracted traffic profile. Such approach needs less storage of monitoring data in comparison with monitoring per unit of consumption and should be implemented only at the edge routers, in which traffic conditioning is performed. The actual price is calculated at the end of service provisioning interval according to provider's specific policy, which should aim to force customers to wisely select the most appropriate traffic profiles and to properly adjust to them.

In this paper we propose that SMEs deploy the bandwidth management server (BMS) in order to optimize the price they pay for communication services in accordance with desired bandwidth for each service. We developed BMS that performs calculations in short time intervals, considering network congestion and network capacity utilization, desired bandwidth and maximal price the user is willing to pay without any users involvement.

The paper is organized in the following way. In Section 2 a brief overview of communication services characteristics for SMEs is given. Pricing issues of communication services are discussed in Section 2. Responsive pricing modeled in form of a Stackelberg game between users and ISP is explained in Section 4. Proposed algorithm and simulation results are presented and analyzed in Section 5. In Section 6 concluding remarks are given.

2. Communication Issues for SMEs

Unlike large enterprises, SMEs typically don't have the necessary IT (Information Technology) resources to deploy, integrate and manage these services. For that reason, they need preconfigured, fully integrated equipment that can be easily installed, used and maintained by non-IT experts (Stojanović & Aćimović-Raspopović, 2006a). The requirements for such equipment encompass a variety of features (Figure 1) such as:

- High speed internet access via ADSL, Cable, UMTS, or other technology converted to Ethernet
- VPNs based on both Internet Protocol Security (IPSec) and Point-to-Point-Tunneling-Protocol (PPTP) for site- to-site and teleworkers respectively
- WiFi at each site with integrated security and authentication
- Authentication, Authorization and Accounting providing complete control and auditing of network resources
- Firewall management, either basic or authenticated stateful firewall for each external link and VPN
- VoIP Gateway for routing between PSTN and IP networks
- IP PBX with a comprehensive feature list for inbound and outbound call management
- QoS and bandwidth management for service and user prioritization and ensuring voice quality
- Web server for intranet, extranet, or Internet
- Intranet out-of-the-box with standard collaborative services
- Email and associated services (SMTP, POP, IMAP, Webmail, anti-virus, anti-spam) for email hosting (or relaying)
- File and printer sharing for office desktop user collaboration.

- Storage with quota management and automatic backup to a local disk or remote server
- Remote configuration and support
- WAN capabilities between sites.

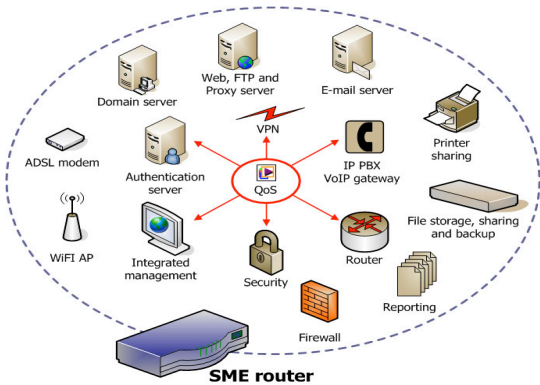


Figure 1 – SME device functionality

On the other side, fulfillment of such requirements poses a number of new issues to service providers, particularly with respect to a unified, highly automated network and service management system. Figure 2 illustrates what is necessary to enable:

- Remote support and maintaining
- Tight monitoring and control over network service usage
- Security alerts on 24hours/7days basis
- Automatic data backup
- Redundancy.

A basic requirement for service integration is QoS support. Providing end-to-end QoS in the IP-based networks requires implementation at the network level a variety of mechanisms and algorithms dealing with the call and packet handling, as well as network resource management.

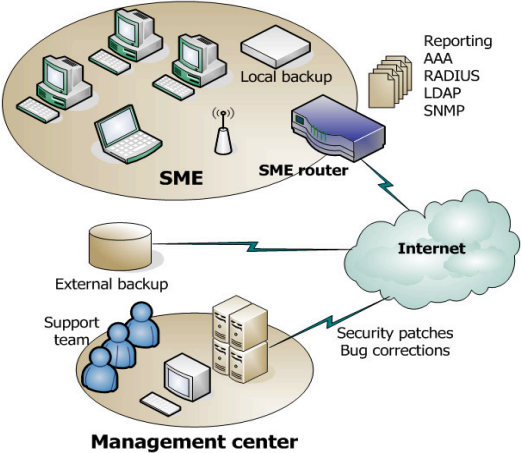


Figure 2 – Remote management of SME equipment

They should operate at different time scales, from picoseconds to milliseconds for handling packets in the routers up till hours and days, for performing certain control and management

operations. Furthermore, a signaling system is extremely required to inform the network about the user application needs. As a consequence, enhanced QoS architectures mainly based on the differentiated services concept (DiffServ) have been investigated and tested in research networks.

3. Pricing issues of communication services

The growing demand for deploying QoS in IP-based networks poses a number of issues related with the accounting functions. Accounting in advanced multiservice IP-based networks can be structured either as transport-based or content-based (Pras, Van Beijnum, Sprenkels & Parhonoyi, 2001). The transport accounting assumes charging of users for transfer of some amount of information over the IP-based network. In QoS-enabled IP networks there is a need for shifting from simple charging schemes such as duration based or flat rate based charging towards the usage based charging (Courcoubetis, Kelly, Siris & Weber, 2000). with different tariffs assigned to different service classes. Still, operators of QoS-enabled networks require simple charging schemes with which they can fairly recover costs from their users and effectively allocate network resources. The goal of the content-based accounting is to charge users for the contents of services that are delivered over IP network. The interest in content accounting arises with the fast growth of commercial offerings over the IP networks, e.g. video on demand, software distribution and mobile IP services.

Considering scalability as a fundamental requirement for multiservice IP networks, the DiffServ approach to QoS provisioning comprises standard-compliant (Blake, Black, Carlson, Davies, Wang & Weiss, 1998), (Nichols, Jacobson & Zhang, 1999) or proprietary architectures that have a common property that packets belonging to different traffic flows, but with similar QoS requirements, may be associated to the same service class and processed at the network nodes in the same manner. Complex processing operations are performed at the edge routers, while core routers perform simple and fast operations.

In general, pricing schemes have to be defined and evaluated with respect to the heterogeneous technical, economic and social aspects (Falkner, Devetsikiotis & Lambadaris, 2000). The main evaluation criteria encompass efficiency in the sense of maximizing utilities of customers and the provider, fairness and feasibility. Additional challenge of DiffServ-based services pricing is to adjust to DiffServ framework main features: simplicity, operation over the existing IP-based infrastructure and pushing complexity to the network edge.

SLA can be negotiated either statically or dynamically, in which case a signaling protocol for negotiation of on-demand service is required. SLA consists of a set of descriptors and associated attributes that describe the particular service class and the traffic profile. It also includes information about tariff and billing principles, as well as penalties for both user and provider in the case of contract violation. The logical structure of SLA (Grossman, 2002) is presented in Fig. 3. Service Level Specification (SLS) describes technical parameters of the SLA. Traffic conditioning agreement (TCA) is a part of the SLA that defines rules for packet classification and traffic profiles, by description of temporal traffic properties, e.g. the rate and burst size. Metering, marking, shaping and discarding rules are also defined, in order to enforce customer's traffic to a particular profile. Traffic Conditioning Specification (TCS) is a technical part of the TCA and also a constitutional part of the SLS.

TCS parameters are a means for control of the amount of resources that each IP flow is using. Therefore, a DiffServ pricing scheme can co-estimate TCS parameters in order to charge the user (Bouras & Sevasti, 2004). Relationship of the TCS and the pricing scheme is illustrated in Figure 3, on the example of well-known token bucket conditioner. Common notation for token bucket is TB (r, b), where r represents the rate of tokens, while b denotes the depth of the bucket.

Parameter r corresponds to the peak or committed information rate and can be used to estimate bandwidth usage, while parameter b represents a measure of peak or committed traffic burst size and can be used to evaluate buffer occupation in network routers.

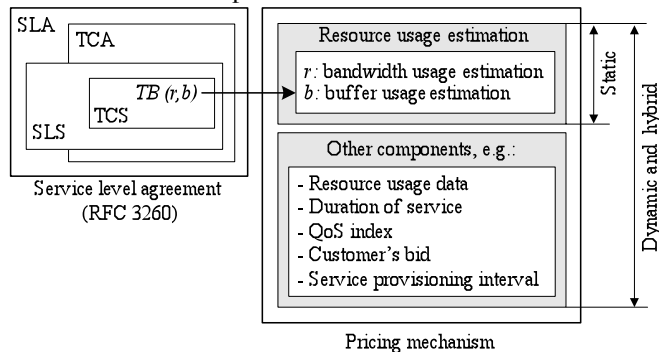


Figure 3 – SLA and its relationship with pricing mechanism parameters

SLA is a starting point for accounting management in the DiffServ network. The use of SLA as the only component of pricing scheme leads to a static or a priori pricing, which is based on anticipation of resources usage, according to corresponding SLA terms. In the broader sense, static approach corresponds to the expected capacity pricing, introduced by Clark (Clark, 1997) and originally designed for ATM and Integrated Services (IntServ) IP networks. Expected capacity represents the user's expectations in the sense of one or more performance metrics, when the network is congested. It can be specified in many ways, including minimum required capacity, maximum delay or an effective bandwidth (a measure of resource usage, which takes into account statistical characteristics of the traffic source type and the QoS requirements) (Courcoubetis, Kelly, Siris & Weber, 2000), (Chao & Guo, 2002). Expected capacity pricing may be applied at the edge routers, thus fulfilling the basic DiffServ objectives.

The main advantage of static pricing refers to its simplicity – measurements of the traffic are not required at all. However, deficiencies concern charging of users who either under-utilize or over-utilize resources that correspond to their contracted traffic profiles. In the former case, a user would be charged for more resources than it actually consumes. In the latter case, there is a risk of exhaustion of resources, and consequently deterioration of QoS delivered to legitimate customers, without penalties for users who over-utilize the resources.

Dynamic or a posteriori pricing is an opposed approach, in which tariff is determined as a cost per unit of consumption and according to level of QoS guarantees provided for the observed service class. Such approach is similar to a number of traditional usage-based pricing schemes that have been proposed to handle short-term congestion, e.g. responsive pricing, smart market pricing, admission control procedure and bandwidth assignment, etc. The main problem with dynamic pricing refers to the need of intensive monitoring of network resources in order to dynamically adjust per-class prices to resources usage and the QoS provided for each service class. Another problem arises from a purely economic point of view, because real economic efficiency for the provider allowing highly variable utility functions over short-term intervals seems to be an unrealistic objective (Falkner, Devetsikiotis & Lambadaris, 2000).

There is also a hybrid model of DiffServ pricing that combine benefits and mitigate deficiencies of both static and dynamic pricing models where tariffs for particular service classes alter over reasonable service provisioning intervals (Bouras & Sevasti, 2004a), (Bouras & Sevasti, 2004b). Prices in DiffServ framework should initially play the role of mediator between the user and the provider, thus forcing the customer to wisely select the most appropriate traffic profile.

In a good pricing scheme, service price should also reflect the users satisfaction with the service. An ISP can exploit the adaptive nature of users to increase network and economic efficiency using responsive pricing model. Congestion arising from system limitations can be alleviated by a usage based scheme with users getting charged for the amount of bandwidth they consume.

4. Responsive pricing model

We analyze the service model for partially elastic users who perceive quality of service solely as a function of the average bandwidth. Pricing issue is treated as an optimization problem with ISP and users behaving as Stackelberg leader and followers (Webb, 2007), (MacKenzie & DaSilva, 2006), (Courcoubetis & Weber, 2003). Each user gives his parameters of desired bandwidth and maximal price per unit of bandwidth he is willing to pay to the ISP. Then the agreement on the time period a user will be charged for service consumption has to be settled. It is usually long time period, e.g. a month or more. Our goal was to develop a mechanism that dynamically adapts to traffic conditions in network in much shorter time intervals, so that both ISP and users benefit from it.

In this paper we use the responsive pricing concept that describes a dynamic price-setting strategy imposed by ISP, illustrating how ISP can exploit the adaptive nature of users to increase economic and network efficiency. Responsive pricing is based on the assumption that users are adaptive and respond to price signals (Market Responsive Pricing Model, 2004). In the case of high network utilization, resources are stressed and the ISP increases the prices for the resources. Adaptive users then reduce the traffic offered to the network. Similarly, in the case of low network utilization, the ISP decreases the price and adaptive users increase their offered traffic. In this scheme, both network and economic efficiency are increased.

Users' preferences may be modeled through utility functions, which describe how users are sensitive to changes in Quality of Service (QoS). Utility can be expressed as the amount of money each user is willing to pay for certain QoS guarantees. Ideally, utility should be expressed as a function of actual QoS parameters, such as delay or packet losses (Cocchi, Shenker, Estrin, & Zhang, 1993). (DaSilva, Petr & Akar, 1997). However, it is impossible to predict such measures of quality in most real networks and they are closely dependent upon factors like traffic models, scheduling disciplines and network topology. Therefore, utility is often expressed as a function of the amount of available network resource offered to a user (Cao & Zegura, 1999), (DaSilva, 2000), (Ganesh, Laevens & Steinberg, 2001), (Ninan & Devetsikiotis, 2005). In this manner, the utility still indirectly indicates, a user's sensitivity to changes in QoS.

Applications exhibit varying degrees of sensitivity to QoS parameters. For instance, real-time voice and video are very sensitive to delay and jitter and those applications are inelastic in their demand for bandwidth (Ming Chiu & Sai-Wah Tam, 2006), (Meiqin, Haiqiang, Chengnian & Xinping, 2006). Unlike the inelastic applications, traditional data applications such as e-mail tend to be tolerant of variations in delay and can take advantage of even minimal amounts of bandwidth, but they are more sensitive to losses. Those are elastic applications (Kelly, 1997), (Ozdoglar, 2007). There are numerous ways in which real-time applications can be made tolerant of changes in available bandwidth through adaptive coding. However, some minimum bandwidth is nevertheless required.

It is suggested that the basic best-effort architecture be left intact with QoS schemes solely reserved for resource intensive high quality real-time services (Ninan & Devetsikiotis, 2005). Congestion can be alleviated by a usage based scheme with users getting charged for the amount of traffic they consume.

As we explained before, the agreement between ISP and user for service consumption has to be settled, usually for a long time period. In our model, depending on the state of network capacity utilization, BMS allocates available bandwidth simulating users' responses to price per unit bandwidth imposed by the ISP according to their individual utility functions. Allocations are performed in short time scales, i.e. half an hour without further users' involvement. The solution of the problem encompasses the optimal bandwidth allocation and the optimal price for that allocation. Each user has to pay the price that is equal to the sum of products of each optimal price and his bandwidth consumption during all his sessions in agreed time period.

QoS requirements induce each user i to request a bandwidth of θ_i from the ISP. The ISP employs a usage based pricing policy by charging M per unit bandwidth consumed. Both the ISP and the users are rational, profit maximizing entities. Further users are assumed to be non-cooperative and refuse to reveal their utility functions to one another in the fear of being misused.

A utility function which best models user behavior is a generalization of the logarithmic function employed, tailored for a connection oriented setting. QoS is defined by bandwidth obtained from the ISP. Depending upon the quality of service requested, each user would require a minimum bandwidth γ . Fewer bandwidth than γ on average are of no utility to the user (Ninan & Devetsikiotis, 2005).

The law of diminishing marginal utility ensures that the user derives the same amount of satisfaction from any bandwidth more than the maximum π (Figure 4).

It is considered that the user is willing to pay a maximum m per unit of bandwidth. When the network price M equals the maximal price m , the user will desire only the minimum acceptable bandwidth, γ . Any price beyond the maximal price reduces the user's desired bandwidth to zero. Over the interval $m\gamma/\pi \leq M \leq m$ the desired bandwidth θ decreases logarithmic with price with π . Dependence of desired bandwidth with price for arbitrarily chosen user is shown on Figure 4.

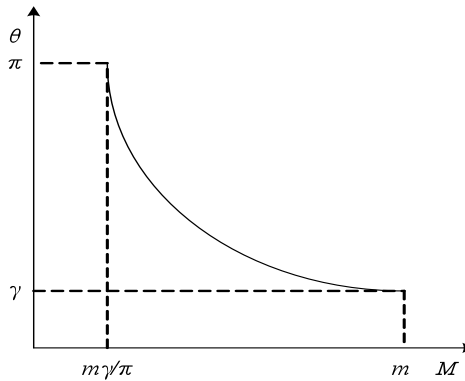


Figure 4 – Desired bandwidth

According to (Ninan & Devetsikiotis, 2005), user utility function can be shown to be:

$$U(\theta) = \begin{cases} m\theta, & \text{if } 0 \leq \theta \leq \gamma \\ m\gamma (\log(\theta/\gamma)) + 1, & \text{if } \gamma < \theta \leq \pi \\ m\gamma (\log(\pi/\gamma)) + 1, & \text{if } \pi < \theta \end{cases} \quad (1)$$

This utility function (Figure 5) is concave and non-decreasing. Also, U is strictly increasing in interval $[0, \infty)$ only when $\pi \rightarrow \infty$. The case of strictly elastic users can be recovered by setting $\gamma = 0$ and $\pi \rightarrow \infty$, thereby rendering U strictly concave in $[0, \infty)$. Therefore, the utility function encompasses a wider spectrum of user behavior by incorporating the range of user bandwidth request (Cocchi, Shenker, Estrin & Zhang, 1993).

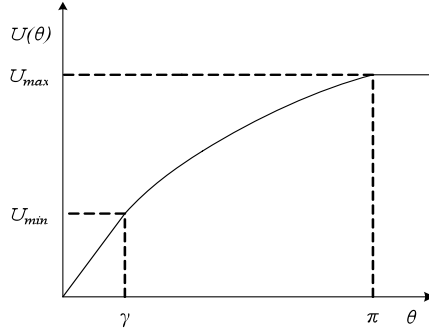


Figure 5 – User utility as a function of bandwidth

We suppose that the shape of these functions (shown in Figures 4 and 5) is the same for all users, but parameters γ , π and m are different for different users.

We also assume that in the network only one critical link exists, concerning high bandwidth/resource utilization. It is a reasonable assumption in a properly designed network (Stojanović&Aćimović-Raspopović, 2006). Such a link usually does not behave badly all the time, but only under certain worst-case conditions.

Ideally any resource allocation between users should ensure that the total user utility is maximized. The optimal bandwidth allocation is obtained by solving the problem:

$$\max_{\Theta} \sum_{i=1}^N U_i(\theta_i), \sum_{i=1}^N \theta_i \leq C \quad (2)$$

where C is the total capacity of the critical resource link.

Because of the non-cooperative setting assumption, we need to develop a distributed algorithm which can be used by BMS for updating each user bandwidth allocation without revealing utility information to other users. The user will try to choose its bandwidth θ which will maximize its net benefit (i.e., utility minus cost) $U(\theta) - M\theta$. Thus individual users can solve the simpler problem:

$$\max_{\theta_i} U_i(\theta_i) - M\theta_i \quad (3)$$

The value of θ maximizing utility function (under conditions $0 \leq M \leq m$ and $\gamma \leq \theta \leq \pi$) is:

$$\theta^*(M) = \frac{m\gamma}{M}. \quad (4)$$

In practice, it would be impossible for each user to update its bandwidth in short time scale. Instead of that, updates are performed by BMS. On the other hand, the ISP's utility T depends on the total revenue generated and hence is a function of the market price and the bandwidth allocated to the various users:

$$T(M, \theta) = M \sum_{i=1}^N \theta_i(M) \quad (5)$$

It is assumed to be monotonically increasing and strictly concave. The ISP chooses an appropriate market price by solving the optimization problem:

$$\begin{aligned} \max_M T(M, \theta^*) &\equiv T\left(M \sum_{i=1}^N \theta_i(M)\right) \\ \max_M M \sum_{i=1}^N \theta_i(M), \quad \sum_{i=1}^N \theta_i &\leq C, \quad M \geq 0 \end{aligned} \quad (6)$$

User's utility function can also be shown as a function of price. Substituting (4) in (1) for a previous condition, we obtain:

$$U(M) = m\gamma (\log(m/M) + 1) \quad \text{if } m\gamma/\pi \leq M \leq m \quad (7)$$

In Figure 6, user's utility as a function of price, for an arbitrary user, is presented.

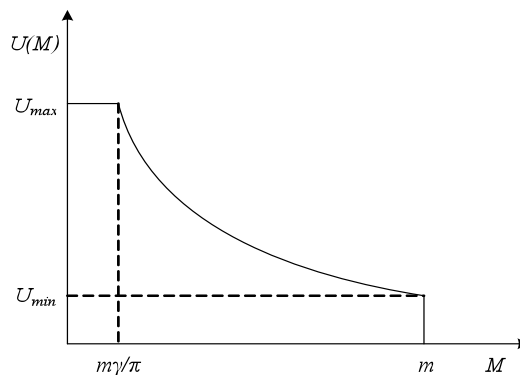


Figure 6 – User's utility as a function of price

Our scenario can be modeled in form of a Stackelberg game. The Stackelberg model is considered as a leader-follower competition model. It is a strategic game that can be played with either price leadership or quantity leadership. Our research is based upon price leadership.

In a Stackelberg game, there is at least one player defined as the leader who can make the decision and commit the strategy on the price before other players who are defined as followers. In such a game players play in a definite sequence. The strategy chosen by the leader can be observed by the followers, and the followers can adapt their decisions accordingly. In a Stackelberg game, due to the timing in decision making, the interaction between the leader and the followers is dynamic rather than static. The leader can choose a strategy such that the profit is maximized, given that the followers will choose their best responses. This is defined as the Stackelberg equilibrium and can be obtained by backward induction technique. With backward induction, the best responses of the followers are obtained first. The best responses of the players in this leader-follower competition can be obtained in the following way. Given the price offered by a leader (i.e. service provider), based on a demand function, the amount of requested bandwidth from the followers (i.e. users) can be determined. For example, if the price is high, the amount of requested bandwidth from the users will be small and vice versa. Then, this best response is used to compute the profit of the leader, and the leader chooses a strategy for which the profit is maximized. The equilibrium is located at the point where all the best responses intersect with each other.

