FRAMEWORKS FOR UNDERSTANDING THE CHANGING ROLE OF INFORMATIONS SYSTEMS IN ORGANIZATIONS

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Abstract: Information Systems (IS) evolve with advances in technology in a silent but radical manner. Initially monolithic and isolated, now they are modular, diversified, integrated and ubiquitous. This ubiquity is not always planned. New applications arise quickly and spontaneously. Current IS applications serve different needs and different audiences, inside and outside the organization, not always in an organized and integrated manner. Technology trends, such as BPM and SOA accentuate the pace of change. The wide range of applications and the pace of innovation brings complexity to the IS planning, developing and integration. This work comprises a study of the evolution and current status of IS in organizations. Its main objective is to provide an integrated theoretical framework helping academy and organizations to understand, plan and conduct efficiently their current information systems efforts.

1 INTRODUCTION

Information Systems (IS) are no more monolithic, expensive and isolated solutions. The wide availability of computers has expanded the availability of applications and today virtually all information organizational needs are supplied by some kind of solution that we can classify as a IS application which is integrated with other IS applications. Currently, IS are a wide range of applications with diversified objectives for different users within and outside the enterprise.

With this wide range of applications, objectives and users, IS, that never was considered a easy discipline (Brooks, 1986), become even more complex. Some authors identify a crisis of identity in IS field (Hirschheim and Klein, 2003), considering the breadth of knowledge necessary to the practice of the discipline. So, IS is complex and complex things must be studied in depth, in all of its dimensions and with adequate instruments.

IS is widely discussed in the literature as a discipline and as practice. Researches are usually focused on specific aspects of IS and we rarely find research which connect all the variables of IS in comprehensive and integrated frameworks. A framework is a basic conceptual structure used to solve or address complex issues, usually a set of tools, materials or components (Wikipedia, 2009). Specifically in a software context the word is used as a name for tools that shows components and relations.

The aim of this paper is to present a set of frameworks that analyze IS in its various aspects: concepts, practices, interrelations, objectives, users, effects, tools, value, and maturity. IT also studies the impact on IS of new concepts and technologies such as BPM, SOA and EA. Thus, we aim to provide an integrated view of IS that can help scholars and practitioners to understand, study, plan and practice IS in a comprehensive way.

2 IS DEFINITIONS

In order to understand IS scope we need a good definition of IS as a product, as a discipline of study, as a activity and as a profession. We also need the understand IS relations, with other products, other disciplines and with other professions.

2.1 IS as a Product

A IS is a combination of technical components (hardware, software, and telecommunications), built and used by people to collect, create, and distribute useful data and used typically in organizational but evolving for personal use (Jessup and Valacich, 2005; King and Lyytinen, 2006). Figure 2 shows these concepts

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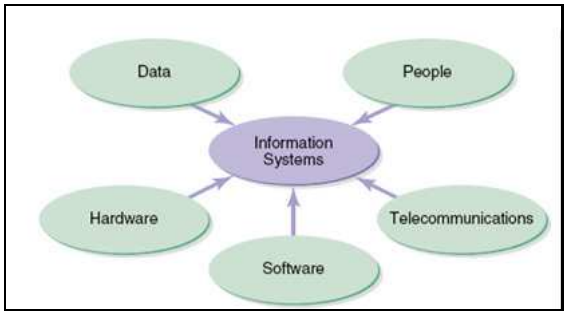

Figure 1: Information Systems as a Product (Jessup and Valacich, 2005; King and Lyytinen, 2006).

together. As a product IS is strongly related to organizational processes.

2.2 IS as a Discipline

In this work we agree with the following definition of IS as discipline of study, suggested by the UK Academy for information system: "The study of information system and their development is a multidisciplinary subject and addresses the range of strategic, managerial, and operacional activities involved in the gathering, processing, storing, distributing and use of information, and its associated technologies, in society and organizations" (King and Lyytinen, 2006).

IS as discipline of study is related with other technical and social disciplines (King and Lyytinen, 2006) as shown in figure 2. With technology IS shares knowledge with Software Engineering, Computer Science and Telecommunications Science. Related with data, information and people IS shares knowledge with Information Science. When related with people IS also shares knowledge with Sociology and Psychology.

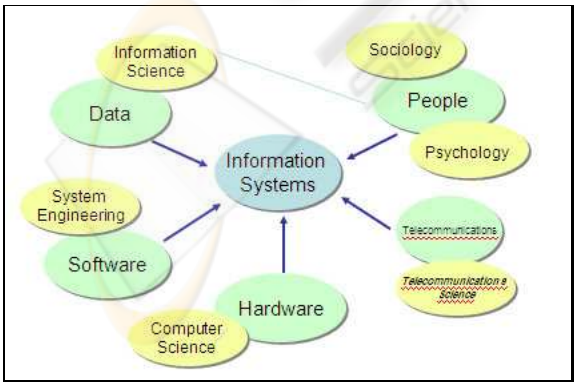

Figure 2: Information Systems Discipline and Relations. Adapted. (Jessup and Valacich, 2005; King and Lyytinen, 2006).

