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ABSTRACT

Enterprise resource planning system is one of the most important projects on business optimization than an enterprise could attempt. Their use can be seen at small, medium and big enterprises. Project management and implementation methodology is a critical success factor mentioned in literature. At this paper is presented a proposal of implementation methodology based on researched literature and the activities that should be done in each phase. It also presented the selection process as other critical success factor and suggestions for future research regarding Petri Nets as a computation intelligence that could be used to simulate selection process.

Keywords

Enterprise Resource Planning (ERP), implementation methodology, selection, adoption, information system, Critical success factor (CSF).

INTRODUCTION

Information and Communication Technology (ICT) allow an organization the possibility to gain a competitive advantage. This cannot be done by ICT by itself (Laudon and Laudon, 1998), the organization must have: Standardized business processes and the knowledge people that have the ability to apply them (Davenport, 2000).

An Enterprise Resource Planning (ERP) is an information system, which integrates most of the data than an organization can process and use in their operations (Davenport, 1998), figure 1.
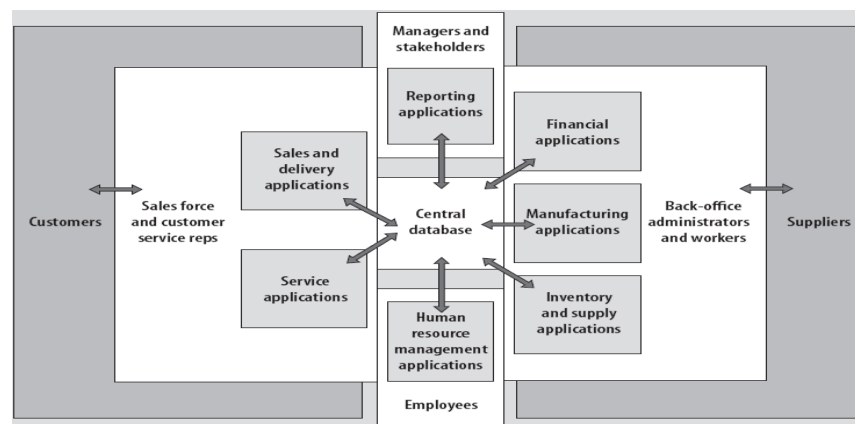

Figure 1. ERP Anatomy (Davenport, 1998)

Its implementation requires: Money, time, and a great amount of people effort; and, as an Enterprise System (ES), enforce a change in the organizational culture (Davenport, 1998).

ERP systems are increasingly important in today businesses, as they have the ability to support organizational strategies, integrate the flow of information and enhance competitive advantage and individual performance (Botta-Genoulaz, Millet and Grabot, 2005; Bravo and Santana, 2010; Razmi and Sangari, 2008). It has a central database that contains all of the transactions that an organization could register; depending on its set of functional modules. Those functional modules could be: material management, production, sales, marketing, distribution, financial services, human resources, reports, etc. (Ali and Saad, 2005; Umble, Haft and Umble, 2003). As its impact affect the whole organization, the ERP system implemented should be the right one (Somers and Nelson, 2004).

The present paper is organized as follows: Section one introduces ERP project management as a Critical Success Factor (CSF), presenting ERP system concept and CSFs. Section two presents ERP implementation methodologies literature review. Section three presents a proposal of implementation methodology, its phases and activities. Section four concludes with discussion regarding suggestions for future research on other ERP CSF, the selection process.

PROJECT MANAGEMENT AS A CRITICAL SUCCESS FACTOR ON ERP IMPLEMENTATION

The main goals of an ERP system are to automate business processes (Ahituv, Neumann and Zviran, 2002; Ali and Saad, 2005; Lau, 2003; Laudon and Laudon, 1998), to improve interactions and communications inside and outside organization (Lau, 2003; Momoh, Roy and Shehab, 2010) and to eliminate patch work to legacy systems (Lau, 2003; Momoh et al, 2010). Its implementation success is affected by CSFs (Ali and Saad, 2005; Aloini, Dulmin and Mininno, 2007; García-Sanchez and Pérez-Bernal, 2006, 2007; Grenci and Hull, 2004; Maldonado, 2008; Maldonado, Wareham, Lorenzo and Lorenzo, 2010). As defined by García-Sanchez and Pérez-Bernal (2007): "CSFs is defined as the limited number of areas in which results, if satisfactory, will ensure successful competitive performance for the organization".