In our model, players are ISP as the leader and users acting as followers. The ISP initializes its algorithm by assigning an initial price M^0 randomly or based on historical data. The price

offered by the ISP, which maximizes its profit, along with the best response bandwidth of each user constitutes the Stackelberg equilibrium — that is $M^* = \arg \max_M T(M, \theta^*(M))$.

5. Pricing algorithm

In our pricing algorithm, where users are charged for variable bandwidth usage, bandwidth consumption and the price for that consumption are optimized. Prices optimization is performed for a single critical resource link in an ISP's network. On the observed link, the total number of users is N (Figure 7). Algorithm consists of S rounds and in each round s , l_s iterations are performed, where $s = 1, 2, \dots, S$. Each round s consists of the following iterative steps:

- Step 1: ISP proposes price: M^{0s} for $s = 1$ and $M^{0s} = k_s M^{\min(s-1)}$, where k_s is a factor slightly lower than 1, $M^{\min(s-1)}$ is a minimal considered price in a circle $s-1$ for $s = 2, 3, \dots, S$, and $M^{0s} > 0$.
- Step 2: For the price M^{0s} , BMS calculates desired bandwidth for each user i , $i = \overline{1, N}$ (Eq. 4) and a set $\theta^{0s} = \{\theta_1^{0s}, \theta_2^{0s}, \dots, \theta_N^{0s}\}$ is determined. Elements of that set are desired bandwidth consumptions of all users for the price M^{0s} .
- Step 3: Calculation $\sum_{i=1}^N \theta_i^{0s}$ is performed.
- Step 4: If $\sum_{i=1}^N \theta_i^{0s} < k_e C$, total sums $T^{0s}(M^{0s}, \theta^{0s}) = \sum_{i=1}^N M^{0s} \theta_i^{0s}$ and $\sum_{i=1}^N U_i(\theta^{0s})$ are calculated; after that, new price M^{1s} is calculated: $M^{1s} = k M^{0s}$, $0 < k < 1$ and it crosses over to a new iteration with new price $M^{1s} < M^{0s}$.
- Step 5: If $\sum_{i=1}^N \theta_i^{0s} > C$, the ISP set new price M^{1s} : $M^{1s} = k M^{0s}$, $k > 1$ and it crosses over to a new iteration with new price $M^{1s} > M^{0s}$.
- Step 6: If $k_e C \leq \sum_{i=1}^N \theta_i^{0s} \leq C$, it crosses over to a new circle $s+1$. Factor k_e points to high level of utilization of total capacity C and we choose $0.95 \leq k_e \leq 1$.

The ISP initializes its algorithm by assigning initial prices based on historical data. In the each next step, initial prices are decreased by factor k_s , so in the circle $(s+1)$: $k_{s+1} = r k_s$, $0.8 \leq r < 1$. After S circles, graphs T and U for values θ and M satisfying condition $\sum_{i=1}^N \theta_i^{ls} \leq C$ are created.

$$\text{The point } M = M_{opt} \text{ for } \max_M T(M, \theta^*) \quad (8)$$

is the Stackelberg equilibrium. Allocation for that price is the optimal allocation.

After executing a number of simulations, we noticed that for fixed number of users the marginal value of total network capacity of the critical link can be determined. Increasing that

value ISP revenue doesn't increase. Following that direction, we analyzed provider's benefit as a function of critical link capacity. We assumed that besides price optimization and bandwidth utility optimization, the ISP should also optimize its capacity amount offered to users. The optimization procedure is the same as in the previous algorithm with the exception of additional variable – the critical network link capacity. In each circle, iterations are performed with different values of the critical link capacity, in such a way that $C_1 < C_2 < \dots < C_S$. The Stackelberg

equilibrium is attained for $M = M_{opt} \wedge C_1 = C_{opt} \max_{M,C} T(M, \theta^*, C), \sum_{i=1}^N \theta_i \leq C, M \geq 0$

The corresponding bandwidth allocation is the optimal bandwidth allocation.

In this algorithm each user receives different amount of bandwidth dependently of given parameters of desired bandwidth and maximal price he is willing to pay to the ISP. Actually, there are different types of users with different expectations regarding expected capacity and price they are willing to pay for using that capacity.

Users' behavior is expected to be rational. Knowing the rules of pricing concept, users have no motivation to give other than their true valuation of the maximum price per bandwidth unit.

For each user, bandwidth and price parameters are parts of the SLA. Each user gives his parameters of desired bandwidth and maximal price i.e. γ, π and m , that can't be changed during the agreement duration/period. The bandwidth allotment to user i is denoted as θ_i^* and that is his best response to the price ISP determined for half an hour period. If he sets maximal price m to be higher than he is willing to pay for using demanded bandwidth, his utility decreases. If he sets maximal price m to be lower than he values demanded bandwidth, he might not receive desired amount of bandwidth, i.e. QoS he desired. Moreover he could lose his sessions during periods of network congestion. Therefore, the dominant strategy of each user is to give his true valuation of the maximum price per bandwidth unit.

Simulation results

For the purpose of carrying out simulations of the pricing algorithms, we developed software in C#. The software is performed by BMS that allocates available bandwidth according to the state of network capacity utilization. Interfaces for determining optimal price maximizing total ISP revenues and total users' utility of critical network link, total ISP revenue and total users' utility graphs for one simulation and bandwidth distribution among users for that case are presented in Figure 7. Algorithm and network parameters can be varied. For application in Figure 7 we chose following values: $k = 0.05$, $k_s = 0.85$, $k_e = 0.95$, $N = 100$ and $C = 10000$. Price and users' parameters can also be varied in certain range. In example of BMS application (Figure 7) we chose: $M^{0s} = 0.5 \div 1.5$, $m = 1 \div 1.4$, $\gamma = 15 \div 20$, $\pi = 25 \div 30$.

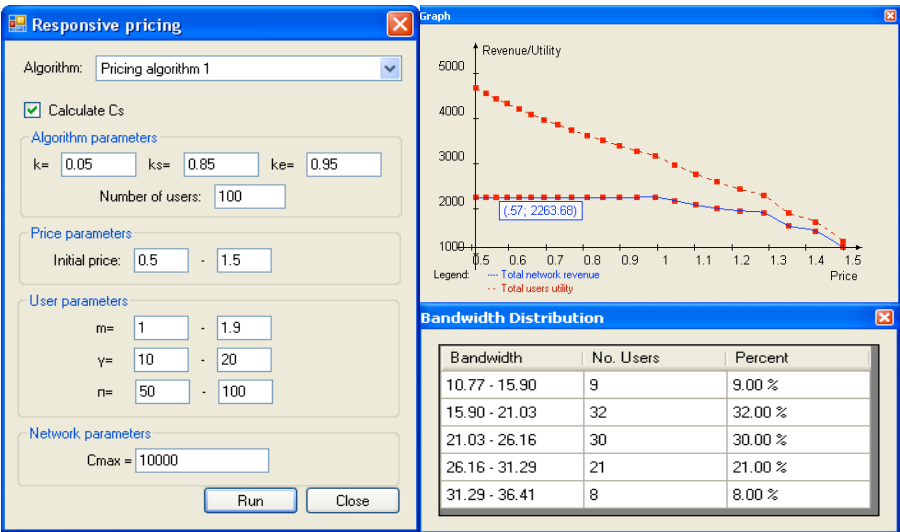


Figure 7 – Users interface, revenue/utility as a function of price and bandwidth distribution

6. Conclusions

Provider provisioned DiffServ-based VPNs seem to be a promising solution for SMEs to become more efficient and competitive in the market. Since they usually do not employ IT experts to deploy, integrate and manage their communication services they should use preconfigured, fully integrated equipment that can be easily installed, used, maintained and remotely managed.

Different services they use require different QoS that is to be negotiated with the provider and result in SLA. During SLA negotiation, the provider estimates resource usage according to the required traffic profile. Pricing of services should be in accordance with the desired QoS. The main pricing criteria encompass maximizing utilities of both the customer and the provider, fairness and feasibility. To achieve these goals pricing scheme should enable dynamic change with the state of network resources usage. For users like SMEs this change should be performed automatically and be in accordance with SLA with ISP.

In this paper the possibility for implementing responsive pricing scheme in the next generation Internet is analyzed. We developed algorithm that solve the pricing optimization problem with ISP and users behaving as Stackelberg leader and followers. We verified the proposed model through simulations using the developed Bandwidth Management Server. BMS allocates available bandwidth among users depending on the level of congestion so that both total users' utility and total ISP revenue are improved. The important advantage of presented pricing model is ensuring a high level of network utilization and stimulation of each user to choose the level of service. ISP takes into account users preferences and charges them in accordance with the quality of delivered service.

Acknowledgment

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Collaborative Multisite PLM Platform

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Abstract: The product development is a result of a collaborative design process in network. The national research network in the field of product and process integrated engineering (INPRO) main objective is the Product Lifecycle Management (PLM) concept and solution promotion through the Romanian industry. In this context, was built a collaborative multisite platform for product and its associated processes that join together the methodological approach, methods and tools for Product Lifecycle Management (PLM), Knowledge Management (KM) and Human Resources Management (HRU), examples of good practice. In the paper are presented: the product lifecycle model which is the base for the proposed collaborative product development methodology and the multisite PLM platform. The universities partners' PLM platforms and the potential industrial partners have connected through Internet/ Intranet.

Keywords: Product Lifecycle Management (PLM), multisite platform, collaborative product development, conceptual design.

1. Introduction

Integrated product and processes development supposes to consider all the knowledge about the product lifecycle from the beginning of product design stage, by integrating the user requirements, with the quality, terms and costs constraints (Draghici, 1999), (Usher, Roy & Parsaei, 2005). Therefore, we can talk about the whole product lifecycle integration and management (Stark, 2005).

In the same time, many product development projects require cooperation between research teams with different competence, which are geographical distributed. When such a project/product team is set up, all the require knowledge must be considered to solve a certain design problem in a collaborative environment. The product development process has changed dramatically in the last time because of the progresses in the information and communication technology field. Nowadays, the product development is a result of a collaborative design process in network (Shpitalni, Guttman, & Bossin, 2005).

The partners' collaboration and synergy in the National Research Network for Integrated Product and Process Engineering (INPRO) (Draghici & Draghici, 2007) was adapted to the actual requirements of product development. In this context, was built a collaborative multisite platform for product and its associated processes (Draghici, Savii & Draghici, 2007), (Draghici, Savii & Draghici, 2008), that join together the methodological approach, methods and tools for Product Lifecycle Management (PLM), Knowledge Management (KM) and Human Resources Management (HRU), examples of good practice.

In the paper are briefly presented: the product lifecycle model which is the base for the proposed collaborative product development methodology, the human resources competencies database development, and the multisite PLM platform infrastructure.

2. Product Lifecycle Model

The collaborative product development model integrates knowledge from all the product lifecycle activities. For the product lifecycle representation there can be used different methods and modeling languages. Among them, there have been choose the IDEFØ (integrated Definition Method) (www.idef.com/pdf/idef0.pdf) as our preliminary research approach. This allows researchers to define the platform needs and also, its future structure.

IDEFØ is a method designed to model the decisions, actions, and activities of an organization or system. IDEFØ was derived from a well-established graphical language, the Structured Analysis and Design Technique (SADT).

The followed purpose is the deep analyze of each product lifecycle activity, under different aspects: the role of each activity, sub activities deployed, the transform parameters, the supports that allowed the development and control of an activity, the information exchange. In this context, IDEFØ method best attend the declare purpose. Each activity can be representing under a modular and graphical form, using arrows with a specific signification. One activity transforms input into output data. The activity development need assistance tools and control tools that allowed its development start or control.

For the representation of the product lifecycle model there have been used the iGrafx 2007 software (www.igrafx.com), which contained the IDEFØ module. The superior level diagram A0 (Figure 1), has defined by the product lifecycle specific activities: needs analysis, design, manufacturing, use, disposal. There was adopted a top-bottom approach which allowed a progressive detailed from general to particular aspects for a clear and complete product lifecycle modeling.

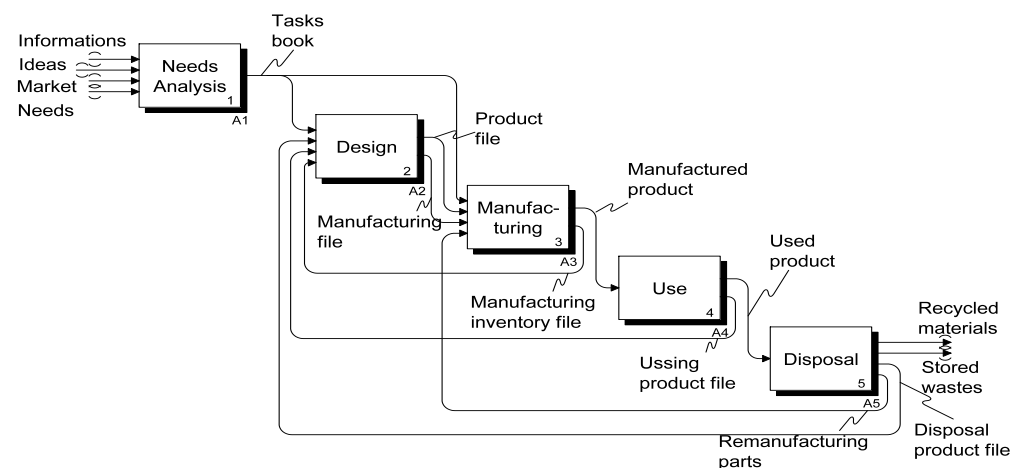


Figure 1 – A0 Diagram – Product lifecycle activities

The superior level diagram, named A0 (Figure 1), has defined by the product life cycle specific activities:

A1 Activity: Needs analysis. The objective is to identify and formulate the needs for product development. The initiation of this activity is determinate by many factors as: a new market perception, an idea and technical and/or commercial un-satisfaction user perception. These correspond to some marketing function roles. The result of this activity is the product task book.

A2 Activity: Design. The activity's inputs are the product task book and the feedback information from manufacturing, use and disposal phases. Using design methods and the study of possible alternatives there can be chosen the conceptual solution which followed the embodiment design and detailed design phases; the process planning is then, defined. Finally, is defined the product file and the manufacturing file that are needed for the following activities.

A3 Activity: Manufacturing, includes preparation and resources allocation for the components manufacturing deployment and for product assembly and so, it becomes ready for delivery. The information results from the manufacturing phase are included in the manufacturing management file that can be use for product design improvement.

A4 Activity: Use. The manufactured product has delivered to the user and his/her expectations have to be satisfied through the use phase. During the use phase, the product is liable to maintainable operations. In the use process all the information are record in the using product file and they had used for the product design improvement, too.

A5 Activity: Disposal. The used product is disposed, at the end of his life cycle. The first action is the disassembly and the components and materials sort in remanufacturing parts that can be inputs for other product assembly components; recycled materials that can be inputs for the supply chain; stored wastes components that have to be destroyed and storage, resulting wastes. All the output information included in the disposal product file can be use for the product re-design improvement, too. Each activity module is the object of a progressive decomposition in diagrams, which contain sub activities, till the elementary detailed level.

3. Human Resources Competencies in the INPRO Network

3.1. Product Life Cycle Ontology

In order to have a global view on the expertise of the INPRO national research network members, ontology was developed to describe the domain of interest: product life cycle. This was the second phase of the research approach for defining the input knowledge resources of the PLM multi site platform.

The creation of the ontology describing the product life cycle started with the evaluation of the network members' expertise. This conceptual formalization of the domains in the product life cycle will be used as a basis for applying intelligent search algorithms with the aim to select the specific task team members (Shpitalni, Guttman, & Bossin, 2005). Six concept categories were defined, which determined the first hierarchical level in the ontology: design, manufacturing, usage/ maintenance, end of life cycle. Each category was further divided and a form was designed and distributed to the network members. A snippet from the ontology, created using Protégé (Protégé, 2007, <http://protege.stanford.edu>), for the design stage, is presented in Figure 2.



Figure 2 – Snippet from the product life cycle ontology

3.2. Building the knowledge/expertise map

Information about the network members expertise are processed following a bottom-to-top scheme, starting from those of the persons and ending with that of the network. To be able to automate the data processing, at least partially, for each field in the form which indicates the presence of a competence, the value 1 was assigned, the rest being left with the value 0 (blank).

The first map shows the personal competencies and was created by summing the fields towards the ontology root. A synthesis of the competencies can be done by computing the percentage of the persons in the network that have competencies in each field.

Two significant values result were obtained: (1) the number of competency fields in the domain of the product life cycle for each partner (department/laboratory), and (2) the number of competency fields for each partner, grouped by products. One must note that a greater number of competencies for a person does not mean that this has a greater global level of competency than another person, with a lower number, but possibly with more impact and visibility at international level (in a narrower field). Another map shows the competencies at the network partners level (Table 1 part a and b).

Table 1a – Competencies at the network partners level – I Life cycle

Partner	CO	P1	P2	P3	P4	P5	P6	P7	P8	P9	INPRO
Person	12	9	19	15	12	14	7	6	1	5	100
I. Life cycle	399	569	811	491	614	639	443	312	45	112	4435
Design	269	385	569	233	393	362	247	146	14	65	2683
>Conceptual design	96	113	141	67	134	114	101	49	5	17	837
>Detail design	143	216	353	106	221	181	77	33	9	39	1378
>Support	30	56	75	60	38	67	69	64	0	9	468
Manufacturing	86	155	189	229	185	240	182	133	30	43	1472
>Manufacturing systems	9	11	8	4	18	27	5	6	1	8	97
>Manufacturing processes	38	55	79	165	84	105	111	48	15	13	713
>Quality control	5	17	49	34	12	9	44	30	10		210
>Operation management	5	25	19	19	36	44	12	24	4	14	202
>Manufacturing support	13	32	7	5	27	28	8	12		4	136
>Management support	16	15	27	2	8	27	2	13		4	114
Utilization / Service	27	24	32	17	28	24	10	16		4	182
>Monitoring	5	3	4	4	7	2	4	2			31
>Diagnosis	3	5		1	4		2	2			17
>e-service	1		4	2	3	2					12
Maintenance	2	4		6	8	4	4	2			30
>Support	16	12	24	4	6	16		10		4	92
End of life cycle	17	5	21	12	8	13	4	17	1		98
>Disassembly		2		1	2		1	2	1		9
>Testing								1			1
>Recycling		2	3	1		1	1	1			9
>Refurbishing	1			2		1	1	1			6
>Disposal				1			1				2
>Support	16	1	18	7	6	11		12			71

The analysis of the map can yield information about the poor covered zones (empty spaces in the tables) by certain partners or at the network level, i.e. indications about the domains in which the network must work to gain competencies through the training procedures of human resources.

Table 1b – Competencies at the network partners level – II Products

Partner	CO	P1	P2	P3	P4	P5	P6	P7	P8	P9	INPRO
Person	12	9	19	15	12	14	7	6	1	5	100
II. Products	17	18	17	23	26	40	24	17		3	185
Manufacturing systems	9	13	12	6	18	15	12	10		1	96
Sheet metal process	1			1		2	2	3			9
Home appliances				5		7	4				16
Medical equipment	1					1					2
Automobiles	1	1		3	3	5	1				14
Tools and dies	4	3	2	5	5	3	3	3		2	30
Industrial		1	3	1		2	1	1			9
Microelectro-mech. equip.				2		1					3
Optoelectronic equipment	1					1					2
Furniture						1	1				2
Cloths						2					2

3.3. Creating the database with the network's human resources competencies

The data from the forms were extracted in a neutral format (CSV), and then used to create a usual database (by importing data from CSV text files). For the Microsoft Access application, splitting the data into three tables was necessary, because of the great number of fields (255+255+253). The three tables were linked by relations using key fields. In order to find the person with certain competencies, a usual Access query is launched (Figure 3) or using SQL.

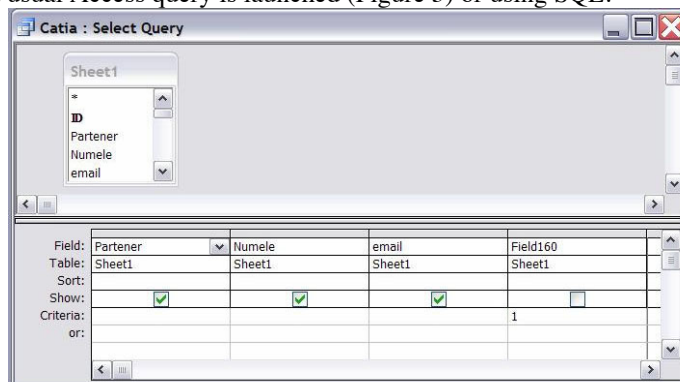


Figure 3 – An Access query about competencies

An Internet based interrogation is in train to be finished, using MySQL. This creates the possibility to query the (sole) competencies database by each partner, from his office or from anywhere an Internet link exists.

4. The Architecture of the Multisite PLM Platform

Based on the preliminary researches concerning the product lifecycle representation and the human resources competencies capitalization and explore, there have been developed the collaborative multisite PLM platform. The main objective and motivation of this approach was to build a collaborative environment for the product design process.

The collaborative product development (Figure 4) is based on the integration of the Product Lifecycle Management (PLM), Enterprise Resource Planning (ERP), Supply Chain Management (SCM) and Customer Relationship Management (CRM) solutions (CIMdata, 2002).



Figure 4 – PLM – ERP – SCM – CRM integration (CIMdata, 2002)

The INPRO universities partners' PLM platform and the potential industrial partners have been connected through Internet/Intranet and they built the multisite PLM platform of the collaborative product development in network. Client-server architecture has been used inside the network (Figure 5). It consists of a four servers cluster, for: Internet/Intranet (S1), databases (S2), PLM and videoconference system.