2.3 IS as a Practice

Information systems are produced and managed in a practice that has many activities. These activities frequently comprises four phases: analysis, design, implementation and maintenance (Freetutes, 2009). The four stages approach is too restricted to analyze the complexity of current information system practice. Figure 3 shows a more comprehensive approach which includes activities divided in six main phases (Ortiz et al., 1999). The early phases are conceptual which help to understand the demand. Other stages deal with details of the multiple elements of the system in activities such as design, implementation and maintenance.

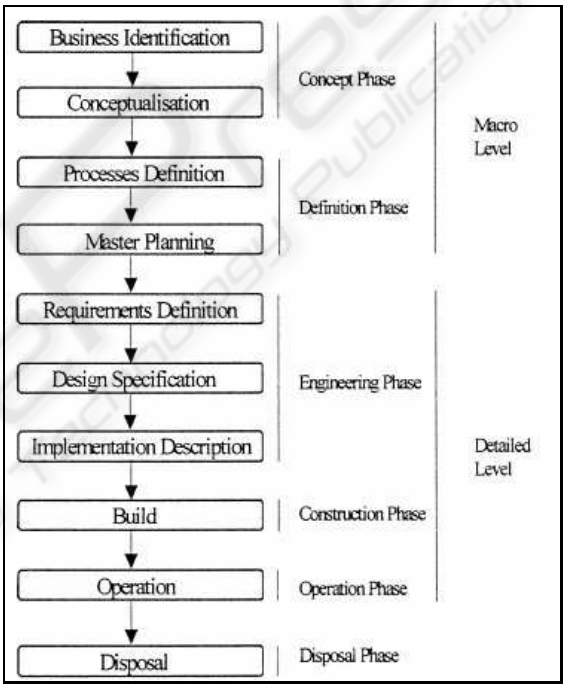

Figure 3: IS Activities and Phases (Ortiz et al., 1999).

2.4 IS as a Profession

Currently there are several kinds of professionals involved in the full cycle of system analysis. Function scope and job names varies from organization to organization depending on its size and technology complexity. Figure 4 shows an approach identifying six professionals: system analyst who analyzes, designes and also manages the entire cycle of the application, business analyst who knows the business, enterprise architect who manages the organizational elements and relations in blueprints, data architect who designs databases, component or software architect who designs components and the developer and tester who

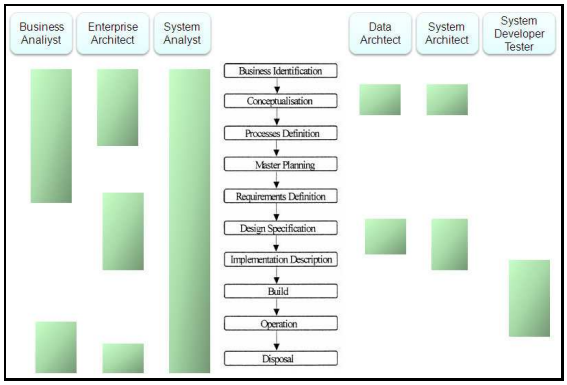

Figure 4: System Analyst - Functions and Relations. Adapted from (Ortiz et al., 1999; King and Lyytinen, 2006).

implements the system.

3 IS AND TECHNOLOGY EVOLUTION

To reach its current state, IS had a series of stages, each one with radical changes in available resources, methods used and products delivered. As an IS professional we have seen this evolution as shown is figure 5.

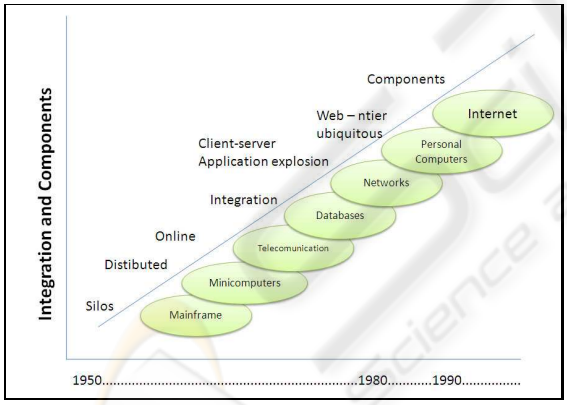

Figure 5: Evolution of Technology and System Applications.

3.1 Stage 1 - Initial

Technological characteristics at this stage: mainframe computers, centralized, complex and expensive. Impacts of technology in IS: Automation of repetitive processes. Characteristics of applications: monolithic, centralized.

3.2 Stage 2 - Distributed Processing

Technological characteristics at this stage: Computers available at departmental level. Impacts of technology in IS: Independence for automation and reengineering departments. Characteristics of applications: Monolithic and decentralized.

3.3 Stage 3 - Data Bases

Technological characteristics at this stage: Databases with high capacity and query language. Impacts of technology in IS: large databases with high availability of information. Characteristics of applications: two layers (data and application) and high availability of information. Other aspects: Datawarehouse, BI, CRM and data analysis as a discipline.