Umble (2003) mentioned clear understanding of strategic goals, commitment by top management, excellent project management, organizational change management, a great implementation team, data accuracy, extensive education and training, focused performance measures, multi-site issues and ERP selection; as CSFs. Meanwhile Mabert (2003) defined thirty CSFs grouped in three categories: planning, implementation decision and implementation, considering schedule and budget as important factors on project goal. Somers (2004) summarized CSFs as: Top management support, project team competence, interdepartmental cooperation, clear goals and objectives, project management, interdepartmental communication, management of expectations and careful system selection. Aloini et al (2007) said that the top ten CSFs are: inadequate ERP selection, ineffective strategic thinking and planning strategic, ineffective project management techniques, bad managerial conduct, inadequate change management, inadequate training and instruction, poor project team skills, inadequate business process reengineering (BPR), low top management involvement, low key user involvement. Ranzhe (2007) presented: top management involvement, department's participation, funds support, cooperation between enterprise and software company, reasonable expectation with definite target, open and honest communication, training, group structure, project management, enterprise information management, outsider competition pressure, level of the supplier of ERP and service of the supplier of ERP; as CSFs.

Garcia-Sanchez et al (2007) defined that: top management support, BPR, project management, project champion, end users involvement, training and support for users, having external consultants, change management plan, ERP system selection, vision statement and have an adequate business plan to facilitate of changes in the organizational structure in the "legacy systems" and in the IT infrastructure, communication, teamwork composition for the ERP project and problem solutions are the most important CSFs. Suebsin (2009) claims that ERP implementation success is determined by ERP adoption process and this can be addressed by: customary requirement, quality of human resources, inadequate support, change management skills from, clarification of project scope and individual value recognition.

Upadhyay and Dan (2009) claim that certain factors are critical in context to implementation of Information Technology (IT) project, those CSFs are user knowledge, goal and objective, infrastructure, improve work efficiency, project champion, top management support, project team competency, scalability and scope, project management, ERP importance, user training, external consultant, interdepartmental communication, package selection, sponsor and vendor support. Iskanius (2009) mentioned that eight of top ten CSFs are

related to human factors, summarized as: top management support, project team competence, interdepartmental cooperation, clear goals and objectives, project management, interdepartmental communication, management of expectations, and careful system selection. In 2010 Pabedinskaite claims there are internal, external and mixed factors, depending on the aim of responsibility. Most of the CSFs are internal, so the organization is responsible of the success of the project. Pabedinskaite said: "The complexity of ERP implementation projects particularly requires extensive methodical planning and weighted management".

Even when literature claim that top management support is the first CSF, project management and implementation methodology keeps a high place on a lot of list of CSFs. As mentioned in their list of CSFs by Burqués,Franch and Pastor (2000); Pastor and Estay (2000); Stefanou (2000); Ahituv (2002); Kyung-Kwon and Young-Gul (2002); Umble (2003); Kahraman, Büyüközkan, and Ruan (2004); Somers and Nelson (2004); Chiesa (2004); Adam and Sammon (2004); Muñiz (2004); Tomb (2006); Ayag and Ozdemir (2007); Esteves and Bohorquez (2007); Vilpola (2008); Supramaniam and Kuppusamy (2009); Haghighi and Mafi (2010). So the leader team of implementation should use and agree with the top management in which project management methodology they are going to use, keeping the organization informed regarding project progress.

ERP IMPLEMENTATION METHODOLOGY LITERATURE REVIEW

As it is mentioned in last section, project management is an important factor for the success of an ERP implementation. Literature indicated that: "If business wishes to increase the grade of implementation success, an implementation method should be used" (Grenci and Hull, 2004).

Table 1, 2 and 3 present ERP implementation methodologies in literature reviewed. Each column represent an author's model, meanwhile, rows each of the phases.