A preliminary stage of the development process includes the definition and the configuration of the INPRO research network's web page (Figure 6). This is linked also, with the project operational objectives and the partners' integration in the research activities. The web page consists of information regarding: the project objectives and activities, partners' description (link to their own web pages), conferences (scientific events), workshops and meetings that are organized by the partners, research results (with public interest) and the link to the Intranet section that was restricted to the network members only.

Beside the INPRO web page development there have been settled an entire communication system dedicated to the common research work in the network, but also, to the access at some research resources of the European Network of Excellence, Virtual Research Laboratory for a Knowledge Community in Production (www.vrl-kcip.org), in the European Research Area (see Figure 6). Also, with the support of the videoconference system the collaboration was possible.

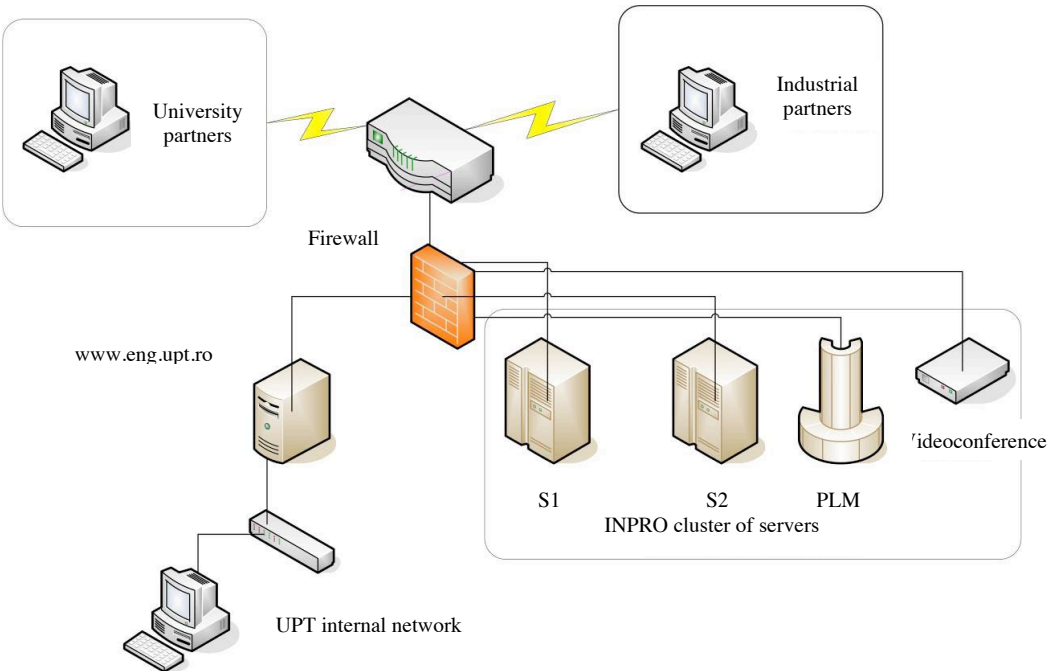


Figure 5 – The collaborative product development network infrastructure

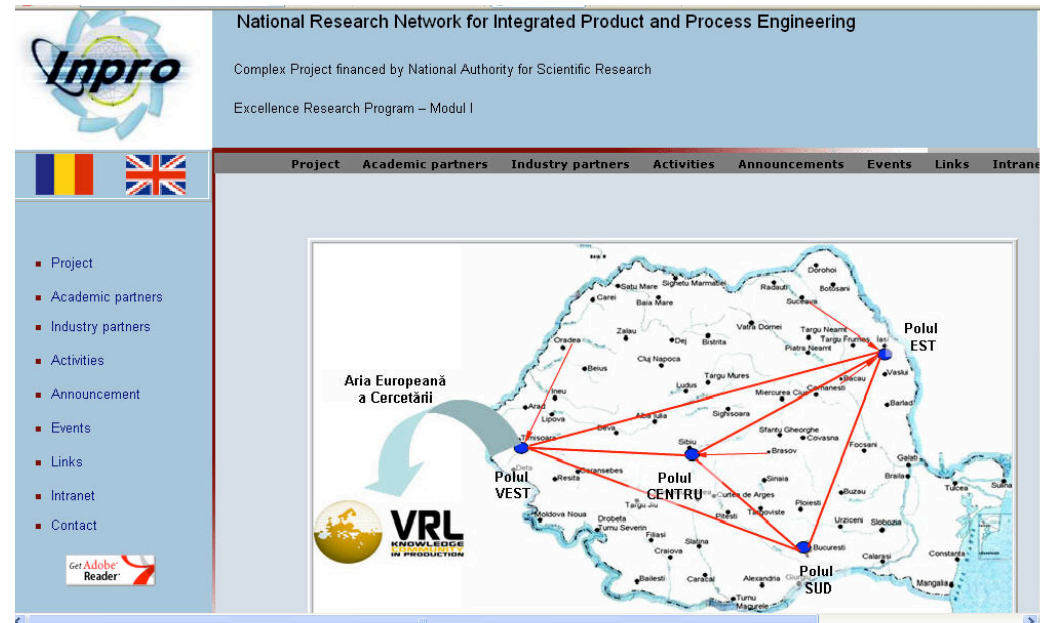


Figure 6 – Detail of the INPRO research network web page

The INPRO partners’ PLM platforms include a large diversity of software. To illustrate the large variety of information technology applications used in such context, the list of CAD/CAM and PDM systems of each partner involved in the PLM multisite platform is shown in table 2.

The most important problem that has to be solved between partners was the compatibility of the design format/representation because of the existing of the different design software. Finally, the Teamcenter Community software solution was the option for harmonizing the design parts delivered by the partners and that have conduct to a final product.

Table 2 – CAD/CAM and PDM systems of each partner involved in the multisite PLM platform

Partners Systems	CO	P1	P2	P3	P4	P5	P6	P7	P8	P9	INPRO
CAD/CAM	8	7	5	8	6	6	6	5	2	6	59
CATIA	1	1	1	1	1	1	1	1		1	9
ProEngineer		1					1			1	3
SolidWorks	1	1		1	1					1	5
Inventor				1		1	1		1		4
AutoCAD	1	1		1		1	1	1	1	1	8
SolidEdge	1		1	1		1	1	1			6
NX			1	1			1	1			4
Tecnomatix	1				1	1					3
DELMIA		1			1					1	3
Other	3	2	2	2	2	1		1		1	14
PDM	1		1	1	1	1	1			1	7
Teamcenter	1		1	1	1	1	1			1	7

5. Conclusions

In the framework of the National Research Network for Integrated Product and Process Engineering (INPRO) it was built a collaborative multisite PLM platform for the product development and its associated processes. The proposed product collaborative development model integrates knowledge from the entire product lifecycle. There have been discussed the product conceptual design phase and there have been presented.

In the paper has presented the main aspects that reflect the achieved stage of the project of building the collaborative product development network: the product life cycle model, the network members' expertise, and the PLM multisite platform infrastructure. The product life cycle model is the base of the collaborative design methodology that has adopted for the PLM multi-site platform. The model of collaborative product development integrated the whole lifecycle. For identifying the persons with the required competencies for a specific project, an Access or an Internet usually query has launched, using MySQL. The universities partners' PLM platforms and the potential industrial partners have connected through Internet/ Intranet, constituting the PLM multisite platform of the collaborative product development network.

The presented research results have been gained in the framework of the Romanian CEEEX Program, National Research Network for Integrated Product and Process Engineering (INPRO) Project (contract no. 243/2006-2008) and the Virtual Research Laboratory for a Knowledge Community in Production (VRL-KCiP) a Network of Excellence project (contract no. FP6-507487).

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EIS Social Aspects

Code of Technoethics Governance for Sustainable Portuguese Organisations – GOTOPS code

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Abstract: Looking at the Portuguese situation related to professions, competences and Codes of Ethics (CE), Conduct (CC) and Code of Practices (CP) of the Information Systems Technology (IST) professionals; we can conclude that such a standard does not exist in Portugal. Some professions have already adopted CE/CC/CP. Physicians, lawyers, and engineers have moral responsibilities and know to whom they are responsible. IST Professionals (ISTP) need similar guidance. The ISTP are the ones that directly contribute to the planning, analysis, specification, design, development, testing, maintenance and certification of the IST. The codes should be dynamic and not static documents. In line with this principle, the objective of the present work is the presentation of the GOTOPS (**GO**vernção **TEC**noética para **OR**ganizações **PO**rtuguesas **S**ustentáveis – Technoethical Governance for Sustainable Portuguese Organisations) interactive voluntary code that was created and which fully includes ethical problems raised by planning, development, management and utilisation of the IST – called “**technoethics**” in this work.

Keywords: Technoethics, GOTOPS voluntary code, model, prototype, orientation directives, IST, ISTP, CE, CC, CP.

1. Introduction

Globalisation is fundamentally due to technological and political developments as they are mainly responsible for the substantial proliferation and spread of territorial connections at global level. Therefore market globalisation raised ethical concerns that only a deep and joint interdisciplinary reflection can lessen by searching for and suggesting paths that promote awareness and consequently socially responsible ethical practices [Campos, 2007b].

With the support of IST, the possibility is open for any person to connect and interact with another one in any place in the world. In this context, in this globalised information society, one still has to add the real scenario, of all the other dimensions – social, environmental and economic (*triple bottom line*) – supported by the technological dimension, the IST. Therefore, besides the image and reputation of all professionals of other business areas and IST users - that need IST for the development of his profession – one has to point out the image, reputation, and responsibility of the IST Professionals (ISTP) to guarantee technological sustainability [Johnson, 2005].

The management of any business area requires a set of activities that cover planning, implementation and control through formal and informal means. At the same time, every business management should include common typical techniques and instruments of ethics management (statements of values, CE/CC/CP, ethics committees or managers, Social Responsibility (SR) programmes, among others) whose main role is the management of the ethical behaviour of the collaborators, the management of relations with the stakeholders and the evaluation of the ethical performance of an organization. Amongst the instruments mentioned, to be pointed out are the CE/CC/CP as they are statements that explicitly outline the desired and expected conduct and practice of the professionals from the ethical point of view within an organisation or profession [Campos, 2006a; Campos e Amaral, 2007a]. This practice is already quite common in many European countries and the USA [Campos e Amaral 2006b; Crane e Matten, 2004].

The confirmation of the importance of ethics in the field of the IST – here called “Technoethics”; the awareness of the many concerns and ethical dilemmas that emerged with globalisation; the recognition of the need for technoethical management and the urgency for ethical leadership on the part of the respective relevant authority are unquestionable findings that led us to the themes of the CE/CC/CP as the first instrument necessary for technoethical management. In line with this confirmation – the need of ethics for the technological civilisation – the objective of the present work is the presentation of a voluntary code of Technoethical Governance for Sustainable Portuguese Organisations (GOTOPS) that was created and that fully includes ethical problems raised by planning, development, management and utilization of the IST. So, this study pursues the importance of the CE/CC/CP for IST. As it presents the first code for ISTP in Portugal, which until now was non existent; its approach is innovative.

2. Research Approach

The elaboration and implementation of a code is not an ad-hoc process [Campos e Amaral 2006b, 2007a, 2007b], but a development process (process of tasks) that undergoes the articulation of possible mechanisms for the construction and sustainability of the code and for the renovation of the energies that led to its development. In this context, once the integrated process of the tasks was constructed, the approach followed consisted of proceeding with the implementation of this process to construct and support the GOTOPS code in an interactive and user-friendly way, resulting in a uniform, dynamic and interactive code, and the first in Portugal of technoethics governance for a sustainable organisation, business and IST. Thus, the GOTOPS code referred to aims at promoting the responsibility and sustainability of Portuguese organisations through the involvement of its top governance bodies [Abramo, 2000; Berleur et al., 2004; Birkett e Barbera, 1999; Brown, 2003; Campos, 2005; Driscoll e Hoffman, 2000; Initiative, 1998; Navran, 2003; Ricard et al., 2002; Webley, 2001].

2.1. Work Carried Out

The construction of the GOTOPS code was an integrated process of tasks (already developed and validated) supported by constructed and supported by: (1) the comparative analysis of the Codes of Ethics, of Conduct and of Practice (CE/CC/CP) already constructed and validated in the IST area [Campos e Amaral, 2006b]; (2) the DIORCODES model (**DI**rectives of **OR**ientation for **CODES**) for the development process of a code [Campos e Amaral 2007a]; (3) the set of ten guidelines for writing a code and by the PROECO prototype (**PRO**tótipo para a **E**strutura de um **CÓ**digo - Prototype for Structure of a Code) that provides the structure (form and content) of a code [Campos e Amaral, 2007b] and (4) by the SSIGOTOPS system (**S**ustentabilidade e **Su**porte

Interactivos do código **GOTOPS** - Sustainability and Interactive Support of the GOTOPS code) of automatic support [Campos e Amaral 2009] – included in the points that follow.

Comparative Analysis of Codes of Ethics in the IST area:

When analysing the literature in the ambit of the CE/CC/CP developed in the IST areas, it was concluded that in all the prefaces the main objective is to get the professions inherent to IST to be considered the most influential in the future of our society [Campos e Amaral, 2006b]. From the comparative analysis of 20 organisations of international reference that were studied in the IST area, it has to be pointed out that a (CE) is a more condensed version that describes a set of general standards and aspirations or ideals at the highest level of abstraction, i.e. it describes the fundamental ethical principles of an organisation or profession. A CC states how the fundamental ethical principles must be complied with, and therefore requires a higher degree of detail. With regards to the CP, it can be concluded that there are few organisations with codes that govern as the person they apply to and executes his work technically [Campos e Amaral 2006b].

DIORCODES Model for the development process of an efficient code:

The DIORCODES model proposed for the development process of a code includes the possibility of the code being constructed (15 steps) or not (11 steps) by the organisation [Campos e Amaral 2007a]. The exclusion of four steps is due to the fact that there is no leadership participation in the construction of the code as the code is a voluntary one.

Directives for Writing a Code / PROECO Prototype

To define how to write and to structure (form and content) a code, if it is CE, CC and/or CP, becomes an obligatory task before its construction. The quality of the writing and structure of a code is fundamental for the professionals to find the guidelines for their problems and key ethical concerns [Campos e Amaral, 2007b]. Thus, we want a structure as uniform and automatised as possible for the code, with its application aimed at both areas business/IST. The essential items of a code considered in the PROECO prototype are in Table 1. One has to point out that the instantiation of the GOTOPS code was followed the structure of the prototype PROECO proposed [Campos e Amaral, 2007b].

Table 1. PROECO Prototype for the form and content of a code

Draft of a prototype for the form and content of a code	
1.	Explanatory and creative title
2.	Presentation of commitment from highest authority
3.	Presentation of writing and approval committee
4.	Introduction • <i>Mission</i> • <i>Spirit</i> • <i>Purpose/Aim of the code</i> • <i>Context</i> • <i>How it must be use</i>
5.	Key Ethics, Conduct and Specific Practices Statements
6.	Implementation and operationalisation of the code
7.	Monitorisation and sustainability of the code
8.	Disclosure of evolution of the ethical performance of the organisation

SSIGOTOPS System

The tool is a system of the web-based type and uses the Internet as communication infrastructure. Above all it is a proof-of-concept in relation to the proposed GOTOPS code. For that purpose, a system was developed based on the WEB architecture on a Database.

The SSIGOTOPS [Campos e Amaral, 2009] has a system of authentication (*login and password*) established in the database. It is thus ensured that the content of the application will only be visualized by 'authorised' users. The SSIGOTOPS objective is to dynamise and automatise the GOTOPS code, thus differentiating it from all the already existing codes that are on paper.

3. GOTOPS Voluntary Code

The GOTOPS code aims to be an 'interactive ethical guide or book' with the necessary ethical components (ingredients) to enable any organisation to construct its own code adjusted to its own culture and mission. The GOTOPS code aims at being the starter, to motivate organisations to have a CE/CC/CP, thus allowing them to choose the most important and significant ethical components – main ethical principles, conducts and practices – previously defined by GOTOPS, so as to establish the objectives of ethical character that the organization intends to achieve and pursue, internally and externally, considering the different interested parties. The great objective of GOTOPS is to be applicable to any organisation that intends to have a CE/CC/CP without having to develop it, just needing to adapt it to its own reality and dimension in a quick and interactive manner. The organization also has the flexibility to choose the categorization and character or degree of specificity of the code it wishes to have.

3.1. Ethics Statements, Professional Conduct and Professional Practices

The key ethics, conduct and good practices statements are the core of the codes. They consist of the definition of principles and/or procedures that the organization or profession believes in and wishes to fulfil [Crane e Matten, 2004].

With the GOTOPS code, which is based on basic ethical principles (CE) accompanied by a detailed set of rules (guidelines) of conduct (CC) for the ISTP's behaviour and good practice (CP) for performance of the IST profession, the target for the ISTP, as professionals in planning, development, management and implementation of the IST (knowledgeable and influential in the construction, maintenance, storage, access and manipulation of IST), is to carry out a role that is distinct from professionals of other areas and from the end users with regards to quality, efficiency and responsibility in the production of IST. As, in what concerns IST, all the other professionals are only responsible for the correct use of the IST. Thus, the ISTP have the responsibility to facilitate the technological performance of other professions and to be proactive technoethical role models.

Ethics Statements – Code of Ethics (CE)

What distinguishes an ISTP before society or the public is knowledge about IST, its theories and methods, what can be done or not with the IST and how to do it. In the meantime, knowledge brings responsibilities and a principle that is generally accepted in all societies is that the greater

the power and authority a person has in any organization the greater the responsibility that person has. Therefore, there is a set of interconnected responsibilities that in an ethical and careful manner may allow for a lighter and more rewarding atmosphere for any professional, taking into account all the relationships that each one has with him/herself, with the family and with all that is an active part and is related to his/her professional performance – country, public, colleagues and peers, profession, professional judgements, product, with his/her relevant authority and in the management and leadership of his/her subordinates (Section 5 in Table 2).

The presence of these fundamental **Ethical Statements** (ten fields of responsibility) found general international acceptance. This is due to the fact that the ISTP has responsibilities and duties towards each one of them:

- The professionals establish a ‘kind of national and social contract’, with country and with public, according to which they are allowed to exercise a certain profession, sometimes with certain privileges and in exchange they undertake to exercise their profession in a manner that is beneficial to the country and to society which, at the very least, means not to cause damage and, at the most, respect the health, environment, safety and well-being not only of the present generations but also of the future ones. That is the origin of the need for professionals to acquire and maintain the highest ethical standard, aiming at the best for the country and for the society to which they belong;
- There is also a ‘work ethics’ of the professionals before their relevant authority (employers, clients, managers or leaders) namely with regards to protection of the employer’s interests in situations where the employer frequently does not have the ability to technically supervise the professional’s work and where the relationship is established based on trust. And the same happens with the client, who generally do not have the knowledge to judge whether the solution proposed is correct or not, or is the best one. Good relations between the parties are important for both as a substantial part of the work must be done in groups, with the coordination and collaboration of several people;
- With regards to their product, the professionals have the responsibility to ensure it meets the highest standards (quality, modifications, updates, safety, tests etc.);
- In their professional judgements they have to be as honourable as possible, namely with regards to conflicts of interest, comments and opinions that must be expressed within their level of competence;
- The leaders and managers with supervisory positions must be examples of responsible ethical conduct and leadership, in order to encourage their subordinates to carry out their responsibilities with motivation and professional dedication;
- In general, the profession deals with aspects of the ethical behaviour that must be avoided so as not to discredit the profession itself. It usually has priority in relation to rules with regards to colleagues because, if a colleague repeatedly does not carry out his/her duties, he/she may be denounced so that the profession is not harmed;
- Respect, support and caution not to take discriminatory actions must always be present in the relationship between the professionals and their colleagues and peers. In particular with regards to collaboration between colleagues of the same profession that usually share the same interests. Although this may be subject to different interpretations.
- The professional has his/her origin in a family. Integrity and ethics must be constructed from inside to outside and, as the family is the first system of orientation, education and learning – the moral guide and fundamental stone of ethical teaching - [Sousa, 1996; White, 1996] its presence has become fundamental. It is essential that ethical behaviour should start within the family for a child to more easily become an ‘ethical professional’. There must be balance between family life and professional life. And for that balance to be achieved several actors have their share of responsibility: (1) the organisation – must

take into account the effort and dedication it demands from its professional, always taking care to safeguard the central core of his/her family; (2) the professional – must bear in mind that when he/she arrives home, his/her family do not want the successful professional but an attentive person with the desire to invest in his/her family environment. The parents, the teachers and the chiefs, in this hierarchy, are responsible for the good training of these young professionals. In this context, professional ethics is a result of personal ethics.[Sousa; White];

- Every professional has responsibilities to him/herself. It seems reasonable to say that if you do not respect yourself, you will hardly be able to respect others, if you are not feeling good with yourself, you will hardly feel good about others; that if you are not persevering i.e. if you do not have the capacity to voluntarily sustain an activity that implies a long task – to be ethical - you will hardly be so – “Ethics is intrinsic to the individual” [Neves, 2008].

The ten fundamental ethical principles presented identify the ethically responsible relationships in which the individuals, groups and organisations participate and the main responsibilities within those relationships. Therefore, the CE is made up of these ten “Ethical Statements” (Section 5, Table 2.) related to behaviours and decisions of the ISTP, including users, educators, managers and supervisors, as well as the instructors and students of the profession [Couger, 1989].

Professional Conduct – Code of Conduct (CC)

After the main fields of responsibility of the ISTP were identified and defined, it was necessary to identify the important rules and/or professional conducts to be followed in order to fulfil those fields of responsibility, aiming at greater detail and depth in the support and guidance given to making better ethical decisions. The set of all the **Professional Conducts** make up the CC, whose support basis was the study of the IFIP [Berleur e d’Udekem-Gevers, 1996b]. The professional conducts are divided into five great categories (Section 5 in Table 2) each one arranged sequentially (3 levels - category, subcategory and sub subcategory) in hierarchical manner and detailing the specificities of the ethical relations between the ISTP and specific interested parties.

