

A review on Enterprise Resource Planning System Selection Process

Augusto A Pacheco-Comer, Juan C González-Castolo

Universidad de Guadalajara, CUCEA Information Technologies Department,
Periferico Norte 799, esquina Av. Parres Arias, Nucleo Universitario Los
Belenes, Zapopan, México, C.P.45100
augustopacheco@acm.org, jcgcastolo@cucea.udg.mx

Abstract. Enterprise Resource Planning system is one of the information system most implemented by organizations. Their use can be seen at small, medium and big enterprises. It is one of the most important business optimization projects that an enterprise could attempt. At this paper we present a research literature review regarding enterprise resource planning implementation models, critical success factors and selection and evaluation criteria. A proposal of implementation methodology and there are suggestions for future research on selection processes and methodologies using Petri Nets and Multi Agents System.

Keywords: ERP; enterprise resource planning; selection; implementation model; information system; evaluation criteria.

1 Introduction

Information and communication technologies (ICT) allow an organization to gain a competitive advantage, but this cannot be done by ICT by itself [1]. The organization must have: Standardized business processes and people that know and have the ability to apply them [2].

An Enterprise Resource Planning (ERP) is an information system, which integrates most of the data that an organization can process and use in their operations[3]. Its implementation requires: Money, time, a great amount of people effort; and, as an enterprise system, enforce a change in the organizational culture.

ERP systems are increasingly important in today's business, as they have the ability to support organizational strategies, integrate the flow of information and enhance competitive advantage and individual performance [4]. 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 [5] could be, but not restricted to: material management, production, sales, marketing, distribution, financial services, human resources, reports, etc. As its impact affects the whole organization, the ERP system implemented should be the right one [6].

The present paper is organized as follows: Section 2 introduces ERP selection process as a Critical Success Factor (CSF), presenting ERP system concept and CSFs. Section 3 presents an ERP literature review, introducing literature ERP implementation methodologies and a propose integrated methodology, its phases and descriptions. Section 4 introduces ERP selection criteria and evaluation categories research literature review and four important criteria categories. Section 5 concludes with discussion regarding ERP selection process, Petri Nets, Multi Agents System and suggestions for future research.

2 ERP Selection Process as a Critical Success Factor

The main goals of an ERP system are to automate business processes [7], to improve interactions and communications inside and outside organization [8] and to eliminate patch work to legacy systems [9]. Its implementation success is affected by CSFs [5, 10-13]. As mentioned by Garcia-Sanchez [12]: “CSF is defined as the limited number of areas in which results, if satisfactory, will ensure successful competitive performance for the organization”.

CSF for Umble [14] are: 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.

Meanwhile Aloini [10] said that the top ten CSFs are: inadequate ERP selection, ineffective strategic thinking and planning strategic, ineffective project management techniques, bad managerial conduction, inadequate change management, inadequate training and instruction, poor project team skills, inadequate Business Process Reengineering (BPR), low top management involvement, low key user involvement.

Mabert [15] defined thirty CSFs grouped in three categories: planning, implementation decision and implementation, considering schedule and budget as important factors on project goal.

Ranzhe [16] 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 [12] 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.

Pabedinskaite [17] claim 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.

Suebsin [18] 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.

In his paper, Pabedinskaite [17], identifies that selecting the appropriate system is the second most important factor of all CSFs. Aloini [10] identifies inadequate ERP selection as the first factor. Iskanius as the eighth [19]. Garcia-Sanchez as the sixth [12]. Upadhyay as the fourteenth [20]. Ahituv [7], Umble [14], Somers [6], Haghighi [21], Esteves [22], Chiesa [23], Pastor[24], Adam[25], Burqués [26], Muñoz [27], Ayag [28], Kahraman [29], Tomb [30], Stefanou [31], Vilpola [32], Supramaniam [33], Kyung-Kwon [34] have mentioned in their list of CSFs.

Tsai [35] claims that ERP software selection criteria is a factor that influences ERP software quality, information quality and ERP success.

3 ERP Literature Review

ERP selection is an important factor for the success of an ERP implementation. Research literature indicated that: If the business wishes to increase the grade of implementation success, an implementation model should be used [11]. Table 1 and 2 present most representative ERP implementation methodologies in research literature reviewed, each column represent an author's model, rows each of the phases.