Esteves and Bohorquez (2007)	Ayag and Ozdemir (2007)	Vilpola (2008)	Lau (2003)	Parr and Shanks (2000)	Aloini (2007)
Adoption	ERP Selection. Requirements analysis	Initiative	Study organization´s needs	Planning: High level project scope	Concept: Strategic planning
Acquisition	Define selection algorithm	Evaluation	Recruit end user involvement	Set-up project	Concept: Selection
Implementation	Search of candidates and first selection	Selection	Assemble project team	Reengineering	Implementation: Deployment
Usage	Selection	Implementation	Decide ERP needs	Design with interactive prototyping	Implementation: Integration
Evolution	Negotiation with ERP provider	Termination	Select software and approach	Configuration and testing	Implementation: Stabilization
Retirement	Selection of IT infrastructure	Exploitation and development	Pre-implementation	Installation building networks	Post-implementation: Progress
			Implementation	Enhancement: System repair, extension and transformation	Post-implementation: Evolution

Table 1. ERP Implementation methodologies found at literature

Das Neves (2004) claims that the model used for the implementation is affected by the complexity of the organization and the quantity of functional modules that is trying to operate.

Grenci and Hull (2004)	Ahituv (2002)	Haghighi and Mafi (2010)	Chiesa (2004)	Tomb (2006)	Burqués (2000)
Planning problem	System Selection	Strategic plan development	ERP selection: Document business needs. Big and detail selection.	Get of requirements	Strategic analysis of business processes and decision
Analysis problems	Definition and complete implementation plan	Pre-selection	Consultant firm selection.	Develop business case	Search for candidates and first filter
Design problems	Implementation, process component, complete implementation	Selection	Project planning and presentation	Design technological solution	Understand solutions candidates and second filter
Implementation problems	Operation	Post-selection	Execute project implementation		Demonstrations and analysis of candidates. Visit providers
Support problems		Implementation			Final decision, negotiation and planning
Big problems					

Table 2. ERP Implementation methodologies at literature

Ahituv (2002) and Grenci and Hull (2004) claim the use of a System Development Life Cycle (SDLC) model for ERP system implementation. Lau (2003) indicates that the organization must be prepared to study organization´s needs, get users commitment and assemble an expert project team as a way to improve the success of implementation. Chang, David, Huang and Hung (2008) claim for a three lifecycle model. Primary lifecycle, where ERP implementation take place using five general phases (evaluation, acquisition, formal introduction, operation and maintenance, and expansion); Supporting lifecycle, where ERP maintenance and improvement process take place after implementation, and a parallel lifecycle: Organizational lifecycle, where all the managerial activities of the organization take place, the organizational life cycle should not be restricted by time.

Hopcroft and Goodland (2010) found the use of traditional software development waterfall model and Dynamic Systems Development Method for ERP implementation with not very good results because a lack of definitive requirements definition and documentation. Momoh, Roy and Shehab (2010) claim that ERP implementations fail because there is inadequate understanding of the way that an ERP solution should be implemented. Mihailescu (2010) claims the deployment of Enterprise Systems Implementation Methodology (ESIM) has the potential to improve the productivity of the implementation process and the quality of the ES product. She also claims for an integrated view on ESIM characterized by three interrelated aspects: formalized which refers to its contents and features, relational which refers to related stakeholders, ES product and ES implementation process; and emergent which refers to ESIM's development and deployment in ES implementation projects, as well as within and between organizations.

Technology Evaluation Centers (2008)	Muñiz (2004)	Kahraman (2004)	Stefanou (2000)	Pastor and Estay (2000, 2002)	Umble (2003)
Research	Actual situation analysis	ERP Selection. Requirements analysis	Business vision	Strategic analysis of business processes	Selection
Evaluation	Search for the new system	Define and apply selection algorithm	Analysis of business needs against boundaries and change wish	Search for candidates and first filter	Implementation
Selection	Demonstrations, test and analysis of providers	Search of candidates and first selection	Evaluation and selection	Understand solutions candidates and second filter	
Post selection	ERP Selection	ERP selection using the best qualified	Final selection	Demonstrations and analysis of candidates.	
	ERP Implementation			Final decision, negotiation and planning	

Table 3. ERP Implementation methodologies at literature

Most of the literature specifies a multi-phases methodology as the normal way of implementation process. Some of the authors include business strategic as a provider of requirements and needs to be fulfilled by ERP system. Other saw ERP system as a software development project integrated on business process using software development lifecycle, but most of them understand that an ERP System is an information system that must be aligned with business needs. An ERP system is a business tool that it needs a multi-phases methodology of implementation to be successful. The methodology for an ERP system implementation could be a mix between software development lifecycle and business project lifecycle, because not all the ERP system is fully compatible with all business organization, so a customization of the ERP system could be needed.