Professional Practices – Code of Practices (CP)

The process of identifying and defining good professional practices for the planning, development, management, implementation and utilisation of the ISTP implied the orderly classification and structuring of the ISTP’s competences and skills, through the reuse of the SFIA framework (Skills Framework for the Information Age). This set of **Professional Practices** gave origin to the CP. This code allows the ISTP immediate access only to the good critical practices to be followed for ethical, competent and professional performance of his/her functions (Section 5 in Table 2). Given the changing nature of the IST industry and the great alteration in the roles, this code is more dynamic requires more frequent review in relation to the CE and CC.

3.2. GOTOPS Code Presentation

Table 2 shows the structure of the GOTOPS code.

Table 2. Structure of GOTOPS code

GOTOPS Code	
1. Title Techno ethical Governance of Sustainable Portuguese Organisations (GOTOPS) <i>“Work Ethically for Technological Sustainability and Governance”</i> 2. Presentation of the commitment from the relevant authority It is hereby declared that this organisation undertakes to comply with the GOTOPS code 3. Presentation of the writing and approval committee Written by: Approved by: 4. Introduction	
Mission	The mission of the GOTOPS code is to be an instrument to help the top governance members of the organisations to include the principles of sustainable development at IST level in their activities and decisions.
Purpose	It aims at the possibility and need to extend the range of work of the top governance bodies and of the main ethical principles established by the organisation at technological level. In this sense, the basic motivations are the following: • <u>The growing social consensus about the need for a sustainable techno ethical development:</u> The top governance bodies of the organizations must meet society’s growing demand that the organisations not only pursue maximum profitability of their actions but that they so in coherence with the principles of sustainable development – in space and time – from the economic, environmental social point of view and, especially in this code, in planning, development, management, implementation and utilisation of the IST. • <u>From shareholders’ satisfaction to stakeholders’ satisfaction</u> Top directive bodies (leaders and managers) must take into account that the organisations and, therefore, their top governance bodies, cannot just consider the requirements and needs of their investors and clients, but also those of all the people and organisations that have some type of interest or influence in their activities at <u>consubstantial</u> level – shareholders and investors, collaborators, strategic partners; <u>contextual</u> – creators of opinion and knowledge, local communities, countries and societies, public administration and <u>contractual</u> – suppliers, financial institutions and clients. • <u>Ethical aspects of sustainable technoethical development:</u> The organization and its top governance bodies in particular, must interiorise that sustainable techno ethical development foresees and demands, in the first place, ethical commitment on the part of the top management, which is then followed by all the stakeholders.
Spirit	The content aims at being the promoter, inspirer and guide of the principles of sustainable development in the IST area of organisation governance.

Table 2. Structure of GOTOPS code (Cont.)

GOTOPS Code	
4. Introduction (cont.)	
Context	Type of the code: corporative and professional Sphere of application: local and national Source: scientific research work End-users of the code: the GOTOPS code is for all ISTP, whatever their degree, and IST students and users Character or degree of the specificity: specific and specialised Origin: voluntary code Promulgation:
How it must be used	CE versus CC versus CP The code is divided into three sections – The Code of Ethics (CE), the Code of Conduct (CC) and the Code of Practice (CP). Although the first, (CE) and the second (CC) are specifically for ISTP, it aims at the possibility of being applicable to these professionals regardless of their role or specific area of specialisation. They were conceived with a set of fundamental ethical principles (CE - abstract) explained through directives and guidelines of professional conduct (CC - detailed) that indicate the acceptable behaviour for each ISTP that works in the industry to clearly comply with the fundamental ethical principles defined by the CE. Moreover, the ultimate objective is for it to be applied to other professionals, since all professionals use IST. Thus the indissociation of the dichotomy “business/IST” is impossible in a global information society. The third (CP) is a set of guidelines on acceptable good practices in the IST profession.
Terminology	The Code makes a reference to ‘you’, the IST Professional (ISTP), to show that it is necessary that the ISTP assume a personal commitment. <u>Relevant Authority</u> – This term is used to identify the person (employers, clients, managers and leaders) that has authority over the individual activity you develop. <u>Top management</u> / <u>Leadership</u> – individual or group of individuals responsible for the formal management/leadership of the organization at the highest level. <u>Client</u> – Any person, organisation or department, before which a member has undertaken the responsibility to supply IST services, whatever the type. Client also means other departments within the organisation of the member in question. <u>Organisation</u> – Any legal private or public entity (company, enterprise, institution, university, firm, governmental department, etc.), corporate body or not, profitable or non-profitable, that has its own functional and administrative structure, in which the member (collaborator, supplier, consultant, student or a volunteer) assumes an individual position in the sphere of his/her professional practice. <u>User</u> – Any person, department, organisation or other entity served by IST. <u>System</u> – The set of electronic equipment and software that together supply a specific service – it also includes any application that involves the use of computers. The term <i>system</i> may be interpreted as non-computational operative procedures like office systems, manual, communication and electro-mechanic processes.

Table 2. Structure of GOTOPS code (Cont.)

GOTOPS Code

4. Introduction (cont.)

Terminology (cont.)

Information Systems and Technology

activities of IS and IT.

Stakeholder – People, or CE activities of an organization. Besides external (collaborators, clients, regulatory authorities, employers’

Code – the term “Code” is used following the practice of other works carried out for improving governance in the organisations, and not with the dictionary meaning of the word.

The CE contains ten fundamental ethical principals related to the behaviours and decisions of the ISTP. The principles identify the ethically responsible relationships within which the individuals, groups and organisations participate and the main obligations those relationships imply.

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5. Ethics Statements, Professional Conducts and Practices

Ethics Statements – Code of Ethics (CE)

This code should be considered the ethical basis of professional commitment. It is a summary of the ethical values the professionals are expected to follow. It points out the aspirations in a high level of abstraction which are expressed as principles that should influence the ISTP to consider who is affected by their work.

RESPONSIBILITY TO

COUNTRY

PUBLIC

RELEVANT AUTHORITY

PRODUCT

PROFESSIONAL JUGEDMENTS

LEADERSHIP AND MANAGEMENT

PROFESSION

PEERS AND COLLEAGUES

FAMILY

SELF

Professional Conducts – Code of Conduct (CC)

The CC is extremely important as it explains how the commitments assumed in the CE are expressed in rules, clarifying and formally stating the ethical requirements that are important in order to achieve those commitments. The code determines your personal and professional conduct whilst a collaborator of the organization and details the categories to follow in order to comply with each of the fields of responsibility stated in the CE. It is a guideline of the professional conduct necessary to be able to follow each fundamental principle included in the CE.

The five big categories listed below are divided into subcategories which, in turn, can be subdivided into subsubcategories. It is worth pointing out that they may not necessarily be followed by all the fields of responsibility of the CE, since it is the field of responsibility in question that determines which categories, subcategories and subsubcategories are to be followed. For example, if it is the ‘Profession’ field of responsibility within the first category – **Respectful general attitude** – subdivided into 5 subcategories, it is enough to follow ‘Respect for the prestige and promotion of the profession’.

Table 2. Structure of GOTOPS code (Cont.)

GOTOPS Code	
5. Ethics Statements, Professional Conducts and Practices (Cont.)	
<u>Professional Conducts – CC (Cont.)</u>	
The dynamic and demanding context of the ISTP profession requires a code that is adaptable and relevant to new situations as they occur. The code offers support to the ISTP that need to act positively in a certain case, documenting the ethical situation of the profession.	
<i>Professional Conducts</i>	
1. Respectful general attitude	▪ Respect for the interests or rights of the people involved ▪ Respect for the prestige and promotion of the profession ▪ Respect for the well-being, public health, environment and quality of life ▪ Respect for the quality of life of the people involved ▪ Respect for the well-being of the Global Information Society
2. Personal/Institutional Qualities: Conscientiousness and Honesty; Positive Attitude, Competence and Efficiency; Integrity, Objectivity and Independence	▪ Conscientiousness and Honesty – Acceptance of responsibility – Acceptance of integrity – Professionalism – Credit to work done by others – Trust, Loyalty and Goodwill (Image, Reputation, Promotion, ‘Good Name’) – Concern to meet overall objectives – Courage of one’s convictions – Avoid injury to others ▪ Positive Attitude – Appeal to respect requirements, contracts or agreements – Appeal to conscientious work – Voluntary work – Be correct and not take discriminatory actions – Promotion of progress in the profession ▪ Competence and efficiency – Professional development and training – Limitation of work within the field of competence – General Competence ▪ Integrity, Objectivity and Independence – Objectivity and Independence – Integrity – Conflicts of interest

Table 2. Structure of GOTOPS code (Cont.)

GOTOPS Code	
5. Ethics Statements, Professional Conducts and Practices (cont.)	
<i>Professional Conducts (cont.)</i>	
3. Promotion of privacy of information and data integrity	▪ Confidentiality ▪ Privacy (Web, Data Base, Encryption, E-mail, Anonymity, Spamming) ▪ Respect for the rights of property – Ownership of property – Intellectual Property (copyright, patents, trademarks) ▪ No to computer crime, no to information piracy or misuse ▪ No to access and unauthorised use ▪ Data Integrity
4. Production and information flow	▪ Information flow to the parties or people involved ▪ Information towards the public ▪ Comprehensive/Detailed information ▪ Production of tests, evaluations, results or specifications ▪ Information flow from the parties or people involved
5. Attitude regarding the regulations	▪ Respect for the code (compliance with the code) ▪ Respect for the existing laws relating to professional work ▪ Respect for IST and the professionals standards ▪ Development of standards ▪ Knowledge and development of the law ▪ Development of the code itself ▪ Sanctions for violation or breach of the code
Professional Practices – Code of Practices (CP)	
We advise following the guidelines in the CP that are relevant in relation to the exercise of your functions and specific practical responsibilities. To facilitate consultation, the CP is divided into SIX ORGANISATIONAL COMPETENCES (ORGC):	
1. Strategy and Planning 2. Development 3. Business Change 4. Service Provision 5. Procurement and Support Management 6. Ancillary Skills	
The 6 ORGC subdivide into 17 Operational Competences (OPC) that, in their turn, are divided into 78 Professional Skills (PS). Through the SP one can visualise which are the most important and representative PS to exercise the respective necessary operational skill to execute the organisational competence in question.	

Table 2. Structure of GOTOPS code (Cont.)

GOTOPS Code		
5. Ethics Statements, Professional Conducts and Practices (cont.)		
<u>Professional Practices</u> – CP (Cont.)		
The set of all the good practices to be followed in each PS constitute the common practical guidelines included in the CP and which include:		
a) Relevant common practices for all IST professionals;		
b) Key-practices for specific IST competences;		
c) Practices to be applied in the field of specific flows of business or education.		
It is advisable to follow all the common practices even though you only have to select the practices pertaining to certain competences and flows in the tool. Here lies the flexi-manipulation, handling and updating of the tool.		
Organisational Competences (ORGC)	Operational Competences (OPC)	Professional Skills (PS)
Strategy and planning	Information Strategy	Information Management
	Advice and Guidance	Consultancy
		Technical Expertise
	Business/Information Systems Strategy and Planning	Research
		Innovation
		Improvement of Business Processes
		Strategic application of information systems
		Business risk management
		Information Security
		Information assurance
	Technical Strategy and Planning	Systems architecture
		Monitoring of Emerging Technology
		Continuity management
		Software development process
		Network planning
		Methods and tools
Development	Systems Development	Systems development management
		Data analysis
		Systems design
		Network design
		Database design
		Programming/software development
		Safety Engineering
		Web site specialisation
		Systems testing

Table 2. Structure of GOTOPS code (Cont.)

GOTOPS Code		
5. Ethics Statements, Professional Conducts and Practices (cont.)		
<u>Professional Practices</u> – CP (cont.)		
Organisation al Competences (ORGC)	Operational Competences (OPC)	Professional Skills (PS)
Development (Cont.)	Human Factors	Systems ergonomics
		Content creation
		Non-functional needs analysis
		Usability evaluation
		Human factors integration
	Installation and Integration	Systems integration
		Porting/software integration
		Systems installation/decommissioning
Business Change	Business Change Management	Business analysis
		Programme management
		Project management
		Business process testing
		Planning and management of change implementation
		Organisation design and implementation
		Benefits management
	Relationship Management	Stakeholder relationship management
Service Provision	Infrastructure	Configuration management
		Change management
		Capacity management
		System software
		Security administration
		Radio frequency engineering
		Availability management
		Financial management for IST

Table 2. Structure of GOTOPS code (Cont.)

GOTOPS Code		
5. Ethics Statements, Professional Conducts and Practices (cont.)		
<u>Professional Practices</u> – CP (cont.)		
Organisational Competences (ORGC)	Operational Competences (OPC)	Professional Skills (PS)
Service Provision (Cont.)	Operation	Data protection
		Application support
		Management and operations
		Network control and operation
		Database administration
		Service level management
	User Support	Network support
		Problem management
		helpdesk and incident management
Procurement and Support Management	Supply Management	Procurement
		Supplier relationship management
	Quality	Quality management
		Quality assurance
		Quality standards
		Compliance audit
		Safety assessment
	Resource Management	Project office
		Asset management
		Information systems coordination
		Client services management
		Professional development
		Resourcing
Ancillary skills	Education and Training	Education and training management
		Creation and maintenance of training materials
		Education and training delivery
	Sales and Marketing	Account management
		Marketing
		Sales
		Sales support

Table 2. Structure of GOTOPS code (Cont.)

GOTOPS Code
6. Implementation and operationalisation of the code
7. Monitorisation and sustainability of the code
8. Disclosure of evolution of the ethical performance of the organisation

4. Empiric Validation

The GOTOPS code was validated through a real case study taken from the literature, aiming at the access, handling and its utilisation in an interactive and automatic manner, i.e., by SSIGOTOPS system [Campos e Amaral, 2009] .

Another validation was through the direct contributions of the MBA and MSC students.

5. Contributions

The sum of the contributions obtained with the development of the research work carried out made it possible for the proposed mission and vision to be accomplished.

Mission: create a code of techno ethical governance for the ISTP and help the Portuguese organisations to adhere to technological sustainability without having to spare dedicated collaborators exclusively to its elaboration.

Vision: sustainability and automatic and interactive support of the code, so that in a simple and friendly manner the ISTP of any one organisation can easily and frequently consult it whenever in doubt or in need of clarification with regards to the techno ethical conduct and practice to be followed in the exercise of his IST profession.

The fundamental contribution of this study consists of making the GOTOPS code the first code for consultation, updating, and automatic handling in Portugal. As all the existing codes are in paper, that explains the strictness and low rate of consultation and knowledge of those codes.

6. Future Work

For the future, we propose right now the translation of the code to the universal language (English) and the progressive and continuous improvement of the GOTOPS code and the SSIGOTOPS system.

In the near future, we should aim to include a discipline of professional technoethics in the undergraduate courses curricula, to make aware students of need and importance of technoethics in their future professional life [Couger 1989]. Through the use of the GOTOPS code, the approach of technoethics in a pedagogical perspective takes the students to interiorize fundamental technoethics concepts which will serve them as basic principles and practices when confronted with problems in their professional careers – today’s students will be tomorrow’s professional.

7. Conclusions

The fact that, the GOTOPS code supports ethical decisions through sustainability and automatic support permits emphasising the analysis of real situations that involve a variety of topics (e.g. 'Intellectual property', 'Privacy', 'Confidentiality', 'Quality of the Professional work', 'Justice and discrimination', 'Risks caused by software', 'Conflicts of interest', 'Non-authorised access') that demand ethical positions and that are ever more present in the lives of the organisations and professionals.

As the first voluntary code of techno ethical governance in Portugal, this code is not simply to judge the nature of questionable acts; it also has an important educational function. As it thoroughly and completely expresses the rules and behaviours about technoethical issues, it is a means for educating students, users, ISTP and trainee professionals about the technoethical obligations of all.

The GOTOPS code supported by the SSIGOTOPS system aims to be dynamic in the sense of constant updates and because it is automatically supported, those updates may be obtained much more quickly and efficiently. These updates come from the utilization of the code itself, whether in organisational, academic and/or scientific (research) environment.

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Modeling the assignment process of personal to teams in software projects

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Abstract: The formation of software project teams of is carried out, in general, in an empiric manner. However, in this process the multiple factors should be considered. In literature the works where this process is modeled are scarce, and most of them do not consider any aspect linked to the formation of the team as a whole. In this work, a model is formulated for the assignment of human resources to teams of software project, and describes the main results of the process of knowledge management carried out to obtain the elements considered in the model, which were identified through the use of the Delphi method, and of the application of psychological tests and tools for data mining. Additionally, a tool was implemented that gives support to the proposed model which was used to solve cases of test and to demonstrate that the model is feasible of applying.

Keywords: formal model, assignment of personal, software project team, Delphi, psychological tests

1. Introduction

Many investigations recognize that human resources play a critical role in the success or failure of a software project (De Carvalho, 2003) (Gorla, 2004) (IEEE, 2004) (Pressman, 2004) (Pyster, 2005) (Acuña, 2008b) however, personnel continues to be the factor least formalized in the modeling of processes which are centered more on technical aspects (Acuña, 2006) (Karn, 2006) (Andre, 2008). The inadequate assignment of personal and the problems among the members of the project team are detected as two of the main difficulties associated with human factors that affect the success of software projects (Charette, 2005)(Ryan, 2007). However, the assignment of personal to the roles of a project and the formation of the team is generally carried out in an empiric manner, with its corresponding impact on the quality of the projects. This situation becomes more complex in medium and large organizations, where the quantity of combinations of possible assignments, in function of the available employees and roles to cover can become a problem with the solution space being too large. This makes this stage practically impossible to approach in an efficient way, without the help of decision support systems that are based on solution algorithms of mathematical models that represent the problem to solve in the most objective manner possible.

The above-mentioned shows the importance of having a formal model that when inserted in a decision support system helps the assignment process, making it more objective. However, although the assignment problem has been an object of study for several decades, the works where the assignment of personal to teams of software projects is modeled are scarce.

In (De Carvalho, 2003)(Acuña, 2006)(Ngo-The, 2008) models are described that approach the assignment of personal to software projects. These proposals are centered in the individual assignment of people to tasks or roles of the project and they do not consider factors associated to the formation of the team as a whole.

In this paper the main results of the process of knowledge management are shown, which was carried out to obtain the essential elements to facilitate the elaboration of a formal model, making use of Delphi, as an expert method, and of the application of psychological tests and tools for data mining to identify useful patterns in the formation of the teams in software projects. As a result of the knowledge management carried out, a formal model is presented whose solution should allow appropriate assignment of personal to teams of software project.

This paper is structured as followed. Section 2 describes related work on models of processes for the assignment of personal to software projects. Section 3 details the main results of the process of knowledge management carried out to obtain the elements considered in the model, which were identified through the use of the Delphi method, and of the application of psychological tests and tools for data mining. Section 4 presents the proposed model. Section 5 describes the validation of the model through the use of a case of study, and Section 6 outlines conclusions.

2. Related works

The assignment of people to software projects has been a topic scarcely approached in the software engineering literature. The models of software processes are centered, generally, in the technical aspects. Such that, recognized models of processes like: People-CMM (Curtis, 2001), Personal Software Process (Humphrey, 1995), Team Software Process (Humphrey, 1998) and the Rational Unified Process (Jacobson, 2000), although they incorporate the human factor, they do not model the assignment process of personal to the project, neither do they formalize the necessary competences for the execution of the roles. In the next part of the paper, works where models of processes for the assignment of personal to software projects are proposed are analyzed.

In (De Carvalho, 2003) a management process of human resources in projects of software development based in the reuse of organizational knowledge of the competences and previous assignments of personnel is proposed. According to the process, the project leaders assign people to each task of the project, taking into account the defined profile what includes competences, experiences and academic formation.

In (Ngo-The, 2008) a method of planning of releases to develop software incrementally was proposed. The method assigns functionalities to the releases, taking in consideration the technical resources, the risks and the budget restrictions, and aims to maximize the value gained (contribution of the functionality to be assigned to the release). In the assignment productivity of the human resources to execute the different types of tasks is taken into account. The method is only applicable in mature software organizations that have well defined and measured processes.

In both papers the characterization of the projects (or stage), and of the capacity of the performance of the employee, is not carried out in terms of the roles but of the necessary tasks to perform the role. However, this focus, in general, is more complex and it presupposes to have the planning of the tasks in very early stages of the project, a difficult situation to achieve in

organizations that are not mature. Additionally, to establish chronograms before the assignment, can cause changes in the planning and in the team in function of the real levels of the competence of the assigned personnel (PMI, 2004), and it disables the team from participating in the elaboration of the project plan. However, as (De Marco, 1999) stated, it is very important for the success of the project to have the complete team and with appropriate people from the beginning. Also, early participation of the team in the planning allows to fortify commitment with the project and to elaborate more realistic plans (PMI, 2004) (Humphrey, 2000).

In this paper it is intended to characterize the projects and the capacity and the employees in terms of the necessary roles to carry out the project. In the definition of the role a set of tasks is assigned to the role.

The Model of Process of Guided Software to Capacities (Acuña, 2004) includes, as an original element, the characteristics of the professional behavior or behavior capacities (generic competences), and it proposes two procedures: one to determine the capacities of the members of the team, and another to assign people to the roles in dependence of their capacities and those required by the roles. The results obtained in their application demonstrate the effectiveness of considering the generic competences in the assignment process. Nevertheless, technical competences are not considered and the assignment procedure of the employees to projects is based on empiric statistical approaches and not through a mathematical model as intended in this investigation.

The evaluated proposals consider different factors in the assignment. However, the fact of not considering in the assignment any factor that contributes to the formation of the team as a whole is common, achieving an appropriate balance, and taking into consideration the interpersonal relationships between their members, as suggested in (PMI, 2004)(ISO 10006:2003). The above-mentioned shows the convenience of elaborating a formal model that takes into consideration the greatest quantity in possible factors and that it contributes to the individual assignment to the roles of the project as well as the formation of the team as a whole.