3.4 Stage 4 - Telecommunications

Technological characteristics at this stage: Availability of terminals to access data, previously available only in reports and connectivity between computers. Impacts of technology in SI: On-line access to information. Characteristics of applications: Applications in three layers (visualization, data and logic).

3.5 Stage 5 - Personal Computers

Technological characteristics at this stage: small machines at affordable prices to individuals. Impacts of technology in IS: personal computing, automation of the office, explosion of applications, ubiquitous computing. Characteristics of applications: client-server solutions and data and application integration.

3.6 Stage 6 - Internet

Technological characteristics at this stage: Information on the Web. Impacts of technology in SI: Access to information from anywhere, communication, globalization. Features of applications: Web as a front end, systems in several layers, systems without borders (Intranets, extranets and web), Components.

4 APPLICATIONS AND USERS

Information systems as a product aims many users inside and outside the organization. Inside the organization we can identify three types of users: operational, managerial and executive (Jessup and Valacich, 2005). For each user, IS needs a specific kind of application systems, from operational

system that automates repetitive functions to executive information systems that gives information trends about the business. Also internally specific applications provides solutions for communication, integration and collaboration between people, given productivity for the team. This type of solution is published in internal sites (intranets),

Outside organizations IS also have many users like clientes, partners, government and other stake holders. For this type of users, IS provides specific applications giving personalized information and transactional resources. For partners, applications can provide business integration. External applications are provided in public web sites to clients and private networks (extranets) to partners and to government. Figure 6 shows main users and applications.

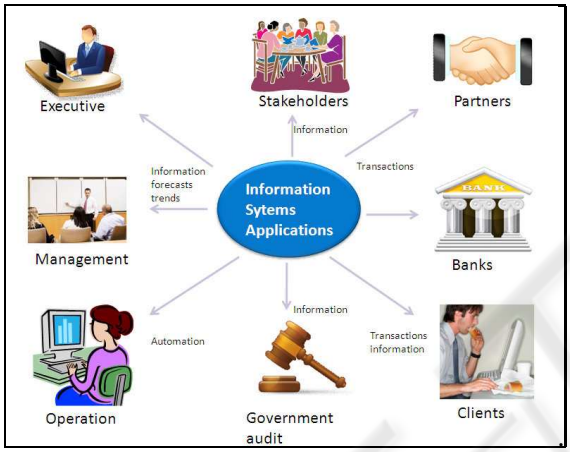

Figure 6: Information Systems Users.

Currently has a wide range of applications with different objective for different users, both inside and outside organizations (Duarte and Lima-Marques, 2006). We can classify the applications above into four categories as shown is figure 7 : Automation of business, information and management, communication and collaboration and external communication.

4.1 Automation of Business

In this category IS automates the core and support business. These kind of applications can be subdivided. There are applications for processing the core business, such as sales applications. Other category is support applications such as human resources, purchasing and finance and accounting. The final category are products that integrate many kinds of applications called ERP (Enterprise Resource Applications).

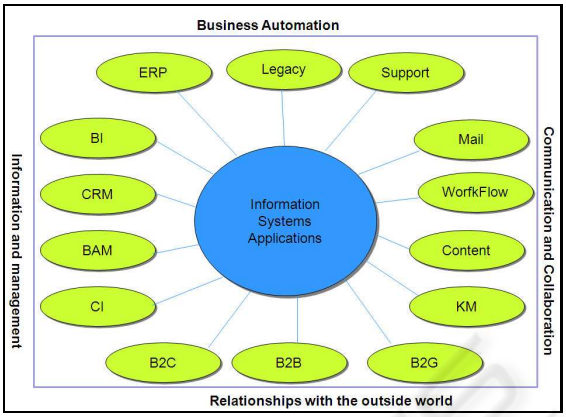

Figure 7: Information Systems Applications (Duarte and Lima-Marques, 2006).

4.2 Information and Management

In this category are applications that provides information about business giving control, forecast and trends. These kind of applications can be subdivide in solutions such as Business Intelligence (BI), CRM (Customer Relation management), BAM (Business Activity Monitoring) and also CI (Competitive Intelligence).

4.3 Communication and Collaboration

In this category are applications that provides resources for communication and collaboration such as email, Work flow applications, office automation, ECM (Enterprise Content Managament) and KM (Knowledge management).

4.4 Relationship with the Outside World

In this category are applications that provides resources for communication with several kinds of external users, such as clients, banks, government, audit companies, and other stake holders such as shareholders and the public in general. These applications can give transaction resources and generic and personalized information.

5 IS AND BUSINESS PROCESS MANAGEMENT

Information Systems are the way to process automation. So they are also related to the way processes and tasks are modeled and optimized at the organization

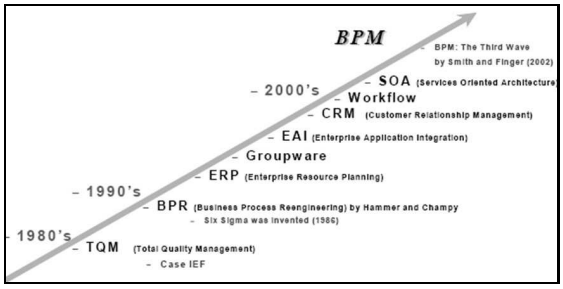

Figure 8: Business Processes and Applications (Chow et al., 2007).