Inside the implementation methodology the selection process is a CSF (Pacheco-Comer and González-Castolo, 2011) that should be attended with care because affect the whole implementation methodology. Since solution providers have their own implementation model, the implementation methodology need to be negotiated between them and the business organization.

PROPOSAL OF ERP IMPLEMENTATION METHODOLOGY

As mention at the end of last section, the implementation methodology must be negotiated with solution provider but, at the beginning of the project, a more general implementation methodology model should be used, because only the organization has the vision that it needs an ERP system, but it does not know if en ERP system is the solution to their problems. So the proposal is a mix of ERP system implementation methodologies found at literature, including phases that help the organization to identify the problem to solve. The phases of the proposal are:

1. Strategic business analysis phase. In this phase the organization identifies their vision, mission, strategic objectives and problems to solve, also the business environment need it to be able to align the solution and solve the problem (PMI, 2000; Umble et al, 2003).

2. Compilation of business requirements list and business readiness phase. Creating a function and feature list with organization's needs to improve business efficiency. Functions should be aligned with strategic objectives trying to gain a competitive advantage and solve organization's processes problems. Evaluating how ready is the organization in terms of the adoption of new technology, technical, functional, processes, communication, cultural, administrative, resource and commercial change (Haghighi and Mafi, 2010).

3. Elaboration of first candidates list and filter phase. Already with functional and feature list, organization does a market search identifying those ERP systems that could fulfill requirements and needs. Next, it does preliminary contact with providers and compiles the necessary information regarding each solution. The systems than did not fulfill obligatory or priority needs are discarded, ending with a list of three to six ERP systems (Parr and Shanks, 2000) to deep evaluation.

4. Identify and agree evaluation method phase. "In this phase the organization should determine which method or combination of methods will be used for evaluating ERP packages" (Haghighi and Mafi 2010). The evaluation committee defines weight of each mayor category that going to be used when the selection criteria applied, including how to measure solves of organization´s problems (Razmi, Sangari, and Ghodsi, 2009).

5. Evaluate of short list candidates phase. The project leader must send a request for proposal (RFP) to the short list of candidates obtained in previous phase. Elaborate demonstration guide line for providers that need to be fulfilled, and be able to integrate the evaluation team with the evaluation method. Attending also, provider's demonstrations and doing visits to providers (Parr and Shanks, 2000), evaluating how solution fulfill organization's process blue-prints.

6. Elaborate evaluation matrix phase. Apply evaluation method doing interviews, surveys, etc., to the evaluation team. Prepare evaluation matrix (Umble et al, 2003) and analysis of ups and downs of each ERP system solution.

7. Decision make phase. Present evaluation matrix to the evaluation committee, top management and stakeholders. Use of defined criteria for analysis and discussion. Main delivery of this phase is the decision of whish solution provider system the organization going to implement (Lau, 2003).

8. Negotiate contract phase. Defines scope, deliveries, cost, resources and key process indicators (KPI) (Chiesa, 2004) with the solution provider regarding ERP implementation project.

9. Plan phase for ERP implementation; Elaborate, together with solution provider, the project implementation plan, including implementation model, data migration, responsibility definition, modules priorities, way to fulfill knowledge transfer between solution provider and project lead team, members of team and definition of teams needed by the project. A deeper use of the Project Management Book of Knowledge edited by the Project Management Institute is suggested.

10. Implementation phase. Executes ERP implementation plan until total deployment of ERP system with training, configuration, etc.

11. Maintenance phase. Negotiate maintenance plan with solution provider, top management and end users to be aware of aspects related to functionality, usability and adequacy to the evolving business processes and organizational changes. Taking care of updates, new functionalities, market´s normative and change on the business environment.