3. Process of knowledge management

In this section the results of the process of knowledge management developed are enunciated with the objective of obtaining the main elements to take into account in the assignment model.

3.1. Application of the Delphi method

The Delphi method was applied in several stages with several objectives. The success of the use of experts' methods in a process of Engineering of Knowledge depends on several factors, among them the appropriate selection of the experts to interview. Therefore, in the first stage the Delphi method was used to identify the criteria of experts' selection. In the stage twelve recognized professionals of several software organizations participated with at least 20 years of experience in the management and the development of software projects.

The criteria to select the experts were the following ones:

- Have ten or more years of experience participating active and successfully in the software development.
- Possess knowledge of software engineering and of techniques in projects management.
- Have supervised at least three people successfully in at least two projects of medium or high complexity.

In the second stage, the most important factors keep in mind for the assignment model of personal to software projects were obtained. These were: the competences (technical, generic, experience in similar projects and experience in the role) to perform the different roles in the software project, the synergy of the team, the availability of personnel (in function of their workload), and the cost for distance (for the case of off-shore development). This stage was developed in two round with 35 experts selected from the criteria obtained in the first stage after an evaluation of the curricular synthesis of the candidates.

As a result of the third stage, a proposal was elaborated that included: invariant roles to face development and implantation software projects, competences required for their execution, as well as the level of importance of each competence for acting each role. This stage was developed in two round with 34 experts selected from the criteria obtained in the first stage.

3.2. Patterns for the formation of software projects teams

Very few studies exist, in the environment of software development, about the impact that group factors have like: the cohesion, conflict, the structure of the team and the coordination (Acuña, 2008b). In (Yang, 2004) the authors intended to determine the index of cohesion or conflict of a team in function of the reciprocally positive relationships or negatives among their members. Taking into account that this proposal is feasible to apply and that it did not have a method to determine the synergy of the team (for the complexity to evaluate this factor), the authors of this article proposed that the assignment model incorporate as objective, to minimize the incompatibilities instead of maximizing the synergy.

With the purpose of incorporating patterns in the model that contributes to the team formation, psychological tests were applied to 336 people belonging to 25 organizations. Of them, 146 (44%) are professionals that work in software organizations and 190 (56%) are people that belong to the academy (79 professors and 111 students of the final year of Computer Engineering). In the experiment psychologists of the Center of Formation and Development of the Human Capital, and of the Universidad Autónoma de Madrid's Faculty of Psychology participated. The battery of tests applied was formed by six questionnaires: Myers-Briggs, Belbin, 16PF (three of the tests most used in the investigations that approach the formation of teams of software projects) (Thomson, 2007)(McDonald, 2007), LPC0.2, LPC0.3 (designed to identify patterns of rejection based on the factors of 16PF test and in the dimensions of the Myers-Briggs test) and Summarize (designed to characterize the participants and it collects: general data (sex, age, career, student / professional, organization), experience in the development and management of projects, as well as preferences and rejection in function of the acting of functional roles).

3.3. Brief characterization of the selected tests

The test, 16 Personality Factors (16PF) is an instrument elaborated by means of psychological investigation, with the purpose of offering, in the smallest possible time, a very complete vision of the personality. It is based on measuring 16 functionally independent and psychologically significant dimensions (Catell, 1993). The 16 factors are identified with letters from A to Q4, where: A-Affability, B-Reasoning, C-Stability, E-Dominance, F-Animation, G-Attention to norms, H-Audacity, I-Sensibility, L-Surveillance, M-Abstraction, N-Privacy, O-Apprehension, Q1-Open to change, Q2-Self-sufficiency, Q3-Perfectionism, Q4-Tension). Besides, each one of the factors has an extreme (pole) negative and one positive in function of the punctuation obtained. Its application for the evaluation of personality traits is carried out, mainly, in tasks such as selection of personal. In (Acuña, 2004) it is intended as a way to evaluate the generic competences from the personnel to be assigned to the roles of software projects.

The Indicator of Type of Myers-Briggs (MBTI) it is an auto perception test that measures four different dimensions of human preferences: Extroversion (E)-Introversion (I), Intuition (N)-Senses (S), Thinking (T)-Feeling (F), and Judging (J)-Perception (P). From the values of each dimension the person's psychological type is identified (of the 16 types) (Briggs, 2004). In software investigations the test has been used, fundamentally, to identify: the type or the pattern that prevails in the personnel of the software (Capretz, 2003)(Varvel, 2003), the most appropriate types to carry out activities (Devito, 2004) and roles (Gorla, 2004) in the development process, to evaluate the feasibility or not of the diversity of types in the team (Rutherford, 2001), the impact of the different dimensions in the results of the project (Yellen, 1995)(Acuña, 2008a) and in the cohesion of the team (Karn, 2006).

Belbin is an auto perception test that allows identifying the preferred and avoided team roles of each person. Meredith Belbin, its creator, defines team role as "our particular tendency to behave, to contribute and to be related socially" and it identifies nine roles classified in three categories (Belbin, 2004):

- Mental Roles: Plant (PL), Monitor-Evaluator (ME) y Specialist (SP)
- Action Roles: Shaper (SH), Company Worker (CW), Completer-Finisher (CF)
- Social Roles: Chairman (CH), Resource Investigator (RI), Team Worker (TW).

The categories represent the dimensions of the grade of people's orientation toward the performance of tasks (action roles), toward the world of ideas (mental roles) or toward the relationships with people (social roles). The test has been used in several investigations linked to software to evaluate the impact of the different Belbin roles in the project team (Thomas, 1999)(Henry, 1999)(Klaus, 2001)(Stevens).

3.4. Results of the experiment

The Belbin test was processed using two procedures: the classic (that identifies primary and secondary roles in function of the hierarchy), and a variant that it takes into account both parameters: hierarchy and punctuation. With this variant the fact of establishing the preference for a role with punctuation greater than 9 is limited, which are identified as favorite: primary, secondary and tertiary roles, according to the following rules:

- Primary role: hierarchy = 1, and punctuation ≥ 18 .
- Secondary role: hierarchy = 1 or 2, and punctuation ≥ 15 and < 18 .
- Tertiary role: hierarchy = 1, 2 or 3, and punctuation ≥ 10 and < 15 .

After processing the tests, a great volume of data was obtained, therefore, the search of patterns became a very complex task. As consequence it was decided to apply techniques and tools for data mining. The first step was the preparation of the data and it included: cleaning (with the purpose of eliminating the greatest possible number of erroneous or inconsistent data) and transformation (with the purpose of presenting the data in the most appropriate way for the mining). To achieve this, it was requested that each person complete or correct their answers in the event of omissions or errors. The transformations were carried out with the help of the tool Kettle (Kettle), and the main purposes were: to create new attributes and to change their type so they were easier to understand or they could be processed by the algorithms for data mining.

As part of the experiment the Delphi method was applied, in a fourth stage, with the purpose of identifying the contribution of the roles from Belbin to the functional invariant roles, involved in software development, proposed in the previous stage (Table 1).

Additionally, the results of the tests of the members of six teams of successful and qualified projects of high complexity (for their size and the use of new technologies) were analyzed. Table 2 offers a summary of the analysis.

The main results are exposed obtained starting from the prosecution of the tests using the tool for data mining Weka (Weka) are shown in the next section.

The application of both procedures in the processing of the 336 tests of Belbin, allowed identifying a common behavior:

- The role Company Worker (CW) and Specialist (SP) are in students as well as in workers (industry as well as academy); followed, generally, by the Team Worker (TW), the Shaper (SH) and the Completer-Finisher (CF).
- In general, the least favorite roles are: Resources Investigator and Plant.
- Prevalence exists in the preference for the action roles (AR) over the mental roles (MR), and of the mental roles over the social roles (SR).

The balance among the categories of roles is identified as a pattern to consider in the formation of teams of software not just for its presence in the processed tests, but because it is present in each of the projects analyzed in Table 2 and in the opinion emitted by the experts that is summarized in Table 1.

The little difference between the prevalence of the action and the mental roles is explained by the own nature of the work. In software development it is necessary that the action role prevails (SH, CW, CF) so that the project finishes in time and with quality. However, software engineering is a discipline that demands creativity. The opinion of the experts corroborates this position since the functional roles, associated with essential tasks as the analysis, the design and the programming; they are associates to action roles as well as mental roles.

Table 1: Contribution of the Belbin roles to the functional roles

Functional Roles	Belbin roles								
	Mental			Action			Social		
	PL	SP	ME	SH	CW	CF	CH	TW	RI
<i>Project Leader</i>				X			X		
<i>Graphic Designer</i>		X				X			
<i>Change Manager</i>			X			X		X	
<i>Configuration Manager</i>						X		X	
<i>Architect</i>	X		X	X					X
<i>Analist</i>	X	X							
<i>Designer</i>	X	X							
<i>Database designer</i>		X				X			
<i>Programmer</i>	X	X			X	X			
<i>Tester</i>					X	X			
<i>Security Specialist</i>		X							X
<i>Quality Specialist</i>				X		X		X	
<i>Documentor</i>					X	X		X	

Another pattern identified is associated with leadership. As it is observed in Table 1, the experts agree that the team roles CH and SH contribute to performing the functional role: Project Leader. This relationship confirms that proposed in (Henry, 1999)(Klaus, 2001)(Stevens). Also, an analysis of 42 people that participated in the experiment with at least five years of experience

in project management allowed checking that 86% had among their favorite roles, CH or SH. On the other hand, like it is shown in Table 2, in all the cases people that carried out the Project Leader role had preference for the team roles CH and SH. A detailed analysis of the Project Leaders involved in the experiment allowed detecting higher preference for the role SH.

Another pattern identified is the necessity to have the presence of the creative role Plant in software projects. As it is observed in Table 2 in all the teams there are people that have preference for the role PL. The project 1 that is the most complex in all those evaluated has eight people with preference for this role. On the other hand, there was also agreement in the criteria of the experts on the contribution of the role PL in the acting of the main functional roles of a project: architect, analyst, designer and programmer. Both results belong together with that outlined in (Stevens) where the author concludes that the presence of at least one PL in the team is required to obtain an appropriate performance.

The pattern proposed by Belbin that demands the presence of all the team roles is validated in this work because they are present in all the projects teams analyzed in Table 2. Besides, as observed in Table 1, the experts associated all the team roles at least to one functional role. However, since the formation of small teams is very frequent in some software organizations, it is intended to offer the possibility in the model of taking as pattern: to demand the presence of at least the three categories of roles whenever they already completed the challenge of the patterns identified (leadership, creativity and balance among categories), or to demand the presence of all the team roles.

Table 2: Analysis of the projects teams

Criteria	Teams					
	1	2	3	4	5	6
Total team members	17	10	11	7	9	9
MBTI Results						
Quantity for types (MBTI)	7	6	8	5	6	6
Preference for dimension	88-71-	70-80-	64-73-	57-100-	56-67-	88-71-
E(%)-S(%)-T(%)-J(%)	59-71	90-80	73-55	86-57	100-67	59-71
Significant patterns	ST(70)	ST(70)	ST(55)	ST(86)	ST(67)	SJ(67)
Pattern(%)	SJ(70)	SJ(70)			TJ(67)	
	TJ(70)					
Project Leader (MBTI)	ESTJ	ENTJ	ESTJ	ESTJ	ESTJ	ENTJ
Bebin Results						
Preference for role						
CW-CF-SH	13-6-2	7-4-2	9-3-2	7-4-2	13-6-1	7-7-1
PL-SP-ME	8-4-6	2-2-5	2-2-7	2-3-3	3-2-6	3-2-6
CH-TW-RI	2-6-3	1-2-1	1-5-1	1-2-1	1-3-1	1-4-1
Balance among roles (AR-MR-SR)	21>18>11	13>9>4	14>11>7	13>8>4	14>11>5	15>11>6
Project Leader (preferred roles)	CH	SH	SH	SH	SH	CH

Little preference for the roles Plant and Resources Investigator constitutes a challenge for this academic formation process of the professional because of the importance that both have in team roles in software development. The role PL is indispensable for success of software projects. However, the necessity to establish good relationships with clients and final users, and the capacity to capture ideas and to develop contacts, behavior that characterizes a RI, is also necessary for the successful performance of a software team.

When processing the 336 tests of Myers-Briggs it is detected that there is a presence of all the psychological types and that ESTJ (22%) and ISTJ (15%) prevail. Besides, 53% of the participants have preference in the dimensions S/N and T/F for the subtypes ST.

From the results obtained from processing the 288 questionnaires LPC0.3 and of evaluating the relationship with MBTI, it was not possible to identify rules of incompatibility among the psychological types. However, when analyzing the preference and the rejection for each dimension, one could observe that, in a general way, people rejected the letter contrary to that of their preference. This suggests that the teams formed by people with the same type (homogeneous) could reach more agreements easily; nevertheless, they would multiply their strengths as well as their weaknesses. Therefore, the potentiality of this pattern could be feasible in simple projects, with well-known technologies. However, in complex projects as those analyzed in Table 2, the diversity of types led to good results. This confirms that outlined in (Rutherford, 2001) about the variety of strengths and weaknesses that contribute to better administrate problems that should be managed in a project better. However, it is intended to re-evaluate these patterns that indicate the necessity of diversity of psychological types in future experiments before it is included in the assignment pattern.

Another behavior to re-evaluate in future experiments in the relationship MBTI-LPC0.3 is the prevalence for the letters E, S, T and J, and the significant percents of rejection for the I, N and P. This not just shows prevalence in the processing of the tests in general but in the six evaluated projects.

A behavior that is proposed as a pattern and is applicable in the assignment of the project leader is the relationship between the functional role and the subtype EJ. As observed in Table 2 in the analyzed projects all the project leaders match the pattern ETJ. On the other hand, in (Gorla, 2004) it is suggested to use the pattern ENFJ to assign a project leader. However, an analysis of the 42 participants with at least five years of experience in project management, allowed verifying that 90% of them match with the pattern EJ; with certain prevalence of the types ESTJ, ENTJ and ENFJ, respectively.

Of 336 people that participated in the experiment, 302 responded the test 16PF and 305 the LPC0.2. However, the processing did not allow identifying any useful pattern for the team formation. In 15 of the 16 factors of the 16PF, more than 50% of the participants had average punctuations. Except in the case of the factor N, 51% had punctuation in the positive pole. This result indicates that 51% of the participants are analytic with an intellectual focus, that that in a general way, it characterizes the professionals of the software; which does not contribute significant elements to the effects of the investigation.

When evaluating the results of the questionnaire LPC0.2, it is detected that more than 50% of the participants reject a group of behaviors: A-(55%), C-(51%), E-(67%), G-(72%), Q2+(69) and Q3-(66%). These results indicate that, in a general way, people are too dependent, not practical, not careful, that don't consider the opinion of the group neither or pay attention to their commitments, and prefer to work alone and not commit themselves are rejected. These manifestations of rejection, like in the previous case, characterize the professionals of the software; however, they don't allow identifying patterns of incompatibility.

In a next experiment it is proposed to investigate:

- The correspondence identified by the experts between the rest of the team roles and the functional roles.
- The relationship among types, dimensions or combinations of the MBTI, and functional roles.
- The relationship between the different factors of 16PF and the functional roles.

The previous analyses were not possible to carry out from the data gathered since in this experiment because only the functional roles that each person preferred or rejected were registered but not those that were carried out with quality. In the case of the professionals it was not possible to contact with their directors, since they belong to diverse organizations. In the case of the students (although they develop real projects), the teams are very small and alone they perform few of the identified roles.

Finishing the experiment it is concluded that the use of the psychological tests can contribute to the formation of teams in software projects. However, by itself it cannot identify the good engineers; neither can their results predict, absolutely, the quality of the execution of a job. In the formation of the team, it is necessary as stated in (Turley, 1995)(Varvel, 2004)(Acuña, 2008a), to achieve a balance among the psychological characteristics, the competences and the personnel's experience.

4. Proposed model

In this section is described a model that represents the assignment of personal to teams in software projects. In its formulation are considered the results from Delphi method application, and the identified patterns from the processing of the psychological tests.

Let:

m : Quantity of necessary roles to develop a project

n : Quantity of available employees

L : Maximum quantity of roles that an employee can assume in a given project

R : Quantity of set of contemplated incompatible roles

J_r : Set of incompatible roles, $r = 1..R$

Z_j : Set of necessary competences to carry out the role j

A_j : Quantity of persons necessary to execute the role j ; $j = 1..m$

c_{ij} : The employee's net competence i to carry out the role j ; $i = 1..n$, $j = 1..m$

v_{ih} : Level of the person i in the competence h

s_{hi} : Incompatibility among the individuals h and i ; $h, i = 1..n$. This coefficient takes value 1 if the employees h and i maintain relationships reciprocally negative and 0 otherwise.

g_i : Total workload of the employee i according to the projects where the employee is currently assigned; $i=1..n$

b_j : Workload that implies the assumption of the role j in the current project; $j = 1..m$

U : Maximum workload that an employee can assume

l_{ij} : Cost of the employee i according to the distance from the project and the role j to be carried out; $i=1..n$, $j=1..m$

k_{hj} : Required minimum value of the competence h to carry out the role j , $j = 1..m$, $h \in Z_j$

ME : average workload that includes the workload of the current projects in execution plus the workload generated by the roles in the project being analyzed.

$$ME = \frac{\sum_{i=1}^n g_i + \sum_{j=1}^m b_j}{n}$$

$B = (b_{ij})$ it is a matrix of values 0 or 1, taking the value 1 if the person i has preference for the first letter of each dimension of the MBTI (E/I, S/N, T/F, J/P), and 0 for the second; $1 \leq i \leq n$; $1 \leq j \leq 4$
 $D = (d_{ij})$ it is a matrix of values 0 or 1, taking the value 1 if the person i has the role of Belbin j as preferred according to his/her personality; $1 \leq i \leq n$; $1 \leq j \leq 9$

The variables:

$$x_{ij} = \begin{cases} 1 & \text{if the employee } i \text{ is assigned to the role } j \\ 0 & \text{otherwise} \end{cases} \quad i = 1..n, j = 1..m$$

$$u_i = \begin{cases} 1 & \text{if the employee } i \text{ is assigned to at least one role} \\ 0 & \text{otherwise} \end{cases} \quad i = 1..n$$

The functions to optimize are:

$$\max \sum_{i=1}^n \sum_{j=1}^m c_{ij} x_{ij} \quad (I)$$

$$\min \sum_{h=1}^{n-1} \sum_{i>h}^n s_{hi} u_h u_i \quad (II)$$

$$\min \sum_{i=1}^n \left[(g_i + \sum_{j=1}^m b_j x_{ij}) - ME \right]^2 \quad (III)$$

$$\min \sum_{i=1}^n \sum_{j=1}^m l_{ij} x_{ij} \quad (IV)$$

The restrictions imposed in the model are:

$$\sum_{i=1}^n x_{ij} = A_j, \quad j = 1, \dots, m \quad (1)$$

$$\sum_{j \in J_r} x_{ij} \leq 1, \quad i = 1, \dots, n, \quad r = 1, \dots, R \quad (2)$$

$$\sum_{j=1}^m x_{ij} \leq L \quad \forall i = 1, \dots, n \quad (3)$$

$$(1 - u_i) \sum_{j=1}^m x_{ij} = 0, \quad (1 - u_i) + \sum_{j=1}^m x_{ij} > 0 \quad i = 1, \dots, n \quad (4)$$

$$u_i (k_{hj} - v_{ih}) \leq 0, \quad \forall i = 1, \dots, n; \forall j = 1, \dots, m, \quad \forall h \in Z_j \quad (5)$$

$$g_i + \sum_{j=1}^m b_j x_{ij} \leq U \quad \forall i \quad (6)$$

$$\sum_{k=1}^3 \left(\sum_{i=1}^n d_{ik} u_i \right) > 0 \quad \sum_{k=4}^6 \left(\sum_{i=1}^n d_{ik} u_i \right) > 0 \quad \sum_{k=7}^9 \left(\sum_{i=1}^n d_{ik} u_i \right) > 0 \quad (7)$$

$$\sum_{k=1}^3 \left(\sum_{i=1}^n d_{ik} u_i \right) > \sum_{k=4}^6 \left(\sum_{i=1}^n d_{ik} u_i \right) \quad (9)$$

$$\sum_{k=1}^3 \left(\sum_{i=1}^n d_{ik} u_i \right) \geq \sum_{k=4}^6 \left(\sum_{i=1}^n d_{ik} u_i \right) + \sum_{k=7}^9 \left(\sum_{i=1}^n d_{ik} u_i \right) \cdot n \quad (10)$$

$$\sum_{i=1}^n d_{ik} u_i \leq \frac{(h_{i1} + v_{i1})}{2} \cdot n, \quad \forall i = 1, \dots, n \quad (11)$$

$$\sum_{i=1}^n d_{ik} u_i \leq \frac{(h_{i1} + v_{i1})}{2} \cdot n, \quad \forall i = 1, \dots, n \quad (12)$$

The variables of decision x_{ij} are binary, taking values 1 or 0, depending of if an employee i is or not assigned to a certain role j , respectively. The decision variable u_i are also binary. They are associated to each possible person i to participate in the project, and they take value 1 only in the case that the person i is assigned at least one role in the project. Each one of the functions and restrictions of the pattern are explained briefly in the next section.

Function (I) maximizes the Competence factor and (II) minimizes the incompatibilities of the team. Function (III) considers the Availability of the people factor and tries to balance the workload. Each term of the sum in i , is a non negative number that represents the difference that exists between the total workload that an individual would have in current projects and the one being considered, and the total average workload considering the new project and the actual ones. Function (IV) optimizes the factor Cost for distance. To consider this factor it is necessary to have the data that reflects how expensive is for each employee to consider according to their localization with regard to the localization of the project and the impact that this has to execute the role carried out in the project at distance.