(Chow et al., 2007). In other words organizational processes and information systems evolve together as shown in figure 8.

5.1 Total Quality Management

Initially processes were improved by total quality management (TQM) programs, a participatory approach aimed at continuous improvement of departmental processes (Walton, 1991). In TQM times computers were in the first stage and were not the main source of optimization because of the cost and low availability.

5.2 Reengineering

With the increasing availability of computers a reengineering approach has came to make centralized and radical changes in organization processes (Hammer and Champy, 2003). Process reengineering lasted nearly a decade and was responsible for the proliferation of automation applications in organizations. In achieving its initial goal this approach declined.

5.3 Business Process Management

After the radical changes caused by reengineering, organizations are seeking the return of continuous process improvement through the use of the concepts of BPM (Howard Smith, 2003). The goal of BPM is to place the management processes in the hands of users. With the new automation tools, the Business Process Management Systems (BPMS), users can model and simulate the processes and the models are used for automation. Metrics collected automatically enable process monitoring and improvement as shown is figure 9.

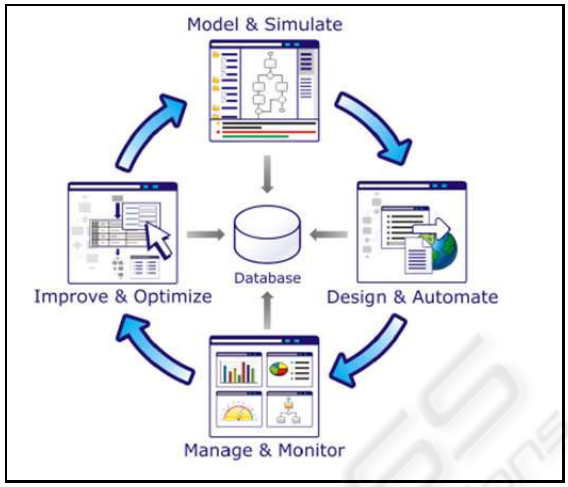

Figure 9: Business Processes and Applications (BPtrends, 2006).

6 IS COMPONENTS AND ARCHITECTURES - SOA AND EA

As seen in section three, technology tends to modularization of components and information systems tend to be a composition of components to meet specific goals. This is a radical change in the way IS are developed. Services (elements of automation) need to be identified, designed, developed and maintained. The architecture of services needs to be known and controlled and the systems need to be designed to integrate all components in a practical manner to user.

6.1 Modularity and SOA

Service Oriented Architecture (SOA) is a technical approach that in one side promotes the modularity of systems and in another side manages this modularity allowing to use modules or services in a secure and performative environment (Papazoglou and van den Heuvel, 2007). SOA is a concept and a collection of products that work together to implement the concept of modularity such as Web Services and ESB as figure 10 shows. SOA can help to implement the promises of BPM. The process model can use services and this services can be executed in SOA infrastructure (Ionita et al., 2008).

6.2 Enterprise Architecture

EA is a approach to govern organizations by architecture models (Ross et al., 2006). Organizations are

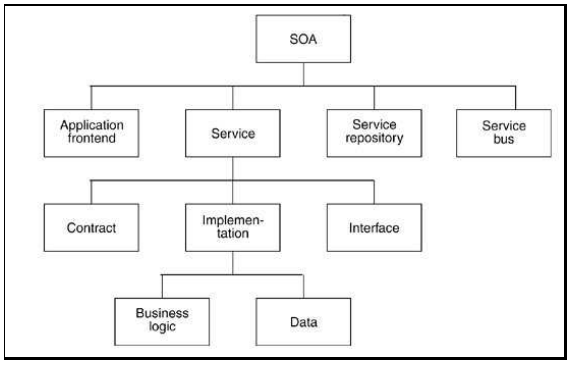

Figure 10: SOA Elements(Ionita et al., 2008).

complex systems and the promise of EA is reduce the complexity by modeling the organization, showing all the relevant elements and its relations in models called blueprints (Lankhorst, 2005). This infrastructure of models allows organization knowledge making easy to change strategies, processes and systems. EA can help to control the elements of SOA and can help also BPM because services are related with processes (Jensen et al., 2008). Figure 11 shows EA, BPM and SOA working together.

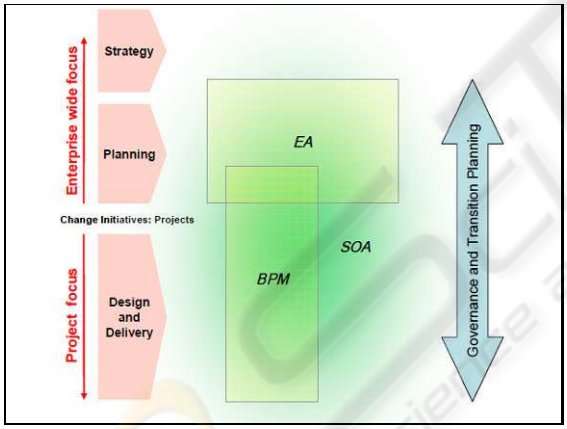

Figure 11: EA, SOA and BPM (Jensen et al., 2008).