Table 1. ERP Implementation methodologies phases

Ahituv [7]	Tomb [30]	Umble [14]	Stefanou [31]
System Selection	Get of requirements	Selection	Business vision
Definition and implementation plan	Develop business case	Implementation	Analysis of business needs against boundaries and change wish
Implementation, process component	Design technological solution		Evaluation and selection
Operation	Implementation		Implementation

Table 2. ERP Implementation methodologies phases (continue)

Esteves[22] Dery[36]	Ayag [37]	Haghighi [21]	Aloini [10]
Adoption	ERP Selection.	Strategic plan	Concept: Strategic
	Requirements analysis	development	planning
Acquisition	Application of selection	Pre-selection	Concept: Selection
	algorithm, defining values,		
	weight attributes and utility		
Implementation	Search of candidates and	Selection	Implementation:
	first selection		Deployment
Usage	ERP selection using the	Post-selection	Implementation:
	best qualified		Integration
Evolution	Negotiation with ERP	Implementation	Implementation:
	provider		Stabilization
Retirement	Selection of IT		Post-implementation:
	Infrastructure		Progress
	Implementation and post-		Post-implementation:
	implementation		Evolution

Neves [38] 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. Meanwhile, Ahituv [11] and Greni [7], claim for the use of a System Development Life Cycle (SDLC) model for implementation. Lau [9] 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.

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. Our point of view agrees with most of the literature, an ERP system is a business tool and project, not an ICT project.

We also think than the methodology for an ERP system implementation could be a mix between software development lifecycle and business project lifecycle. And inside the methodology the selection process could be a CSF that should be attended with care because it could affect the implementation methodology since solution providers has their own implementation model.

Our own propose is a literature integrated implementation methodology for ERP system. The description of the phases and their sequence is presented at Table 3:

Table 3. ERP Implementation methodology propose, phases and description of phases

Propose phase order	Description
Strategic business analysis	The organization identifies their vision, mission, strategic objectives and business environment to align the new system.
Obtains business requirements list and business readiness	Creating a function list with organization's needs. Evaluating how ready is the organization in terms of the adoption of a new technology, technical, functional, processes, communication, cultural, administrative, resource and commercial change.
First candidates list and filter	Organization does a market search identifying those ERP systems that could fulfill requirements and needs. Preliminary contact with providers. Compile of informations regarding each solution. Discard of systems than did not fulfill obligatory or priority needs. Ending with a list of three to six ERP systems to evaluate.
Identify and agree evaluation method	Determine which method or combination of methods will be used for evaluate ERP packages.
Evaluate of short list candidates	Elaborate demonstration guide line for providers that need to be fulfilled. Integrate evaluation team who's going to attend provider's demonstrations and visiting providers.
Elaborate evaluation matrix	Apply evaluation method and prepare evaluation matrix.
Decision-making	Present evaluation matrix to the evaluation committee, top management and stakeholders. Use defined criteria for analysis and discussion. Main delivery is the decision of which system the organization going to implement.
Negotiate contract	Defines scope, deliveries, cost, resources and key process indicators (KPI).
Plan ERP implementation	Elaborate the project implementation plan, including data migration and responsibility definition.
Implementation	Executes ERP implementation plan until total deployment of ERP system with training, configuration, etc.
Maintenance	Negotiate maintenance plan with providers, top management and end users to be aware of aspects related to functionality, usability and adequacy to the evolving business processes.

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.

4 ERP Selection Criteria

Implementing an ERP system is not an inexpensive or risk-free venture. An estimated 40-70% of ERP implementations experienced some degree of failure [39]. That is why an organization should select the most appropriated ERP systems for their business needs[10].

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 [40], in Small and Medium Enterprises (SME). Mexican economical census [41] shows that there are more than 77 thousand economic units in Guadalajara. More than 1% of them could attempt to implement an ERP System. If we calculate the amount spent in the attempts that could 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 selection process could be evident.

Literature presented different approaches to selection and evaluation process.

Razmi [42] presented a hybrid multi-criteria model evaluating five categories in two consecutive wave, the first one evaluating with Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) and the second one with PROMETHEE.

Haghighi [21] included a three phase process where a criteria weight table must be filled.

Chiesa [23] also used a weight criteria weight table, but identifying six categories to compare. In both cases, the algorithm for calculation is a weight by evaluation matrix.

Ahituv [7] did not mention an evaluation criteria, just the necessity to submit a feasibility report to the steering committee.

Llal [43] proposed a data envelopment analysis approach using linear programming to measure and compare the relative efficiencies of decision making units. This evaluation approach use two sets of criteria: Meet of business needs and vendor attributes.

Karaarslan [44] proposed an Analytic Hierarchy Process (AHP) defining a hierarchical structure of the problem and forming a pair wise comparison matrix to compute weight of each element and their aggregated weight.

Kahraman [29] proposed a fuzzy heuristic multi-attribute conjunctive approach, using fuzzy heuristics to eliminate the worst alternatives among all at the first stage and then using a fuzzy conjunctive method to select the best among alternatives.

Ayag [28] preferred a Fuzzy Analytic Network Process (ANP), to take quantitative and qualitative elements to evaluate ERP software alternatives. Because the nine-point scale pairwise comparison in the conventional ANP could be insufficient and imprecise for reflecting the right judgments of decision makers fuzzy logic was integrated.