Restriction (1) guarantees that the roles are covered exactly as demanded. Restriction (2) models the existence of incompatible roles. In (3) restricts the maximum number of roles that any employee can assume in the project. Restriction (4) guarantees that the variable u_i takes value 1 if the employee i is assigned to at least one role in the project, and value 0 otherwise. Restriction (5) imposes complying with minimum conditions such as the necessary competences in a person to be assigned a given role. Restriction (6) establishes that total workload assigned to an employee should not surpass a maximum value. Restriction (7) imposes that in the selected team, the three categories of Belbin roles should be represented. Restriction (8) imposes that in the team the preference to carry out action roles should surpass the preference to carry out mental roles. In (9) it is imposed that the preference to carry out mental roles should surpass the preference for the social roles. Restriction (10) imposes that if the person i performs the role, Project Leader, at least one of the following Belbin roles should be preferred: Shaper or Chairman, assuming that in the matrix D , the preference for Shaper and Chairman is registered in the columns 1 and 7, respectively. In (11) it is imposed that in the team at least one person has as preferred the role "Plant", assuming that in the column 4 of the matrix D is registered the preference for this role. Finally, (12) imposes that if the person i assumes the role Project Leader, the person should have the subtype EJ (Extroversion-Judging), the dimension E/I is registered in the column 1 and the J/P in the column 4.

As observed, the model allows solving the problem of assigning employees to a team of software project in such way that all the roles are covered in the established quantity. Therefore, it is possible that an employee carries out more than a role (until a maximum quantity) and that a role is carried out by more than one employee (if it is required).

The proposed model considers so much factors that contribute to the individual assignment to the project roles (competences, workload, cost for distance, characteristic psychological) like to the formation of the team as a whole (balance between roles and incompatibilities between the members and roles of the team). Besides, the model is able to integrate great part of the factors considered in the evaluated assignment models and it incorporates, as original elements: the cost of carrying out developments at distance, the incompatibilities among the members of the team and a group of restrictions that belong together with the identified (balance among categories of team roles, leadership and creativity) starting from use of the method Delphi, psychological tests and tools of mining of data.

5. Validation

A decision support tool was implemented that sustains the model as well as the methods and the solution algorithms of the problem. The tool, developed in Java, possesses a friendly and flexible interface, is able to treat the factors as objectives as well as restrictions, and for adjusting parameters of the model.

To demonstrate the applicability of the proposed model in this first stage, a test case was designed which corresponds to an organization of sixty employees where it is required to assign persons to a team of six roles. Each of the implemented solution algorithms: Hill-Climbing with Re-initiation (HCR), Simulated Annealing (SA), and hybrid algorithms such as: GRASP with Hill-Climbing (G+HC) and GRASP with Simulated Annealing (G+SA) were executed twenty times using the tool. The executions were carried out using two cases: 1-considering one objective to optimize, to maximize the personnel competences, and 2-considering three objectives: to maximize competences, minimize workload and minimize incompatibilities, using the method of weighted factors with weights 0.36, 0.31 and 0.33 respectively. In both cases the response times were acceptable.

6. Conclusions

The application of Delphi method allowed: to establish the criteria for the selection of experts, to identify the main factors to consider in the elaboration of a formal model of assignment of personal to teams of software projects applicable to any software organization with a special value in medium and large organizations, as well as to elaborate a proposal of invariant roles and necessary competences to face software projects which serves as a guide to software organizations in the implementation of management by competences.

The application of the psychological tests and tools for data mining allowed identifying patterns that contribute to the formation of teams of software projects like the appropriate balance among the categories of team roles, the presence of the role "Plant" and the demands for the acting of the role Project Leader. From the results obtained it was possible to elaborate a formal model for the assignment of personal to teams of software projects that considers so much factors that contribute to the individual assignment to the project roles (competences, workload, cost for distance, characteristic psychological) like to the formation of the team as a whole (balance between roles and incompatibilities between the members and roles of the team).

The use of the developed tool in the solution of the test case allowed the conclusion that the proposed model is feasible to implement and the algorithms used lead to solutions in acceptable times. Besides, the tool is flexible because it allows the decision maker to evaluate different assignments by varying objectives, restrictions and parameters. In addition, it is possible to outline that the model as well as the tool that support the process of management of human resources in the organizations, and contribute so that the assignment process is more objective and transparent.

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Toward a More Holistic Reliability of Business Information

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Abstract: Modern business environments require innovated business concepts. Meeting them in enterprises' functioning depends also on creation and implementation of appropriate information support. In terms of contents, information support and information must be reliable to not be misinformation; ICT is not enough for it because information means impact. Potential errors on the long path from data to information must hence be prevented. A one-sided approach, which belongs to the practice of professionals as narrow specialists, can prevent errors and misinformation rarely – when rather one-sided information is enough. More complex situation and processes require a more holistic approach that, in its turn, requires interdisciplinary creative co-operation of specialists of various interdependent professions. We try to contribute to discussion about reliability of information by thinking how can one tackle the data-to-information-to-decision process in order to diminish dangers of poor reliability of information/decision. We have no room to add quantitative analysis to the qualitative one.

Keywords: Business information; errors; information management innovation; reliability of information.

1. Introduction

For centuries, handicraft and agricultural producers used to prevail and to basically know who their expectable customers (= market) are (Collins, 2001; Florida, 2002; Daft, 2003; Potocan, 2003; etc.). Their technology did not change much either. Thus, their information requirement was limited to finance. This old habit is still around – finance and accountancy still tend to be one department; controlling tends to be a little bit more holistic only. There is hardly any “Information Department” making all kind of data and messages into requisitely holistic information for business operation management (Afuah, 1998; Laudon, Laudon & Laudon, 2005; Potocan, 2005; Kelley, 2009).

It must serve a much innovated business management concept, which most authors briefs: from “make-and-sell”, to “sense-and-respond”, toward “anticipate-and-learn” (Afuah, 1998; Cohen, 2002; Barabba, 2004; Bernson & Standing, 2008). The new situation requires a new approach – “state of mind” that balances creativity and intuition with analytics and science (Afuah, 1998; Gunton, 1998; Brown & Duguid, 2000; Verma & Kapur, 2006; Curtis & Cobham, 2008).

Information management innovation is needed, and (requisitely) holistic thinking must be its background. The problem of the theory and practice of business informatics has lied in the target orientation aimed at requisite business information (Gunton, 1998; Anderson, 2000; Harmon, 2003; Laudon, Laudon & Laudon, 2007; Potocan, 2008). And in attempts to increase holism of information, we are facing two basic problems of data suitability, e.g. what is adequately target-oriented information; and how to create (and define) a suitable level of generalization of information, resulting from data and messages, in order to avoid errors.

We hence try to research more deeply errors in information systems and add to discussion about reliability three pointed-out topics: reality and captured data are not the same, decision-making takes place within a context, and only selected data are processed. We also try to contribute to discussion by thinking how can one tackle the data-to-information-to-decision process in order to diminish the number and weight of errors. Data recording errors follow earlier errors – data selection, and data selection basis and errors in it.

2. Wholeness of Information Support for Business Operations

2.1. The Concept of Requisite Holism and Wholeness

Holism of human behavior has never been attainable, neither is wholeness of its outcomes if the word is taken completely literally like it is put in dictionaries: in them it includes every attribute, all attributes, and nothing (!) is left aside. All (!) professions (which tend to be several thousand) would have to be included. And this cannot be done. That's why Mulej and Kajzer introduced the law of requisite holism (Mulej, 1974; Mulej & Kajzer, 1998; Mulej et al, 2000; Mulej et al., 2003; Mulej, Likar & Potocan, 2005; Mulej, 2007) to make the Mulej's concept of the Dialectical System (DS) clear and acceptable. It expresses the experience that one has the unavoidable habit to select the DS as a synergetic network of all crucial viewpoints to be considered, and to leave the others aside, or to reduce even more. Reductionism is both unavoidable and dangerous. See Table 1.

Table 1: The selected level of holism and realism of consideration of the selected topic between the fictitious, requisite, and total holism and realism of approach and wholeness of insights, actions, and other outcomes.

←-----→		
Fictitious holism/realism (inside a single viewpoint)	Requisite holism/realism (a dialectical system of all essential viewpoints)	Total = real holism/realism (a system of all viewpoints)
Dangerous due to causing one-sided oversights along with partial insights based on specialization	Attainable, but depending on human choice of the essential viewpoints/professions from all possible, and their synergies	Ideal, but impossible to attain due to huge complexity of reality reaching beyond human capability

Selection of the crucial viewpoints and neglecting of other viewpoints of consideration is due to the decision-makers and their attributes as their subjective starting points that include—in synergy—both knowledge and emotions. The latter are expressed as values and may become culture, ethics, and norms.

2.2. Ethics, Culture, Ethics, and Norms and Their Impact over the Wholeness of Information Support for Business Operation

We mentioned dilemma about a requisitely holistic, dialectically systemic consideration of a synergetic entity made of norms, values, culture and ethics and their impact over the wholeness of information support for business operation (see Table 2) (See: Mulej, 1974; Mulej & Kajzer, 1998; Potocan, 1997; Mulej et al., 2000; Potocan, 2003; Mulej, 2007; Potocan, 2008; etc.).

Table 2: Circular interdependence of values, culture, ethics, and norms (VCEN)

Individual values (interdependent with knowledge)	☐	Culture = values shared by many, habits making them a round-off social group
☐		☐
Norms = prescribed values on right and wrong in a social group	☐	Ethics = prevailing values on right and wrong in a social group

How do we understand this synergetic entity? From business practice, we are persuaded that ethics is more a feeling than a part of the left-brain rationality/knowledge/skill. It enables us to distinguish right from wrong (Ulrich, 1997; Jennings, 2005; Shaw, 2007; etc.). Empirical researchers consider ethics a synergy of behaviors, which tend to be preferred in a society or community, as a social group, for long enough periods of time to become codified. Moral rules result, as a formal next step (Ulrich, 1997; Jennings, 2005; Shaw, 2007; etc.).

Rules co-create a culture, be it the one of social sub-groups, of organizational units, of organizations as wholes, or the one of regions, nations, social classes, professions (Mulej et al., 2003; Potocan, 2003; Mulej, Likar & Potocan, 2005; Potocan & Kuralt, 2007; etc.). Thus, something, which is originally an individual attribute, comes to be objectified as a component of the objective conditions (i.e. outside the impact of tackled individuals). It becomes a part of broader requirements imposed over the individuals, and tends to return, in this way, back to individuals as a part of their (socially obligatory!) values, i.e. their emotional perception of the objective needs or requirements and possibilities they face.

Thus it enters (or re-enters) the individual's starting points, which influence perception, definition of preferences, their realization in the form of goals, later on of tasks, of procedures of realizing the tasks, and achievements etc. It means that for any human activity ethics is equally essential as professional knowledge and skills, creativity and co-operatively. We have even found all of them mutually interdependent.

Thus, the prescribed norms result from values of the influential people, such as opinion leaders in the society at large, market, business organizations (or another organization all way from family to United Nations), and influence the less influential people, if the latter accept them. This acceptance or refusing or circumventing results from the influenced people's emotions, such as trust to the influential people, and/or knowledge causing their capability to comprehend the norms.

VCEN influence the selection of the Dialectical systems, including the content of the information support to decision and actions.

2.3. The Contents of Information Support, Its Holism and Wholeness

Globalization of the world economy puts competitive pressure over the businesses, requiring their high quality business operation, which can be significantly improved by management innovation

providing a more holistic managerial and operational behavior. Management, be it innovated or outdated, determines the quality of the entire business. Business management uses information presenting important characteristics of the field dealt with, and its own and co-workers' knowledge, i.e. long-term information (from both the content and methodological aspects) (Potocan, 1997; Harmon, 2003; McLeod & Schell, 2003; Potocan, 2005; Baltzan & Phillips, 2008).

Information differs from data. Available data tend to be too many to become informative (= influential). Selection of data enables informing, which cannot attain full wholeness, but the requisite wholeness, hopefully. This requires an information management innovation (Potocan, 1997; Schultheis & Sumner, 1998; Anderson, 2000; Tichy & Cohen, 2002; Moss, 2004; Potocan, 2005; Bernson & Standing, 2008; Potocan, 2008). It results in the requisite wholeness of information. In business, it surfaces in and influences the basic business and other processes supporting the entire business.

Both non-economic and general economic information on business operation dealt with are needed in the business managers' economics-oriented decision making, and can be quantitative and/or qualitative. To run one's business operation well one, namely, needs all / requisite various information with which quantity, value, and quality (or any other important) characteristics of business are presented. Making and using information opens a variety of content, VCEN and methodology issues making it adequate (= providing requisite, wholeness, realism, applicability, and influence).

The business operation can be found adequate, when it is successful (efficient and effective in economic terms), respected (from the aspect of business behavior), and ethical (morally adequate from the aspect of a responsible attitude towards the social and natural environment). To make it so, the business operation managers need general information, too.

The majority of general information can have a direct or indirect impact on economics of business operation. For this reason, this information can be also a part of the economic information in the broadest sense of the word. Beside, there is also information that can be called non-economic information for business (such as law, technology, sociology, political trends, local, national, professional, and other cultures, values, ethics, norms, education, demographic trend, etc.). These include messages, data, or information that is not directly related to the business operation, or is not included in the management of the business operation dealt with, but of its environment. Because of its impact over economics of business operation this "non-economic" information can be called indirect economic information. Especially, under an open-system approach to business management it is included in requisite information and knowledge.

With all the briefed diversity, the problem of the theory and practice of business informatics, since its beginning, has lied in the target orientation aimed at requisite wholeness of economic information. In the past, information support to management was very often limited to the financial aspect of the economics business operation alone. Financial information does present an important subsystem of information and nothing more. The modern business information focuses on providing more / requisitely holistic information necessary for the business operation management. This is an important trend in information management innovation.

Herein we find the increased importance of the indirect economic information. It is difficult to treat because its definition is problematic. Its content can be objective and subjective: defined by processes events as well as by observers and decision makers.

The information is called objective, if it can be well defined and, therefore, well investigated on the basis of different quantitative units (e.g.: quantity, weight, value). Under equal conditions it is repeatable. But conditions can be subjectively selected, depending on the selected system of viewpoints (per professions, interests, etc.), and so can "objective" information. It tends to lack wholeness, which is precondition of total objectivity, for natural reasons:

- Nature has enormously many more attributes than humans can capture,

- There is no information without perception by observer/s, and
- Humans are neither able to know everything, nor to think of everything at the same time.

Reductionism is consequence of this limited human capacity, and it allows for depth and hinders holism of behavior and wholeness of insight and other outcomes. Therefore objectivity of reality is not limited, but objectivity of data and information is.

On the other hand, information that cannot be exactly defined is called subjective. As a rule, it is collected and examined by the application of various qualitative units, or even by application of descriptive criteria only, which cannot be measured in quantitative units. Reductionism results again, allowing for depth and hindering holism and wholeness. But now its presence is clear and admitted.

Thus, the information capacity of collected data and messages depends of the level of holism of the selected system of viewpoints of both the data providers and data collectors and processors. If their holism lacks, misinformation and / or disinformation can results from lack of wholeness of insight.

Therefore, in attempts to increase wholeness of information, we face two aspects of data suitability, i.e.:

- An adequately target-oriented information, and
- A suitable/requisite level of generalization of information, resulting from data and messages.

For the needs of the individual business operation (different kinds, types, and forms) and business operation in the individual areas of work (e.g. per business functions, or per projects), we need the information that is suitably conceived and created in accordance with the set goals of our work. On the other hand, we need different general information for each business operation, both for business participants to set goals and to realize them.

Information can be created on different levels of generalization resulting from requirements of the business management. The level of generalization can be in the interval between entirely general information and completely specific information. This fact brings us again to the issue of background of attainment of a selected level of holism/wholeness. It is essential for information to be reliable rather than misinformation or disinformation.

Creation of requisite wholeness of information provides content, which serves as a basis for the consideration of the informational support to business. Though, such information provides only for the basic, but not for the sufficient precondition for the informational support to business to attain requisite wholeness. The other basic precondition of understanding and application of information consists of creation and use of a suitable information infrastructure as a component of wholeness business intelligence.

All these and similar issues allow for the conclusion that the attainment of wholeness of information faces entanglement.

2.4. Entanglement of Provision of Requisite Wholeness of Information Support for Business

Let us now spend a few minutes with the issue of entanglement (Mulej et al., 2000; Potocan, 2003; Mulej, Likar & Potocan, 2005; Potocan, 2005; Mulej, 2007).

The concepts of entanglement are not always precisely defined, on one hand. On the other hand, there also appears the question how to manage/master entangled phenomena as economically as possible and, at the same time, successfully - effectively and efficiently.

What are both theoretical and practical issues of entanglement? We are more interested in the process than in the structure and in holism of consideration than in its partiality (one-sidedness).

The entanglement has been increasing since the existence of life on earth. However, one also knows of the need for a more detailed consideration of entanglement. If one does not consider both

synergies and details, one risks oversimplification and important oversights, as a result, which may cause entangled consequences.

We can hardly choose between levels of entanglement of reality. The choice we have is rather between the entanglement of consideration / investigation / management of reality and the entanglement of their consequences. It is probably logical to find it more beneficial to devote most of our attention to the phenomena of entanglement in order to avoid complicated and/or complex consequences:

- When we discuss the details concerning an individual component of an entity under investigation, then we can talk about the entanglement of the type complicatedness. It can also be defined as the entanglement based of the characteristics of the components and present a part of the real characteristics of phenomena, which have different components / parts. The greater is the variety of components, the higher is also the level of complicatedness and vice versa. Synergies do not count.
- With concentration on the characteristics, which result from mutual influences between the components of an entity (and their background - basically their interdependence) we deal with the entanglement called complexity. It shows the characteristics of phenomena, which differ in structures and synergies from their components alone. Their structure is formed by a number of different types, varieties and forms of relations between the components inside the systems and with their environment. The greater is the variety of relations, the higher is also the level of complexity and vice versa. Synergies are central and critical. Attributes of components are found less important.

Both entanglements exist in reality, of course. There can, therefore, be a number of their various contents. A similar conclusion holds of the variants concerning the level of entanglement of both types which is, very often, bigger in reality than in a usual consideration (also in a scientific one). When examining the phenomena, the following can be achieved, hence: (in one extreme) totality, (in the other extreme) zero-level, or (between both extremes) a requisite level, of consideration of characteristics of phenomena. It all depends on our selection of a viewpoint / viewpoints / system or network of viewpoints / dialectical system of all essential and only essential viewpoints.

In our consideration of entanglement, we additionally encounter the problems of how to define a requisite entanglement of our examination. But this issue exceeds frames of this contribution.

How do the discussed characteristics impact consideration of reliability of information in the case of business information?

3. Reliability of Information

Failure to inform depends on more entangled processes than the ones offered as their first and, of course, simplified approximation quoted by Eli B. Cohen, and aimed at provoking our thinking (Cohen, 2002; see also Tichy & Cohen, 2002; McLeod & Schell, 2003; Laudon, Laudon & Laudon, 2007) in his book. We used Cohen's book as a base for our discussion, but his cognitions are very similar to cognitions of other authors on reliability of business information in last 30 years (See also: Schultheis & Sumner, 1998; Verma & Kapur, 2006; Laudon, Laudon & Laudon, 2007; Kelley, 2009; etc.). Two tables from Cohen's book (Cohen, 2002) (3 and 4 below) say so:

Table 3: The simple three-stage framework of information delivery

Data → Processing of data → Information

Table 4: Expanded Framework on information delivery

Reality → Data recording → Processing of selected data → Decision maker ← context Error types: I. Data recording, II. Process Stage, III. Decision Making

We see an essential part of entanglement to be added in the following facts, at least (Mulej et al., 2003; Potocan, 2003; Potocan, 2005; Mulej, 2007):

- Which part of attributes of reality does one consider? In a business case, the same business reality can provide basis for different pictures of reality, if it is watched from the viewpoints of e.g. book keeping, marketing, sales, supplies, technology for the daily routine, technology research, development, innovation (which can be of many kinds – from technology to culture and management style etc.), human resources, organizational culture, private relations along with the official ones inside the company or with its business, social or natural environments, legal situation (which again can be of many kinds – from business and employment contracts to punishable actions), etc.
- Which part of possible data does one record? In a business case, they can have to do with all the above realities or some of them; they can depict their past, present, or future situations, their local, regional, national, or international situation, their situation in terms of the stage in their process of unfolding, their situation in terms of availability and eligibility of qualitative and/or quantitative data, their situation in terms of computer support to recording or another technology, etc.
- Which contents can the processing of selected data have? In a business case, they can have to do with all the above realities and possible recording types, and add to them very different levels of e.g. depth and/or breadth of insight; further routine processing or creative processing can be added, all the way to innovation, or perhaps to manipulation leading to misinformation or des-information, which can tackle co-workers, managers, owners, or competitors, government, etc.
- Who is the decision-maker? In a business case, these may be managers and/or owners. But it is not realistic enough, if one thinks of them only: everybody makes his or her decision every moment (including decisions such as: »I am going to have a cigarette now / later«, or »I am going to toilet now / later«, »It is time to go home«, »It is time to work harder«, »I will read / not read this message / I may read it later«, »I will make a / no suggestion«, »I will be passive / active about the company problems«, etc.).
- Do decision-makers acknowledge that complexity of business has grown and most attributes of the life reality in business have changed, while the need to make good decisions has not changed? A simplified, e.g. quantified, model of reality can hardly be realistic enough for good, i.e. requisitely holistic and realistic decisions, and resulting actions.
- Do decision-makers admit that problems are to reality what atoms are to tables, and we experience tables, not atoms? Problems are abstracted from experience by analysis. We do not experience individual problems, but complete systems (= complex entities) of those that are strongly interacting. Most authors call them messes. Defining them is the first step of real problem solving.
- How do decision-makers deal with the old proverb “What you see depends on where you sit in an organization”, i.e. the multiple and diverse viewpoints and resulting insights into the same fact, causing (very) different assessments of fact resulting in (very) different conclusions? (“Everyone’s eyes have their own painter”, an old proverb says.)