EA help to control the elements (services) of SOA linking this elements to the rest of the organization (processes, products, strategies, etc). In order to promote the construction of the architecture there are proposal of frameworks and languages specific to EA, such as Zachman framework (Zachman, 1987), TOGAF (open Group, 2009) and Archimate (Lankhorst, 2005), shown in figure 12. The models can be constructed applying tradicional techniques, such as UML (Pereira and Sousa, 2004) or specific languages to EA, such as the Archimate proposal.

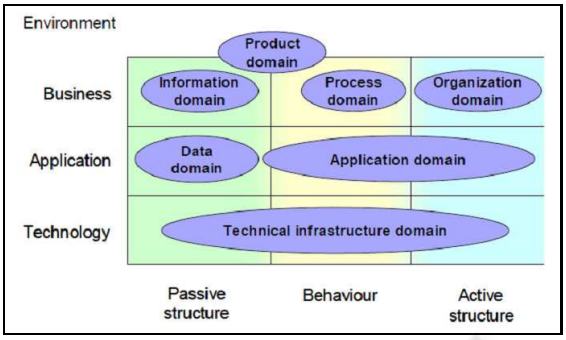

Figure 12: The Archimate Framework (Lankhorst, 2005).

6.3 Composite Applications

With SOA, applications are compositions of specialized modules of presentation, processes, rules, integration and security. Information is privided in portals that give to user an integrated vision of information (Arsanjani, 2004). Figure 13 shows the application composite components. Information systems are no more monolithic. They are a puzzle.

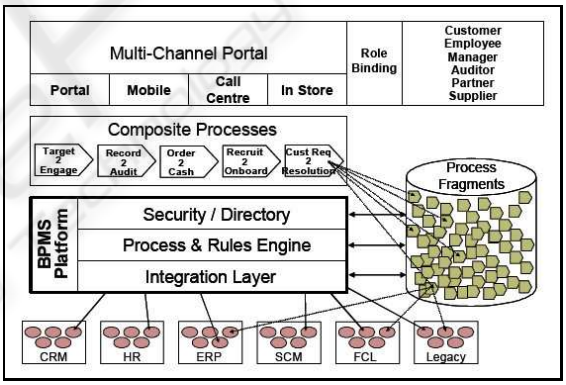

Figure 13: Application Composite Components (BPtrends, 2006).

7 IS METHODS

As we have seen in section two, IS has many activities and phases. Each phase has different methods and techniques that make up a domain of knowledge shared by a group of professionals. In five decades of research and practice in IS, each one of these domains of knowledge, has evolved in its methods, mainly those related to business analysis and systems design. In times of SOA, a new field of knowledge has emerged: services analysis and design.

7.1 Systems Analysis

In system analysis domain, systems analysts interact strongly with business professionals, identifying goals, processes, rules, actors, resources and other elements in order to identify concepts, relationships and business requirements as shown in figure 14. (Bubenko et al., 1998).

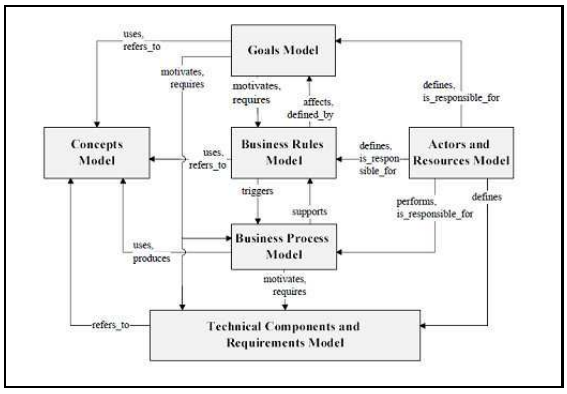

Figure 14: System Analysis and Design Techniques (Bubenko et al., 1998).

There are many different techniques for systems analysis and requirement identification (Kettinger et al., 1997). Each technique is suitable to specific needs and circumstances (Parviainen and Maarit, 2007). Choosing a specific technique is a decision that depends on the type of modeling needed and the level of business knowledge (Tsumaki and Tamai, 2005). System analysis domain can be divided into two main kinds os modeling: static modeling and dynamic modeling. The level of certainty in the knowledge of the business requirements also determines the best technique. Figure 15 suggests some techniques depending on the static and dynamic modeling and also according to the degree of knowledge of the organizational elements.