Perera [45] presented a multi-criteria decision model using AHP based in a study from Sri Lankan manufacturing organizations that found seven criteria categories using Expert Choice Software.

Burqués [26] and Pastor [24] introduced SHERPA methodology and a NoFUN notation. This methodology uses weight criteria tables in an incremental process until the best option emerges.

Nikoukaran [46] claims that a hierarchical framework for evaluation software is essential for proper selection.

Reuther [47] claims that the duration of the selection process has an impact on the success of the ERP implementation and the system functionality requirements is the

highest critical selection criteria. Carvallo [48] claims that the enterprise can organize selection criteria into a criteria catalog built for a scope, which can be either a domain or a category of domains arranged in a hierarchical tree-like for the comparison and evaluation. Dimitrova [49] refers than the application of ANP in a framework, together with a Priority Matrix, offers guidelines in the evaluation and selection of alternatives. Jadhav [50] proposed a hybrid knowledge based system integrated with rule based and case based reasoning components. He claims that: “this system assists decision makers, not only in evaluation and selection of the software packages, but also to specify requirements of the desired software package using well defined set of evaluation criteria and criterion values”. Bernroider [51] presented preliminary results in terms of ERP systems selection criteria. The paper support the view that ERP decision making is dominated by quality and project related criteria rather than potential benefits on the organizational or individual level. Lv [52] claims than return of investment, functional match, flexibility, complexity, consultants and vendor profile are the most important factor to take care about them to select and appropriate ERP system. Ya-Yueh [53] use six factors to evaluate a useful ERP system. Fuzzy AHP method is used to measure the related weights between different factors based on pair-wise comparisons. Ya-Yueh claim that chief enterprise officer decision, system functionality versus business processes needs and purchasing cost are the more important decision factors.

Different computational methods has been attempted to find the better way to select the appropriate ERP system for different businesses. We think that the best evaluation method should include functional, technical, economical and operational criteria's, because each of these criteria is an organizational resource concern.

5 Discussion and Conclusions

This survey helps to identify that this topic keeps attention of several research communities. Those communities claim for a general lifecycle model divided on phases. We present our own propose methodology on Table 3, integrated by methodologies of literature. 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 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. We think that multivariable criteria used until now are right, if it includes functional, technical, economical and operational criteria's. But future research could 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.

Also, there are other computational modeling and simulation methodologies that can be researched to get more knowledge regarding this multi-criteria decision problem. As an ongoing research, our opinion is that: Petri nets could be one of those computational modeling and simulation methodologies because they allow to model complex behavior affected by state changes [54], the selection process could be seen as consecutive change of states. Also multi agents could be used to model the selection process because they allow to define behaviors that can be applied by different agents [55]; each agent could be programmed considering stakeholders and their different point of view and evaluation criteria. On both cases, we have to identify clearly, how the evaluation criteria variables interact against each other. For that purpose, we think that an empirical study, focused on that matter, could help us to identify interactions and variables used in Guadalajara, Mexico, by decision makers on the ERP selection process.

Acknowledgments

CONACYT, <http://www.conacyt.gob.mx>.

References

1. Laudon, K.C., Laudon, J.P.: *Management Information Systems: New Approaches to Organization & Technology*. Prentice Hall, New Jersey (1998)
2. Davenport, T.H.: The Future of Enterprise System-Enabled Organizations. *Information Systems Frontiers* 2, 163-180 (2000)
3. Davenport, T.H.: Putting the enterprise into the enterprise system. *Harvard Business Review* 76, 121 (1998)
4. Bravo, E., Santana, M.: Impacto de la implementación de los sistemas de planeamiento de recursos empresariales ERP en el desempeño individual. In: *Americas Conference on Information Systems*, pp. 265. Association for Information Systems, (2010)
5. Ali, H.B., Saad, H.B.: Enterprise resource planning: a review and a STOPE view. *International Journal of Network Management* 15, 363-370 (2005)
6. Somers, T.M., Nelson, K.G.: A taxonomy of players and activities across the ERP project life cycle. *Information & Management* 41, 257-278 (2004)
7. Ahituv, N., Neumann, S., Zviran, M.: A system of development methodology for ERP systems. *Journal of Computer Information Systems* 42, 56 (2002)
8. A., M., R., R., E., S.: Challenges in enterprise resource planning implementation: state-of-the-art. *Business Process Management Journal* 16, 537 - 565 (2010)
9. Lau, L.: Developing a successful implementation plan for ERP: Issues and challenges. In: *International Association for Computer Information Systems*, vol. 4, pp. 223-229., Las Vegas, Nevada, USA (2003)
10. Aloini, D., Dulmin, R., Mininno, V.: Risk management in ERP project introduction: Review of the literature. *Information & Management* 547-567 (2007)
11. Greci, R.T., Hull, B.Z.: New Dog, Old Tricks: ERP and the Systems Development Life Cycle. *Journal of Information Systems Education* 15, 277-286 (2004)