- How do decision-makers deal with the experience that the “information asymmetry” makes you know a part of reality better than your counterparts do, while making you blind for another part / many other parts (your business partners, including your staff, may distrust you and fail to disclose their information to you).
- How do decision-makers perceive, understand and assess context of their decision-making / thinking / action? All the above varieties may enter the scene, and make a long set of very different synergies. Very different information may result.
- How do decision-makers consider the fact that totally holistic information (i.e. knowing everything) is impossible, and they must base their decisions on assumption about reality and its future? How do they use imagination to make realistic strategies? How do they select the essential from the less essential data / viewpoints / information / insights / knowledge?
- How do decision-makers tackle the fact that managing today includes a lot of innovation / transformation of e.g. way of interaction with customers, way of formulation of problems internally, way of imaging the future – in order to make a difference, hence to survive in globalize competition? How is informing adapted to this rather new fact?

We do not say that Cohen's Tables 3 and 4 are not O.K (Cohen, 2002). We are just following his suggestion to think more deeply about errors in informing systems to add to his quoted three pointed-out topics:

- Reality and captured data are not the same,
- Decision-making takes place within a context, and
- Only selected data are processed.

He is right: »decision-making is only indirectly influenced by reality; there are many steps that separate reality from the decision-making process«. On this basis he wants to apply »this framework as a means to organize the types of errors that lead (information) systems to misinform their clients«.

We want to contribute by thinking in another direction: how can one tackle the data-to-information-to-decision-to-action process in order to diminish the number and weight of errors. Data recording errors follow earlier errors in data selection, and in data selection basis.

We will follow the concept depicted in Table 5 (Mulej et al., 2003; Mulej, Likar & Potocan, 2005; Potocan, 2005).

Table 5: Dependence of the errors on the decision-makers' approach

Errors to be detected, classified, and prevented or removed	
Non-Essential errors (with no-critical consequences)	Essential errors (with important consequences)
□□	□□
No over-biased / too one-sided / too partial / too poorly holistic approach, but requisite holism reaching sufficient holism of decision makers in any step of the entire process from setting criteria for watching reality and collecting data all way to the final (business) decision and action – caused by no crucial lack of specialists' interdisciplinary co-operation	Biased / one-sided / too partial / too poorly holistic approach reaching insufficient holism of decision makers in any step of the entire process from setting criteria for watching reality and collecting data all way to the final (business) decision and action – caused by a crucial lack of specialists' interdisciplinary co-operation
□□	□□
Selection and application of subjective starting points following the Dialectical Systems Theory and Standardized Decision-Making Model	Selection and application of subjective starting points not following the Dialectical Systems Theory and Standardized Decision-Making Model, but a one-sided / single-disciplinary approach

For decision makers to use a requisitely holistic approach and thus to attain requisite wholeness of their decisions and actions, knowledge of one single profession and use of one single viewpoint can suffice only exceptionally. The given reality is too entangled. Thus, creative interdisciplinary cooperation is often unavoidable. Though, specialists tend to learn to be specialists rather than to intentionally and carefully listen to humans who disagree with them and thus tend to help them attain requisite wholeness.

4. Some Conclusions

Modern business environments require innovated business concepts. Meeting new requirements concerning enterprises' functioning depends also on creation and implementation of appropriate information support. For centuries information requirements of enterprises were primarily limited to finance. In modern environment enterprises need information management innovation; holistic thinking must be its background for action to attain requisite wholeness.

Information support and information must be reliable to not be misinformation. Reliability of both is crucial for quality of business. Over the recent decades technological innovations improved acquisition, distribution and application of business information. Less has been done for assurance of quality of contents of business information, aimed at requisitely holistic behavior and resulting requisite wholeness of attainment of business goals definition and realization. The available technological solutions concerning informatics technology (hardware, software, communications, or data bases) must hence be completed up with non-technological innovations (e.g. Creation of Requisitely Holistic Management Information). They can enable more reliability of information's contents.

Reliability of business information can be improved, if one understands, considers and realizes business process requisitely holistically, because information serves it. Requisite holism and wholeness can essentially contribute to its reliability. Hence at matters one tackles the data-to-information-to-decision process in order to diminish the number and weight of errors. Data recording errors follow earlier errors – data selection, data collection and errors in their backgrounds.

A requisite contents' reliability of business information depends on (dialectical) systems thinking and business cybernetics, which have been to poorly apply so far in this content.

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The Social Cost of Social Value Creation – An Exploratory Inquiry into the Ambivalent Nature of Complex Information Technology Intensive Firms

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Abstract: Google, eBay, Amazon, Facebook, Myspace, Craig's List and their foreign equivalents, such as the Chinese QQ and Baidu, for example, are ostensibly complex, and – more troublesome – their attitudes are becoming increasingly contradictory, controversial, and conflicted: For one, Tom Malone's decade-old predictions of a decentralized network of a multitude of small, cooperating firms did not materialize; to the contrary and counter to the spirit of the democratic nature of information and information technology, these e-giants are defining their own industries and defying regulation, submitting the participants in their respective markets to proprietary rules via three central tenets: regulatory capture, regulatory arbitrage, and regulatory opportunism. In the present critical paper we explore these traits of the Complex Information Technology-Intensive firms and formulate elements of a framework for their ambiguous nature that may lead to social cost exceeding their initially glorified social value creation.

Keywords: Complex Information Technology-Intensive Firms; Social Cost; Social Value

1. Introduction

Our object of inquiry are information technology-intensive firms that are also 'complex' system, serving multiple constituencies with multiple objectives, their existence as networks is virtual, they are modular or even incomplete firms with mostly only fractional functionalities compared to the traditional Porterian value-chain model, their user constituencies are fragmented and mostly not the paying clients, the metrics to measure the attainment of their goals are based on unobservables and rather difficult if not impossible to quantify and capture. They are community-based, social value-oriented, and network-centric models. Of an entirely new character, they do not merely represent a form of speciation or evolution from previous models. In order to configure and sustainably maintain such volatile and inherently unstable social networking models tremendous amounts of intentional and deliberate intelligent design is required. This is especially true when – as is the case with those types of firms – the variables strategy, structure, scale, scope, and social position have been radically deconstructed, reconfigured, and

reconstructed in truly Schumpeterian spirit of creative destruction. Indeed those firms are not merely some adaptive evolution with a change in degree from some previous state but represent a radical departure from the original design of firms with a new nature altogether.

Insofar our perspective is different from previous treatments of the subject: While much of the literature concerned with this aspect of IT since the mid 1990s deals with the pragmatic impact of information technology on organizational design, and primarily remains concerned with epistemic problems and transactional aspects: their focus is on structuration issues, harnessing the potential of information technology through optimization, and the impact of IT on firms' activities, decision making processes and management effectiveness (see for example Brynjolfsson & Hitt 1997, and Brynjolfsson, et al. 1994), on one hand, and the necessary attributes to function under the new environmental conditions brought about by IT on the other (see Huber, 2003). Others have been concerned with the fragmented, partial, fractional, and modular nature of firms morphing into network structures (see Brusoni & Tronchetti-Provera, 2005). And yet an entirely separate issue was the effect of IT on markets (e.g. Varian, 2001, and Varian et al., 2004). Our concern, however, is ontological and explores the very reason for existence of such firms, their new nature, their fundamentally redefined character as productive elements of the economic complex. Indeed, they are a new breed of firms that represent a paradigmatic change but with paradoxical consequences.

They are designed *sui generis*, *ex nihilo*, *ex ante*, and *de novo*: The design variables strategy, structure, scale, scope and social position are used at the opposed and of the spectrum of their initial meaning. For example strategy is not competitive but cooperative; structure is not bureaucratic-hierarchical but network-flat, scope is not driven by transaction cost, but by transaction profits; size is not a quantified measure, but a qualitative result of dominance; finally, the social position of the firm is not across the table of its users, consumers, and clients, but implicates them as partners in a collaborative way to co-produce and co-generate the products, experiences, and content. The resulting entirely new business models of social networks, transmutability (Arakji & Lang 2007; Hughes & Lang 2005), and community models, do not evolve organically, however. Unlike traditional industrial firms that coalesced around different technologies by carefully designing the management control structures as the integrative mechanisms, the new firms require an *a priori* conceptual design and configuration of the above five variables much like the blueprint for an architecture.

This paradigmatic distinctiveness, however, comes with a series of paradoxes: strategy and structure of these firms are becoming increasingly controversial as is the anecdotal ambition of Google for 'world domination'. The scaling and scoping of their activities to monopoly status and single-firm dominant industry position increasingly contradicts the original aspirations for an atomized and consequently democratized network of equal participants. And since pursuing social goals with economic means was never straight forward they seem increasingly conflicted with their for-profit model for social value generation; unlike taxation, Google's redistribution of income and revenue between different constituencies is devoid of formal authority.

And a further combination of these three paradoxes could result in social cost outweighing the social benefits of the paradigm shift towards a new nature of those firms. And while their existence is certainly a result of creative destruction, their actions would prove contradicting the Schumpeterian spirit of increased competitiveness for the benefit of productive capacity and efficacy.

2. Methodology

In the present exploratory paper we propose elements of a framework that captures three important components responsible for the resulting ambivalent nature of these firms. Methodologically our approach is a composite of (a) an empirical (grounded-theory) approach based on several dozens of semi-structured interviews with high-profile professional and practitioners in the larger New York metropolitan business community in the context of a larger inquiry into “the new nature of the firm” that we have been conducting since early 2007; (b) an exploratory inquiry based on observable behaviors of these firms as publicly traded entities followed by Wall Street analysts; and (c) a critical conceptual study exposing the unobservable context and suggesting new theoretical developments with regards to the unanticipated consequences of such ambivalent nature of the said Complex Information Technology-Intensive firms.

3. The contradiction in scale and scope

Originally, at the advent of the digital age, we may have expected the notion of size to lose its importance. Size as a protection against environmental turbulence and contested market share became overrated. The nature of IT was utterly different from the previous technologies of transformation, transportation, energy-generation, energy-distribution, coordination, and communication. Unlike information that simply exists (in its own right), previous technologies only existed when they manifested themselves, when they were practiced; and the more they were practiced the more credible their existence, i.e. economics of scale were important. A notable property of information is, however, is that it is in fact independent of its practice. Information doesn't have to be practical to exist.

Yet, the prominent forms of our newly proposed category are all but indifferent to size and scale. While traditionally firms were either part of the problem, or part of the solution, or part of the landscape, they can now be either

- the entire landscape or
- move the landscape altogether. So, Amazon, Google, and eBay did not content themselves to being yet another player in their respective industries; they became the entire market respectively, inviting everyone else to join and participate. Apple single-handedly changed the way music will be enjoyed in the future.

The organic logic of the network has thus been undone. Similar to the notion of market makers, several firms realized the advantage of actually themselves becoming and being networks. The network effect has thus become captive of individual firms quickly stepping up and internalizing network effects. And they didn't do it by chance or accidental evolution, they did it by intelligent design to do just that. Amazon had overengineered their capacity from the early beginning in order to not have to struggle and incur risks with incremental adaptation later.

Ronald Coase informed institutional economics in 1937 of the true substance of the firm: its ability to arbitrate transaction *costs* which markets couldn't. (See also the subsequent work by Williamson, 1981, and Williamson & Winter, 1991, ultimately resulting in what is called New Institutionalism). The CITI firms have not only substituted this concept with transaction *profits* (e.g. eBay), but moreover expanded it to a level where scope becomes an instantaneous decision, not a deliberate, incremental process.

The CITI firms

- have demonstrated their ability to morph from single company models to markets in their own right at will and nearly instantaneously, all the while passing through stages of intermediary, infomediary, and aggregator, to name just a few prominent e-business and e-commerce positions (e.g. Amazon as a bookseller and as a business enabler for a myriad of smaller booksellers and individuals who want to recycle their used books but can't afford the fixed cost in marketing expenditure for their e-commerce presence);
- can hop from industry to industry and between industries at will and almost instantaneously (e.g. Google's search engine activities, yet also the G1 phone, and the recently reported aspirations to generate green electricity; Facebook is a platform for users to produce themselves with other users but quickly become an essential tool for job seekers, employers, and recruiters for various purposes with respect to sourcing and hiring issues);
- escape definitions and notions that tie them to a particular industry and thus potentially avoid the associated regulations and constraints (e.g. Craig's List that only recently and under only under political and ethical pressure accorded to policing their immorally solicitive personal ads).

Such radical redefinitions with respect to scale and scope are worrisome for several reasons:

- The all-fixed-cost-zero-variable-cost characteristic of digital production that so easily results in a near-natural monopoly argument for single-firm digital industries dangerously justifies conglomerates of unprecedented levels of power and control. While their size may not be easily quantifiable in accounting and financial terms their impact on our everyday lives is profound. And while many aspects of their activities and their existence enrich our lives tremendously, it remains that their sole existence and the lack of market space for alternative options predicate our lives in unpredictable ways as well.
- The ease to morph from market forms to intermediary model to single integrated company can preempt many an attempt at innovation and improvement by new entrants. The barrier to entry can be raised indefinitely and to insurmountable heights, and potentially more effective and efficient solutions can be kept from the public discretionarily.
- Finally, the intensity of competition is raised beyond rivalry. All that counts is to occupy enough of a market space that includes the tipping point; such competition in the early stages before the merit of any technology is identifiable is highly skewed and can result in entirely unjustified early technological choices with uncertain and unpredictable consequences.

4. The controversy with regards to strategy and structure

Much is being written and analyzed with regards to CITI firms' strategic and structural ambitions. They appear grounded in cooperation or co-opetition at the least, their structures are open and accommodative, they are engaging and integrative with respect to their fellow market participants. Yet, of less prominent nature is the agenda of their strategies and structures vis-à-vis the regulator. In there lies the real value of analysis.

CITI firms spend a disproportionate amount of energy dedicated to influencing and manipulating their legal and regulatory environment. They do so in three particular ways:

- At the most intense level, they exhibit a rightout hostile attitude translating in so called regulatory capture, a term first introduced by Joseph Stigler (1971):

As the CITI firms assure to grow intensely and extensively so as to become their own industry they concomitantly refocus much of the regulatory energy onto them. But the novelty, velocity, and ingenuity of their activities overwhelms even the most imaginative regulators quickly as was evidenced by the recent Craig's List scandal and the associated belated reaction on the part of authorities to curtail the immoral and rightout illegal soliciting prostitution.

With their particular version of market dominance they have distorted the construct of monopolistic competitions by taking it to an entirely unprecedented level, even more extreme than monopoly. At least in the traditional model, the monopolist's freedom to make discretionary decisions was counterbalanced by the demand decisions of consumers. The monopolist's decision therefore was still limited to $\text{Marginal Supply} = \text{Marginal Revenue}$. With their controlling position over the entire network, however, the CITI firms are not bound by this limitation. They can ultimately sidestep it by proposing their own currency, such as in the famous Amazon gift certificate cases. While competition is certainly not the panacea to many of the traditional lack of capacity to innovation, so neutralized regulatory efforts, concentration of market power, and control of creative initiative (such as Amazon's Kindle and the associated proprietary system software and enhanced Digital Rights Management, for example) nevertheless reduce competitiveness bar beyond what might be considered beneficial competition. This may result in social cost by what was prevented from being created or what was created suboptimally without there being appropriate oversight or stimulating competing activity.

- Of lesser nominal intensity, but nevertheless heightened level of aggression are the CITI firms' efforts with regards to regulatory arbitrage. These represent a veritable assault on established institutional legal standards through either aggressive expansion of the law (such as the intellectual property protection mechanisms to patent business methods, preventing many transactions in e-commerce) or sheer sidestepping of the law (such as in contractual disputes, ignoring the rule of *due process*).

We define regulatory arbitrage as the exploit as yet unrealized opportunities resulting from some information-technological asymmetry.

One such example is the accelerated enforcement of contractual obligations and the punitive character of contractual terminations with so called shrinkwrap or clickwrap contracts in the interest of expedience and efficiency. The age old rule of *due process* requiring court-based proceedings for breach of contract is rendered ineffective and firms self-manage contract issues.

Another example is the restrictions on fair use by digital rights management practices lobbied into law through the Digital Copyright Millenium Act (signed into law by President [Bill Clinton](#) on [October 28, 1998](#)).

Finally the most telling example is ironically also the most ambivalent, and near inconclusive:

Important impact was exerted by CITI firms through a less noticed market-institutional by-product, the regulatory framework for intellectual property rights. In an initial wave, it was a defying P2P movement symbolized by Napster that tried to neutralize copyright.

In an offsetting movement the extension of patent law proved even more controversial. While it seemed a benign idea initially, the framework's extension to include business method patents in the 1998 State Street Bank v. Signature Financial group decision (*ibid.*) was nothing short of a true quantum leap in terms of legitimizing monopoly and chilling competitiveness. The lobbying for this integrative approach to

patents paid off handsomely: Amazon leaped ahead with a series of controversial patents such as the One-Click-Stop-Shop, Google patented its method of assessing relevancy, and eBay snapped up the repackaging of trust with its seller rating application. In fact the U.S. PTO saw rapid rise in patent applications from 1998 to 1999 and had to change the durational terms of patents from 17 years (as of grant) to 20 years (as of filing) (see Alter 1999).

While the recent *Bilski* decision (*in re Bilski*, [545 F.3d 943](#), [88 U.S.P.Q.2d 1385](#), Fed. Cir. 2008) may have effectively put an end to this period of protective excess for intellectual property right, it remains that the then unthoughtful complacency and convenience of the regulator may have caused irreversible damage. For many information technology-industrial categories the monopolies are in place and are exerting control over ideas, resources, and commercialization. While large amounts of value were generated, much value creation may also have been prevented.

The described situation seems rather antithetical to the spirit of information and information technology. While intellectual property rights were intended to allow information creators to secure benefits from their innovation creation they were not intended to allow for a comprehensive position of monopoly. Granting such a position was bestowed on the legislator. Yet the framework for IP is admittedly antiquated and rather inadequately adapted from an industrial world where scarce resources necessitated allocational efficiency and economies of scale. By judicious, selective, and discretionary manipulation of a framework that has long overwhelmed its regulators, these firms are taking the law in their own hand creating *de facto* situations often stronger than authoritative law or legitimate governance: In the name of freedom of the Internet these organizations are increasingly restricting the functioning of industry participants and preventing new entrants by creating monopolies and forging ever-faster consolidation. They are outmaneuvering legitimate legal governance through regulatory arbitrage waging standard wars and sidestepping due process.

These actions rival in fact the position of the legislator in this respect. They have assumed the position of the legislator through clever combinations and synergies among several intellectual property rights patents, combining them to an effective weapon against other industry participants, securing their own position and not limited to securing the profits and benefits from their creations. Such behavior, primarily anti-competitive and only secondarily profit-motivated had already previously been an issue in Microsoft securing its own position beyond what had been solely possible through marketing. (For a comprehensive treatment of this particular attitude on the part of CITI firms see the work of Lawrence Lessig, 1999, 2001 as well as Van Waarden, 2001)

This last example also demonstrates the ingenuity of the CITI firm to increase effectiveness of their quasi-regulatory ambitions through a layered approach, synergistically leveraging a composite of all three regulatory strategies including the one of regulatory opportunism (c below).

- Finally, in its least intense form, the posture of firms is that of regulatory opportunism, i.e. the deliberate, intentional and preemptive occupation of yet unregulated space via the creation of *de facto* regulation and near-binding proprietary standards. With regulatory opportunism we are addressing the proclivity of CITI firms to fill regulatory vacuum resulting from intentional and explicit regulatory forbearance. Analogous to the construct of technological opportunism (Srinivasan et al., 2002), we propose that in a more benign and docile posture these CITI firms hone their law-sensing and law-response capabilities in the light of changes and turbulence in their legal environment and are likely to create pressures to make the legal environment gravitate towards them. We suggest that regulatory opportunism prompts those firms to perceive regulatory vacuum as legally

turbulent and therefore as a potential source of growth for the firm responding affirmatively to absorb the inefficacies as a result of absent regulation.

5. The conflict with respect to social position

Complex Information Technology-Intensive firms initially campaigned on a platform of social value creation. Their purpose and reason for existence was the disproportionate generation of social value far above and beyond the residual private profit that they would also generate. They conveniently deemphasized the fact that their legal configuration was very much for-profit. They claimed to be able to meet an even exceed not-for-profit aspirations with formal for-profit structures.

In the financially constrained pos-recessionary world for patient capital formation this is a particularly tempting and attractive model because of its sustainability and capacity. Compared to the difficult and discretionary and opaque charity, donor, and public funding model, and the restrictive earned income strategy, in the for-profit mode, the private sector can be tapped consistently for its wealth and transparency is easier to come by through equity positions of funders.

But while this may seem very compelling from the point of view of financing it is questionable if not objectionable in terms of the redistributive effects between the different constituencies involved. Such models indeed equate to a form of taxation: make the marketers pay for the home users' benefits of a search engine, for example. The critique here is not with respect to the ingenious model itself, it is with respect to its unchecked consequences. These activities, while undoubtedly beneficial to all parties involved sidestep the original authority for such redistribution, the taxing fiscal entity. The self-imposed and self-regulated responsibilities may prove inadequate in the long run. They may reveal discriminatory in yet unanticipated ways. They may yield yet unrecognized exposure and ultimately discredit the model. And they may macroeconomically suboptimally allocate the proceeds of the redistribution. In all they are merely subject to the biased control of one single of the involved entities, the shareholder constituency, but otherwise escape responsibility on the part of the other stakeholders and sidestep public scrutiny.

6. Conclusion

The empirical data of our more than two year's inquiry into 'the new nature of the firm' has been increasingly inconclusive as to the social efficacy of the major and most prominent Complex Information Technology-Intensive firms. While at first we expected to be able to simply identify some elements and substantial components of a paradigmatically motivated new framework for the CITI firm, we are increasingly concerned with the paradoxical effects of the existence of these firms. In the above we have attempted to capture these paradoxical effects as they affect the nature of these firms and render its contributions in terms of social value creation more and more questionable. Not only are CITI defined by an entirely different understanding of each one of the constitutive design variables strategy, structure, scale, scope, and social position, they indeed have also to some extent skewed their definition and their application resulting in an ambivalent nature of the firm with ambiguous outcomes.