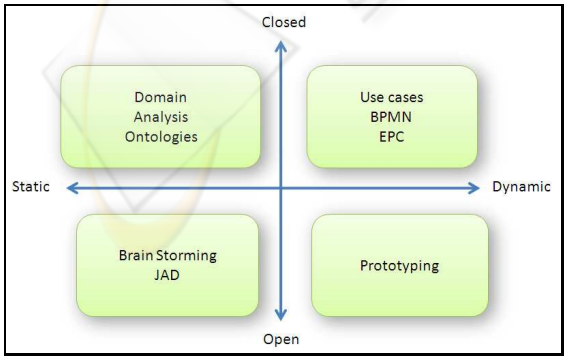

Figure 15: System Analysis Dimensions and Techniques (Tsumaki and Tamai, 2005).

In static analysis, when elements are well known, analysis can be made with conceptual modeling, domain modeling or even ontologies (Sutcliffe and Maiden, 1998). If there is no consensus on the concepts and relations, techniques are required to identify such information with participatory tools such as JAD and Brainstorming (Parviainen and Maarit, 2007). In dynamic analysis, if elements are well known can be analyzed with Use Case UML technique (Buhr, 1998), or BPMN (Weske et al., 2004) and EPC (Scheer and Nuttgens, 2000), techniques for modeling business process flow. If there is no consensus on the process flow, it is recommended to use the technique of prototype applications (Nuseibeh and Easterbrook, 2000).

7.2 Systems Design

In the Design domain, systems analysts interact strongly with technical specialists, such as data architects and software architects. This domain is specialized in architectural modeling and recently we can see the predominance of UML techniques for modeling a system (Larman, 2004).

There are many modeling notations in UML, each one dedicate to a specific objective and that are related (Berenbach and Wolf, 2007), as we can see in figure 16. There are techniques to model elements and relations, to model sequence of activities and so on, as shown in figure 14.

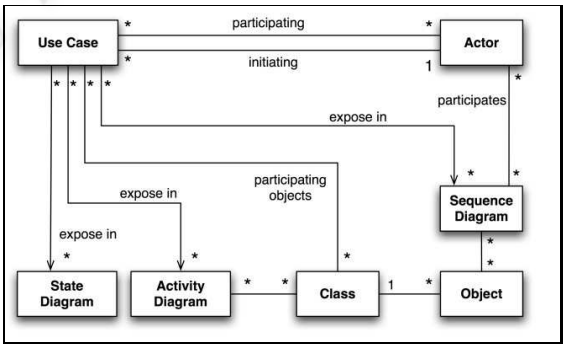

Figure 16: UML Diagramas for Analysis and Design of Systems (Berenbach and Wolf, 2007).

7.3 Service Analysis and Design

In times of SOA and BPM a new field of knowledge and practice is necessary for the business analysts. Analyst must be able to identify the parts of the business that were candidates for services (Papazoglou et al., 2007). Services can be modeled and developed as individual components that compose the

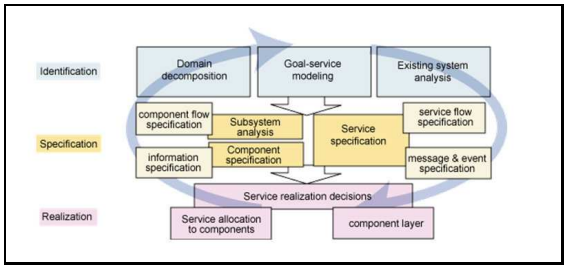

Figure 17: Modeling Services (Arsanjani, 2004).

whole organization with specific methods and techniques as shown is figure 17 (Khoshafia, 2007; Arsanjani, 2004).

By identifying and developing individual services systems analysts can easily build an application composed of these elements, as identified in Figure 17. In this approach, a systems analyst does not analyze and design systems, but services. These services will be the infrastructure for the assembly of systems. We are talking about the system of systems (Cole, 2006).

8 IS STRATEGY AND VALUE

Each IS application provides value to organization. But this values is different in time and in type of application. The level of value a application provides depends on three organization environments: technology, organization and competition (Mooney et al., 1996). The three environments change every day and each situation demands a different strategy that will demand focus in a different type of application as shown is figure 18.

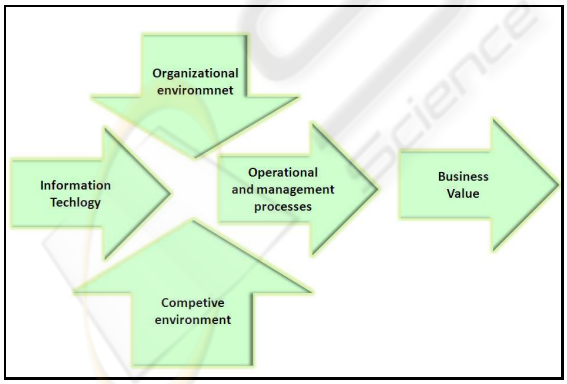

Figure 18: A Process Oriented Business Value (Mooney et al., 1996).

We have made a categorization of SI applications in Chapter 4. There's another way to classify them: in the effect they cause. Applications can be automational, informational and transformational (Mooney et al., 1996) as shown in figure 19. Application with transformational effects are that one that can make radical changes, innovating in products, markets or processes. Although some authors state that systems with transformational effects generate the best value (Jessup and Valacich, 2005), we advocate that value depends on the organization's strategy. Applications related to automation can generate greater value, reducing costs for example.