Before the implementation of an ERP, the project lead team needs a clear understanding of business objectives, goals and metrics to be fulfilled. As most of the critical success factors are human related, a culture change plan must be elaborated.

In general, all the implementation methodologies mentioned at tables 1, 2 and 3 are separated in five major phases: Identify business needs, selection process, implementation planning, ERP implementation and maintenance. Most of the literature implementation proposals have a lack of definition regarding the selection process, which it is one of the most important CSFs since (Pacheco-Comer et al, 2011), in this process, is where business organization defines the problem that they want to solve, why they want to solve it, why an ERP system is the solution to their problem and how they are going to implement the ERP system to solve the problem. So the proposal is oriented in the resolution of those questions, mainly in the definition of the

problem to solve because it is not an ICT problem, it is a business problem. With this premise, a successful implementation could be achieved, because if everyone knows the problem, everybody contribute to the solution of it, that, it is the main goal of change management, another of the CSFs found in literature, help on the address of problems arised from a change in organizational culture.

DISCUSSION AND CONCLUSIONS

ERP system implementation keeps attention of several research communities. Those communities claim for a general lifecycle model divided on phases. This paper present a proposal of implementation methodology and phases order, obtained by the mix of literature´s methodologies with the main purpose of identify business problem to solve and how to solve it.

Economic research data show that the average mean investment for an ERP implementation could be between fifty thousand dollars to several millions by ERP implementation attempt (Jutras and Castellina, 2010), in SME. Mexican economical census shows that there are more than 77 thousand economic units in city of Guadalajara, Mexico (INEGI, 2009). More than one percent of them could attempt to implement an ERP System and if the attempt would fail, an estimated of at least 15 million dollars could be wasted, not including labor cost and business opportunities losses (770 economic units by the minimum dollars spend of 50 thousand dollars per attempt by 40% of fail). In this matter, the importance of a good implementation methodology could be evident.

CSFs must be covered before, during and after ERP implementation. An adequate selection process is one of the CSF found the most on research literature. And, as selection is one of the first steps on the ERP life cycle, the whole implementation is based in this important process that could affect the whole implementation process and future business operations.

Since main goal of the enterprise top management is the improvement of its operations, if they are unable to use the ERP system appropriately after implementation project, because they choose a too small or too inflexible system to their needs, or other cause, they could have poor operations and financial results that could affect the own business existence.

In selection process, different ways to identify and evaluate the selection criteria have been attempted. The multivariable criteria used until now is right, if it includes functional, technical, economical and operational criteria´s. But future research should be done to evaluate how the methodologies proposed in literature have improved the ERP implementation success and how the quantification of improvement can be measured. The same thing could be said to project management and implementation methodology CSF.

ERP project could be seen in two different ways, as a software development project or as a box of the shelf project. In both visions the project lead team needs to use a consistence implementation methodology. The implementation methodology propose presented fulfill both visions because this method includes most of the CSFs fund at literature and it has a special attention to the definition of the problem, or problems, that the business organization tries to solve. If those problems are identifying at the beginning of the project, a successful implementation could be achieved more easily, improving change management and ERP deployment. The terms of knowledge and mastery of computer that is perceived or identified in the companies in Mexico (and perhaps in Latin America) shows the appropriateness of this proposal, focusing particular attention on the selection process and the agreements and joint plans that should be achieved with solution providers because the project is working on an important solution that will involve the entire organization. In this matter, the executive team should pay special attention in the complete learning of ERP solution, in parallel with an efficient use of IT by all organization´s members.

Regarding the selection process phase that has been presented within the implementation methodology proposal, there are ten different selection models found in literature but this multi-criteria decision problem can be researched using other computational modeling and simulation methodologies in order to get more knowledge regarding the selection process. As an ongoing research, Petri nets could be one of those computational modeling and simulation methodologies because they allow to model complex behavior affected by state changes (Petri, 2008), the selection process could be seen as consecutive change of states. In either case, there is the need to identify clearly, how the evaluation criteria variables interact against each other, wish one are independent variables and wish one are dependent variables. For that purpose an empirical study, focused on that matter, could help to identify interactions and variables used in Guadalajara, Mexico, by decision makers on the ERP selection process.

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