7. Limitations and further research

The present was a exploratory paper, outlining the contours of what we labeled the “ambivalent nature” of CITI firms based on a composite of empirical data and critical theory. The alleged activities of CITI firms are to a large extent unobservable and don’t lend themselves easily to direct empirical investigation. They could, however, be captured via proxy metrics, such as market share, regulatory disputes, and public action. A necessary next step is to juxtapose the results of such quantifiable and qualifiable data with the ones already available for positive feedback effects, accelerated innovation, lock-in and switching cost principles of networked and digital goods. Next steps would proceed to collect and evaluate such evidence. And in a further step yet, via abandoned projects or firm failures in the industry, assessing for example the number of firms or innovations that never reach their tipping point, one may be able to quantify social costs and potential losses of social value.

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POSTERS

Senior Executives Contribute to the Success of the Business within the IT Governance Framework

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Extended Abstract

This paper describes the importance of senior business executives that contribute to future business success driven from within the IT governance (ITG) framework; the most important are:

The Chief Executive Officer (CEO) is a company's top executive and handles the business of government, together with its board of directors and senior company executives, is responsible for determining IT strategies and their implementation, is also in charge of assuring the company's smooth operation with a view to achieving added value and satisfying customer needs.

The Chief Information Officer (CIO) liaises with the CEO, working on the best strategies to develop the business and make better decisions; CIO is a highly valued leader in the organization, is responsible for the smooth operation of IT and is knowledgeable about the information within the company; is considered a "leader of business innovation"; because can be take place inside the company or be enacted for external clients, depending on the product or service delivery.

Chief Financial Officer (CFO) directs the organization's financial goals, objectives, and budgets. They oversee the investment of funds and manage associated risk, supervise cash management activities, execute capital-raising strategies to support a firm's expansion, and deal with mergers and acquisitions. CFO must adjust their roles to the demands of changing times.

The Chief Operation Officer (COO) is a corporate executive, responsible for managing the production operations developed by the company, monitor the daily operations and report to the board of directors and the CEO, and others; should ideally have domain knowledge of the business, as well as a good theoretical understanding of management and its tools. Similarly, a COO must have knowledge of the standards required for company activities, including ISO: 9001, 27001, 20000, 38500, Six Sigma, ITIL, CobiT, CMMI, PMBOK, and others standards.

The Chief Human Resource Officer (CHRO) plays a very important role, is positioned at the intersection of strategy and execution, with a charter to recruit, assess, develop and deploy talent across an organization, is responsible for providing adequate human resources for each business unit, and the success of a business depends largely on the capabilities and skills of each member.

The conclusions most important can be drawn are: (1) the senior executives have the mission of properly conducting the company's business. (2) Each of these senior executives plays a major role within the business, and the sum of their knowledge and ideas will lead to business success. (3) The best practices in the IT Governance and the participation of the senior executives must be taken by companies that are developing or are about to begin its operations by adopting or modifying existing models according to their own need for your business. (4) The successes of large corporations that lead the market for IT, which have succeeded in making good management within the IT Governance and the effort of the senior executives to achieve best practice.

Distributed Information Management using a Database Rules' Hub

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Extended Abstract

Technology progress has resulted on computer usage on everyday tasks, from enterprise to personal tasks. Over a working day we interact with many computer systems, directly or indirectly, and we can manipulate (access, create, change, or even delete) information from many devices at any time and any location. So information can be distributed, centralized, or replicated. If information is distributed then we interact with many computer systems, digging for relations between information sources, sometimes tough to find what we want. With centralized information, we interact only with one computer system that owns all information that we need, but it is hard to build such huge system and it has a single point of failure. Replicated information allows us to interact with information from many locations and synchronization is made between all replicas. Replication can be total or partial. Total replication solves the problem of single point of failure. Partial replication can be used for many purposes such as availability issues. Problems about replicated information are mainly correlated with data coherence and consistence.

Typically, enterprises have many information sources that appear from business needs. Enterprises have large amounts of information stored in databases, and they have several applications that manipulate it. Database management systems are used by enterprises for data storage, management, use, and access. Every day, enterprise information are growing making the need for tools and services to search, analyze, model, mine, organize, present, store, and preserve information. Enterprise information is often distributed. In this scenario we should be concerned with some issues such as database performance and distributed information handling.

The developed system allows manage distributed databases making information consistent and is based on a database rules hub, that manages all actions that can be done, and a set of agents located on database's hosts. The system centralizes information about operational rules about logical relations between remote databases. There are two main components: Central/Hub and Agent. The Central/Hub component contains all the information needed to interact with Agents located at remote distributed databases, while Agents are responsible for local data processing. In this system may exist one Central/Hub and one or more Agents. An Agent interacts with one Central/Hub. The Central/Hub interacts with one or more Agents. The system configuration is done using the Central/Hub component. After setting up all operational rules, Central/Hub sends the updated rules to each Agents, this communication is done through the Agents databases at clients. Only Central/Hub has the ability to start a dialogue with an Agent, which itself never initiates a communication with the Central/Hub. Agents interact with other Agents based on rules received from Central/Hub component.

Elements of process-based design in service orientation

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Extended Abstract

The changes produced in the industry regarding the concept of organizations and their relation with their context and the way in which software is developed, combine technological and business-related aspects.

Software development has been evolving greatly with technology and with the changes in the complexity of the problems and their solutions.

Today, the goal is to improve the capacity of the systems in order to achieve new requirements: adding new interfaces, merging multiple data sources into one, interacting with mobile devices and replacing old applications with new ones.

The tendency today is towards a business processes and services oriented paradigm, in which applications will attempt to cover the global activity of a company, and the tools of choice are BPMSs (Business Process Management Systems).

The added value of this paradigm is that its concepts can be used in the development of new computational solutions or as integration mechanisms for existing applications, while allowing for the capture of underlying knowledge in the manner in which the business processes are executed.

Service orientation as a way of integrating applications and process orientation as a method to model the reality of the organizations and maintain this model up to date, combines two ideas which state the need for a methodological framework that puts concepts in order and establishes the life cycle of business processes in a clear manner, thus reducing the gap between the business process and its realization as software.

The methodological proposal presented in this article differs from other proposals in that it covers all the stages in the life cycle of the software, even the requirements specification stage. It is a contextual framework which attempts to identify the stages of the life cycle of the processes together with the development of the software, looking for points of contact to employ the most adequate methodology in each phase.

This work also highlights the importance of modelling the organization in terms of the processes it executes. These processes behave as consumers of the services which are identified as software pieces which implement a certain functionality. Thus, while the business processes go through the organizational structure and define their rules independently from the development process, the services solve concrete, required functionalities within each organizational unit and are composed to realize the business processes through their choreography and orchestration.

Comparative Performance Evaluation of Laboratory Wi-Fi IEEE 802.11a Point-to-Point Links

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Extended Abstract

Wireless communications are increasingly important for their versatility, mobility and favorable prices. It is the case of microwave based technologies, e.g. Wi-Fi. The IEEE 802.11a standard has been receiving increasing interest as it uses the 5 GHz band [1] and the growing use of the 2.4 GHz band is leading to higher interferences. Performance is a very important issue, resulting in more reliable and efficient communications. New telematic applications present special sensitivities to performances, when compared to traditional applications. Performance studies exist in several contexts, including for high speed FSO [2]. In the present work several performance measurements are made for Wi-Fi IEEE 802.11a laboratory point-to-point links, namely at OSI levels 4 and 7, using TCP, UDP and FTP. Comparative studies are carried out through two types of experiments, i.e. Expa and Expb, using RBTR2 (APa) and RBT-4102 (APb) access points (APs) from Enterasys Networks, respectively [3].

The link was 30 cm long. In each type of experiment the corresponding AP was set to typical nominal transfer rates in the range 6-54 Mbps. Interference free communication channels, minimum power and no WEP encryption activation were used. SNR values were monitored. For Expa and Expb and for every nominal fixed transfer rate, TCP connections gave an average TCP throughput. This value was used as the bandwidth parameter for every corresponding UDP communication test, permitting average jitter and average percentage datagram loss to be obtained. FTP transfer rates were measured versus nominal fixed transfer rates. It was found that both APs had similar TCP throughput performances. Concerning jitter, the results were found sensitive to AP type. For the percentage datagram loss, the results were not very significantly dependent on AP type. At OSI level 7 it was found that both APs had similar FTP performances. This result shows the same trends found for TCP throughput.

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Cooperative collection development in Portuguese university libraries

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Extended Abstract

The aim of this study is to know what is being done by the Portuguese university libraries at the CCD (Cooperation Collection Development) level. More precisely identify activities of CCD, identify motives that led to the CCD, register barriers and benefits, check the possibility for other projects beyond the existing ones, and what professionals expect for CCD future.

CCD solutions are justified by the improving quantities of available publications, the electronic publications and the libraries consortium for the sharing of these resources which are too much expensive to be acquired for only one library. CCD is associated to the resource sharing and takes as an objective the building of a collection as complete as possible. Two or more libraries establish partnerships to acquire materials together, with lower costs, exchanging them freely, trying to offer better services, as well as a bigger number of available materials. CCD can assume different practices such as electronic resources and printed documents sharing, shared acquisitions and archives, inter-libraries loan (ILL) and periodical publications cooperative management. There are many advantages but also some obstacles in these kind of projects.

CCD is almost unknown in Portuguese university libraries. Electronic resources sharing is the main activity found and it is through the share of these materials that the CCD has known a larger number of followers, as soon as the share of printed resources becomes more difficult due to several questions like the possession and the access to the publications. The two biggest experiences made in Portugal were RUBI, in middle nineties, although this project does not exists anymore, and the B-On, adopted since 2004, which objective is precisely electronic resources sharing.

This study suggests that there is some concern from Portuguese professionals about the questions related to the cooperation, which could be checked by the creation of union catalogs; partnership for exchange of publications; the topics for librarians meetings; relationship to foreign consortium; the existence of some political will similar to the one that have lead to B-On creation. Library professionals have interest at CCD activities and look at it as an effective solution for information resources sharing. They confirm that the consortia activity is the easiest way to put libraries collaborating, once there are no interferences in the library management. Although, Portugal has no tradition in cooperative activities, which is without doubt an obstacle to attain this goal; there is also no collection development policies in the libraries, not even at the universities where the libraries are integrated; and there are several difficulties in CCD projects establishment that includes all kind of practices.

As the result of this analysis some recommendations were leaved for the creation of printed resources sharing projects in Portugal but also other relevant topics for CCD projects establishment.

A Web-Based Enterprise Report Management System

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Extended Abstract

A Report Management Systems is responsible for bringing data together from different data sources and present it to the user as information, in the form of a report. There exists software oriented towards the creation and management of reports in a Web environment. However, they are highly constrained by their report design based on templates and are not very flexible and dynamic. For example: Cognos, RReport, BIRT, Pentaho Reporting, Crystal Reports, etc.

We used existing open source tools and reporting libraries for designing a report management application based in a web interface, which allows to generate, setup, manage and run dynamic reports. It is based in Java Server Faces (JSF) framework, using the Jasper Reports (JR) tool, and developed entirely in Java. Users can create reports from many data sources and print them in different formats, such as PDF, HTML, CVS, RTF, XLS and XML, and thanks to its evolution named Dynamic Jasper, also makes possible to create and manage multiple reports with few restrictions and high scalability, there is no need to use templates as the basic layout. Additionally, data can be taken directly from a relational database, through SQL queries, to the visualization area of the client application. These tools allow developers to create a variety of reports thanks to an intuitive API, which permits defining the report in execution-time.

Our application is based on the Model-View-Controller (MVC) model. It separates the functional model into three layers: client (visualization or interface with client), application or business logic and data layer (also known as Enterprise Information System layer).

Users can provide the specific SQL queries that will retrieve data from the database and will be used for configuring the layout. The SQL queries will be added to the report as data source and the configuration parameters will enable JR engine to create the specific layout for building the report. Then, the report is sent to the user who can export it a file in any of the supported formats.

It has been considered three types of reports. The basic type allows adding columns from the SQL sentence to the report as it has been taken out from the database. The crosstab type crosses the fields retrieved in rows and columns, in order to set any field as a total (cells). And the crosstab with many totals allows setting several columns to show aggregation functions used in the SQL query. What is more, we could add support for charts, images, draws, sub-reports, etc. Any of the existing Jasper Reports features could be used in the future. At functional level, we can foresee to implement more mechanisms to generate reports (for example, in cascade) or to modify the application to improve the reports delivery (like doing it by ftp or e-mail).

In conclusion, we used the latest existing technologies in the field of open source, with large use and popularity. Then, the proposed solution can contrast with some of the current companies strategies, which tend to expend large amounts of money and time in purchasing a reporting tool for its business, also extending the functionality to data warehouses and data mining, where its use by final users is overestimated.

Implementation and Management of Outsourcing of IT processes on a Data Center of Public Sector in Brazil

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Extended Abstract

Prodesp - Data Processing Company of the State of São Paulo is a company of Information Technology, responsible for the Data Center that meets the Government of the State of São Paulo – Brazil with more than 40 million people distributed in 645 municipalities.

The implementation processes of outsourcing in the Data Center Prodesp originally due to the need for expansion in the demand for services, which often results in increased, or reset the table of employees, which in the public sector is not always possible within the agility required in Technology of Information. The activities selected for outsourcing, do not represent the main activity of the Data Center, though, even historically, had been held since the beginning of the Data Processing Centers. In this situation, we had the activities of Data Transcription Services, Shipping and Delivery of Products, Technical Services and Microfilming, Printing Service Large Volume, Help Desk (Call Center), Technical Aid Services, Maintenance of Hardware and Departmental Printing.

To the traditional activities of the Data Center were hired specialized services for each case. Instead of recruitment of personnel, it was made provisioning of services on demand, it is used (and paid) only when needed, eliminating the seasonal peaks and valleys.

The adoption of outsourcing in the Data Center Prodesp presents innovation as the ability to make quick and agile the expansion of services if necessary to meet an emergency demand, and shows the ability to save in situations where it is not require a table size of staff. The key phrase is "Use of services on demand". We can measure the reduction of costs around 70% on previously practiced with the use of own staff, inputs and materials in stock. The target audiences of the solutions presented here are all citizens of the State of São Paulo.

The team previously involved in the implementation of outsourcing tasks have been reallocated to other activities within the Data Center, more focused on the management services with a high personal and professional satisfaction of our employees.

It was highly positive for the Data Center Prodesp the adoption of outsourcing solutions. Using this method, it has focused our activities on our order activity through the other tasks to specialized providers. As a result we have had great financial economy, ease of allocation of human resources according to seasonal demands beyond the personal and professional satisfaction of our employees.

Implementing ISO 27001 Certification – Management System for Information Security in a Data Center

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Extended Abstract

For some historians, after the last great transformation of human standards, occurred with the Industrial Revolution, we are going through similar phenomenon today with what we termed the Information Revolution. The rise of personal computing, with practices of net banking, e-commerce, B2B, and others, brought to light the urgent need to ensure that the information exchanged between the parties had already mentioned the guarantee of the tripod Confidentiality, Integrity, Availability.

ISO 27001:2005 is the natural evolution of the standard BS7799-2: 2002 a British standard that addresses the definition of requirements for a System Management Information Security.

When a Data Center hereby certify ISO 27001, it is essential to create a project that will include the preparation of a series of steps, as listed in the sequence: Model Management System Information Security; Defining the scope; Development of security policies; Methodology for Analysis and Risk Assessment; Development of the Handbook of Information Security; Implementation of risk analysis; Documentation of Security; Communication and awareness; Implementation of Business Continuity Plan; Implementation of change management.

After the development of Project Security described above, to obtain ISO 27001 certification, it will happen through the implementation of the following audit procedures: Training of Internal Auditors; re-Audit Certification; Audit of Documentation; Audit Certification. The Certification ISO 27001, provides for the Data Center and consequently for the company, benefits and wins that can be observed even before the execution of the certificate, which occurs after the audit, as seen in previous sections.

The main benefit is to excellence in management of the service performed within the scope of certification. We can also cite as a major benefit, transparency and visibility offered to customers, about the importance of Information Security at Data Center is guarded to the Company. It is important to note that there are always the skeptical and those who have the vision that certification will bring difficulties of all kinds. For these cases there is only one exit, already thoroughly discussed, awareness, and, not always achieve success in a first approach. So in this situation, the key is perseverance.

Conclude by noting that for the Data Center and the Organization as a whole, the certification was very beneficial, and that above all had an increased quantity and quality of our services and professionals, especially those that will have a differential in the certificate not only from a professional perspective, but also about the personal aspects.

Profile of the SME manager

Competences defining the profile of the European entrepreneur

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Extended Abstract

In a dynamic and competitive world, understanding the existing and required knowledge, skills and competences of managers of small and medium enterprises (SMEs) is an important endeavor to ensure that both academic and business training institutions offer well formed programs/courses and curricula. Several studies, conducted by academic researchers and business associations around the world, focused on managers' skills and competences, but there isn't an overall perspective on today's requirements for European managers of SMEs specifically. This is a critical aspect because managers' competences strongly influence enterprises' competitiveness and, therefore, the economic competitiveness of countries themselves. To help overcome this problem, we conducted a study in six European countries (Portugal, Italy, Greece, Austria, Finland, and Romania) through an extensive literature review and several interviews with business associations' executives. The result is a list of 34 key competences (table 1), covering a rich set of complementary areas, on which an SME manager should be well prepared in order to perform her/his job. The findings enable a better understanding of the profile of SME managers and may help in the design of new training programs.

Table 1. The competences defining the profile of the European SME entrepreneur/manager

• Attitude towards uncertainty and risk • Innovative spirit • Fulfillment of tasks and goals • Self-confidence • Communication skills • Ability to discover new opportunities • Conceptual ability (understanding the business as a system) • Negotiation and decision-making abilities • Time management for own work and team's work • Communication to the team of clear expectations of performance • Regular provision of information to the team about its performance • Fully leverage the capacities and the knowledge of employees • Promotion of mutual confidence • Development of the autonomy of a group • Raising awareness of collective responsibility • Ability to build and lead a team (leadership spirit) • Project management ability • Ability to create and provide Strategic/Tactic/Operational plans • Allocation/attribution of tasks to human resources in an organization • Management of other (non-human) resources	• Knowledge of what to think about when deciding whether to found a business or not • Awareness of corporate social responsibility • Knowledge of legal requirements for business • Knowledge of the most important legal forms of business ownership • Process analysis and change management • Knowledge of the administrative/bureaucratic procedures for founding a company • Knowledge of general business conditions and functions • Knowledge about foreign trade and international business relations • Knowledge about the difference in financial issues between different types of enterprises (manufacturing vs. services, for instance) • Knowledge about how to manage the different functions within an enterprise (production, sales, financial management, research & development...) • Understanding the different forms of financing (self-financing, external financing) • Basic skills for sales planning • Knowledge about accountancy and taxes • Ability to plan and control: direct costs, overhead costs, cost prices, gross and net sales price, and earnings/profit

Business simulator in the Second Life virtual world

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Extended Abstract

Understanding how a real business operates is fundamental for the effectiveness of the training process in information systems and technologies. This is particularly noticeable in courses requiring high-level abstraction skills (for instance, courses involving systems modeling).

In order for students to achieve an encompassing understanding of how a company operates, they need both a solid theoretical background and to contact practical realities.

However, frequently students do not have access to any practical realities, and are faced with the need to develop modeling assignments for entities about which they don't have a real notion of the issues at stake.

Since it's not always easy (or at all possible) to provide students with the opportunity to have close contact with businesses during their education, the three-dimensional Second Life® (SL) virtual world sprung to mind as a possible solution for this problem, since it allows the simulation of several aspects of the real, social life of human beings.

With the goal of supporting students enrolled in information systems courses, so that they can achieve a broad understanding of how a business and its operations develop, a project is ongoing within the University of Trás-os-Montes e Alto Douro, whose aim is to create a business simulator. The figures present several screenshots of the current prototype.

This simulator, being developed in the multi-user virtual world of SL, aims to present, step by step, the global operation of a business, in order to allow students a direct contact with the operation of a business, even if simulated. It is thus expected that this system can be used in the teaching of information systems courses, and in this way contributing to improve the results of the learning process. In the future, this simulator may also be used to create application scenarios for hands-on assignments.

A pilot e-Marketplace of Social Care and Health Care Services for Individuals with Special Needs

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Extended Abstract

Health and social care services to individuals with special needs clearly represent a priority in the European Union strategy. If continuous health care systems and care to individuals with special needs (elderly and permanently or temporarily disabled) is performed in an unarticulated and fragmented manner, provided by entities that do not communicate among themselves, the results will be wholly undesirable. Often, those two specific areas of health care and social services must be provided at the patient's home. On the other hand, the existence of a network of health care, social care and professional services providers, working articulately with an underlying effective management and intermediation service, based on an electronic marketplace for health care and social care services, can be a powerful tool and result in effective and efficient service to these individuals.

A wide range of supporting technologies already exist that can contribute to such purpose. What is needed is an integrating environment to identify user needs transmitted over an e-marketplace platform and the allocation of service providers to answer these needs, integration and management, performance monitoring and evaluation, commitment control, etc.

The authors are developing a pilot project for the Municipality of Guimarães envisaging the definition and implementation of an e-marketplace for healthcare and social services, integrating healthcare professionals and professionals of social services with people with special needs (or their relatives) and institutions willing to accede to these services.

The objectives of the project consist of offering new solutions in the area of health care and social care, providing home services, making available privileged communication means between:

- the individual and the entities with social concerns, or entities that provide social and healthcare services or independent service providers;
- institutions that provide social /healthcare services and independent service providers;
- two institutions providing social / healthcare services, for complementarily addressing a given situation.

Secondly, this project will give more independence and better quality of life to individuals that for some reason must stay at home, as they can find in this Social and Healthcare Services e-Marketplace (GuiMarket) many of the services that they require for their daily life.

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