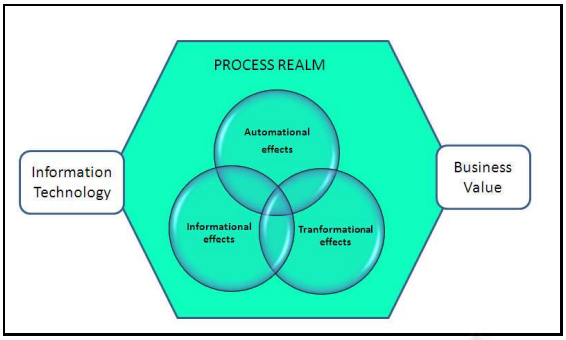

Figure 19: Dimensions of IS Business Value (Mooney et al., 1996).

8.1 Organizational Innovation

Innovation has a cycle in organizations (Gartner, 2008). A new technology grows in interest because people believe it is the solution to a number of problems. However, experience can lead to frustration, because people hope a miracle. But some people really identify the value of a new technology, identifying true benefits. This technology is then used in projects for which it is actually useful and then evolve to a level of productivity. Figure 20 shows a hype cycle where java is at productivity stage and BPM suites (BPMS) are at the top of expectations.

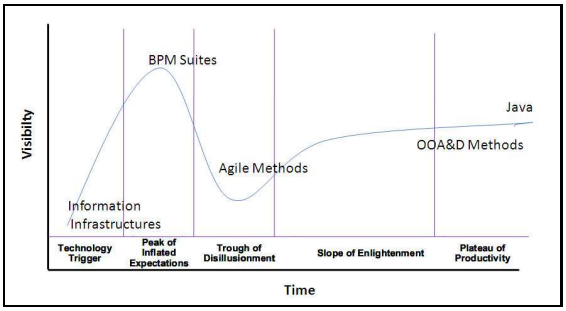

Figure 20: Hype Cycle for Business Application Development - 2008 (Gartner, 2008).

Approaches such hype cycles show that good technology will prove its benefits, but people always exaggerate the initial expectations undermining the

effective use of technology. What is needed, therefore, is a realistic analysis of the potential of each technology.

8.2 Organizational Strategies

Organizations set their strategies following market, technology and the internal environment. In the internal environment organizations have a division of power between centralization and decentralization. Between freedom to the departments and actions and centralized processes (EMERY and TRIST, 1965). Thus, strategy works with two variables: external and internal focus and centralization and decentralization (Quinn and Rohrbaugh, 1983). The choice of variables determines the strategy: Growth indicates external focus and requires decentralization as shown in figure 21. Efficiency and cost control demands internal focus and centralization of processes. There is no right or wrong strategy. It depends on the moment of the competition and of the enterprise and also of the technology. A new technology can allow cost reduction, new products or new markets.

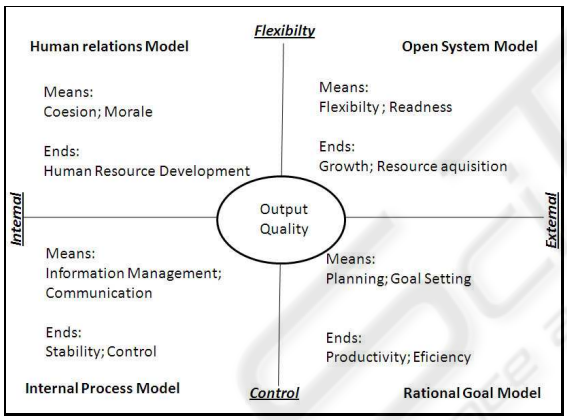

Figure 21: Organizational Strategies (Quinn and Rohrbaugh, 1983).

There are several two of this approach. The first one is that strategies always will change because there are variables beyond the control of the organization. The second is that IS strategy must accompany these changes, so that applications will continue adding value to each strategy at each moment. IS strategy must identify the variables and build an architecture for change (Ross et al., 2006).

8.3 IS and Business-IT Integration

The integration between IT/IS and the business is reached in two dimensions: external and internal (Silvius, 2007). As figure 22 shows, IT/IS strategies

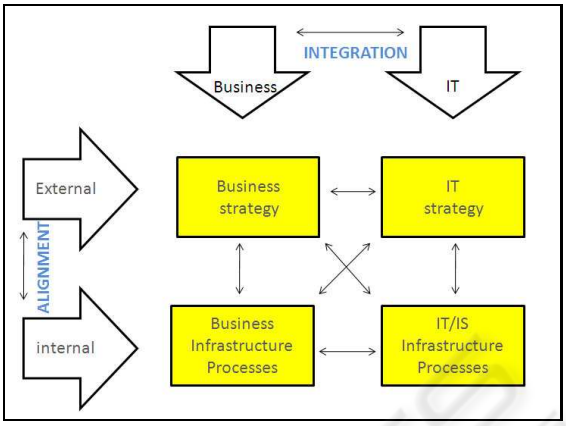

Figure 22: The Strategic Alignment Model (Silvius, 2007).

should be linked to business strategies, and internally IT strategies must fit with IT infrastructure and business processes must fit to business processes and both should also fit.

Internal integration is a problem with several components. It involves among other variables: IT governance, enterprise architecture (EA) and also business communication (Chen et al., 2008). Historically, organizations have difficulty in aligning strategy with the internal operations and it really does not happen easily. With the objetive of integration companies can rely on approaches such as the Balance score card (BSC) (Kaplan and Norton, 1997).

9 IS MATURITY

Success is an arduous task for organizations in a competitive world. Both, organization and IT must work efficiently to achieve proposed objectives and there are many variables to be controlled. There are approaches to measure how much organizations are prepared to achieve this efficiency. These approaches do not guarantee efficiency. They measure only organization's actions and structures that potentially can help promote efficiency. On the business side the Software engineering Institute (SEI) of Carnegie Mellon University proposes the Capacity Mature Model (CMMI-SEI, 2002). On the IT / IS we have ITIL (ITIL, 2009).

CMMI analyzes organizational processes maturity. The Highest level is when organizations have processes with metrics continuously improved trough teams, as shown in figure 23. Ross suggests a similar approach to systems where the highest level of approach is modularity that promotes strategic choices as shown in figure 24 (Ross, 2003).

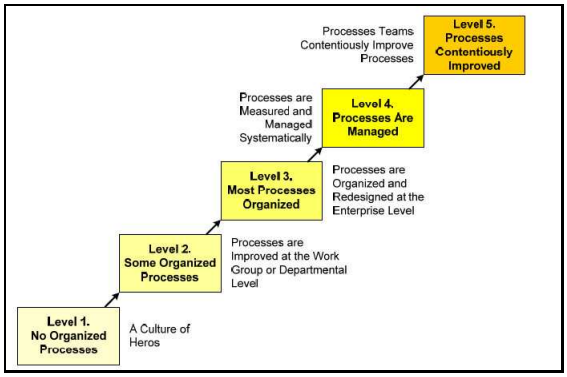

Figure 23: Levels of CMMI - (Harmon and Wolf, 2008).

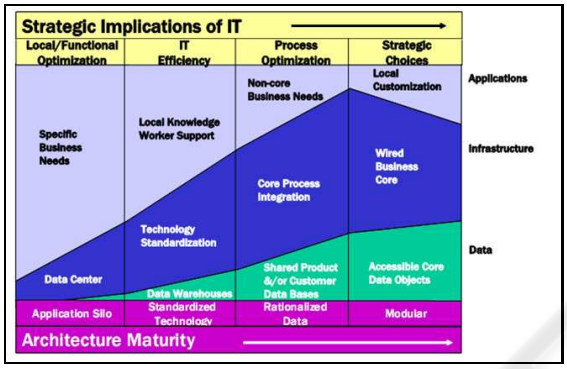

Figure 24: Maturity in Information Systems Applications (Ross, 2003).

For promotion IT/IS service management we have the Information Technology Infrastructure Library (ITIL) proposal. ITIL is a set of concepts and practices for managing Information Technology (IT) services (ITSM), IT development and IT operations. The most popular instrument of ITIL is the Service Level Agreement (SLA) where IT units celebrate a contract of service level with its users.

10 CONCLUSIONS

It has long been recognized that IS is not a easy discipline and practice. Information systems and their applications can not be treated with a simplistic view. information Systems involves the knowledge of several disciplines and the practice involves several kinds of professionals.Here we presented a series of difficulties and also paths to succeed.

There no simple approach to information system. There is no silver bullet. Organizations are complex systems and information system is a complex matter. There are many elements and variables to be analyzed. We presented a series of framewoks that help to understand the various parts that make up the current information systems. We discussed key concepts about information systems and their applications. We presented the evolution and current stage, composed of a wide range of applications to different types of users internal and external to organization.We presented the integration of systems and organizational processes and analyze the impact of new trends such as EA and SOA. We showed the radical change is information in information systems in several characteristics as type of users, professions involved, methods and techniques and types of solutions. We saw information system as a composition of fragmented elements. We confirmed the growing importance or enterprise architecture as a approach to manage these elements. We analyzed the complexity of IS and identified recent methods and techniques that deals with it. We identified strategies and approaches to business and IT integration. Finally, we also discussed Frameworks to evaluate organization and IT maturity in their structure and actions.

Componentization seems to have come to stay as well as the SOA approach. EA is a need in the short term. EA can not be a function of IT. BPM approaches are not so mature but can bring agility to business if well conducted. Success is possible with a broad range of solutions that require maturity of the organization and technology. The integration of business and IT is a double issue. There is no success of one without the other. IT must understand the business and business must understand technology.

The complexity of the fragmented current information systems environment is huge but its benefits are also great. It is for organizations beat the complexity and to prepare for the benefits. Academy can help studying new ways of designing and implementing integrated information. Organizations must construct an infrastructure of information and applications that can provide agility.

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