12. Garcia-Sanchez, N., Perez-Bernal, L.E.: Determination of critical success factors in implementing an ERP system: A field study in Mexican enterprises. *Information Technology for Development* 13, 293 (2007)
13. Maldonado, M.: El Impacto de los Factores Críticos de Éxito en la Implementación de Sistemas Integrados de ERP. (Spanish). *Cuadernos de Difusión* 13, 77-118 (2008)
14. Umble, E.J., Haft, R.R., Umble, M.M.: Enterprise resource planning: Implementation procedures and critical success factors. *European Journal of Operational Research* 146, 241-257 (2003)
15. Mabert, V.A., Soni, A., Venkataramanan, M.: Enterprise resource planning: Managing the implementation process. *European Journal of Operational Research* 146, 302-314 (2003)
16. Ranzhe, J., Xun, Q.: A Study on Critical Success Factors in ERP Systems Implementation. *IEEE*, pp. 1-6. (2007)
17. Pabedinskaitė, A.: Factors of Successful Implementation of ERP Systems. *Economics & Management* 691-697 (2010)
18. Suebsin, C., Gerdri, N.: Key factors driving the success of technology adoption: Case examples of ERP adoption. In: *Portland International Center for Management of Engineering and Technology Proceedings*, pp. 2638-2643. Portland, Oregon, USA (2009)
19. Iskanius, P.: Risk Management in ERP Project in the Context of SMEs. *Engineering Letters* 17, 266-273 (2009)
20. Upadhyay, P., Dan, P.K.: ERP in Indian SME's: A Post Implementation Study of the Underlying Critical Success Factors. *International Journal of Management Innovation Systems* 1, 1-10 (2009)
21. Haghighi, H., Mafi, O.: Towards a Systematic, Cost-Effective Approach for ERP Selection. *Proceedings of World Academy of Science: Engineering & Technology* 61, 231-237 (2010)
22. Esteves, J., Bohorquez, V.: An updated ERP systems annotated bibliography: 2001-2005. *Communications of AIS* 2007, 386-446 (2007)
23. Chiesa, F.: Metodología para selección de sistemas ERP. *Reportes técnicos en ingeniería de software* 6, 17 (2004)
24. Pastor, J., Estay, C.: Selección de ERP en Pequeñas y Medianas Empresas con un Proyecto de Investigación – Acción. (2000)
25. Adam, F., Sammon, D.: *The Enterprise Resource Planning Decade: Lessons Learned and Issues for the Future*. Idea Group Publishing, London (2004)
26. Burqués, X., Franch, X., Pastor, J.A.: Formalizing ERP Selection Criteria. (2000)
27. Muñiz, L.: *ERP Guía práctica para la selección e implantación*. Ediciones Gestión 2000, España (2004)
28. Ayag, Z., Ozdemir, R.G.: An intelligent approach to ERP software selection through fuzzy ANP. *International Journal of Production Research* 45, 2169-2194 (2007)
29. Kahraman, C., Büyüközkan, G., Ruan, D.: A fuzzy heuristic multi-attribute conjunctive approach for ERP software selection. *World Scientific Publishing, Estambul* (2004)
30. Tomb, G.: *Implementing Enterprise Resource Planning: Lessons Learned from the Front*. January, (2006)
31. Stefanou, C.: The Selection Process of Enterprise Resource Planning (ERP) Systems. In: *Americas Conference on Information Systems Proceedings*. AIS Electronic Library, 418, (2000)
32. Vilpola, I.H.: A method for improving ERP implementation success by the principles and process of user-centred design. *Enterprise Information Systems* 2, 47-76 (2008)
33. Supramaniam, M., Kuppasamy, M.: Investigating the Critical Factors in Implementing Enterprise Resource Planning system in Malaysian Business Firms. *Proceedings of World Academy of Science: Engineering & Technology* 57, 332-341 (2009)

34. Kyung-Kwon, H., Young-Gul, K.: The critical success factors for ERP implementation: an organizational fit perspective. *Information and management* 40, 25-40 (2002)
35. Tsai, W.H., Lee, P.L., Shen, Y.S., Yang, C.C.: The relationship between ERP software selection criteria and ERP success. In: *Proceedings of International Conference on Industrial Engineering and Engineering Management*, pp. 2222-2226. (2009)
36. Dery, K., Grant, D., Harley, B., Wright, C.: *Work, organisation and Enterprise Resource Planning systems: an alternative research agenda*. *New Technology Work and Employment* 21, 199-214 (2006)
37. Ayag, Z., Özdemir, R.G.: An intelligent approach to ERP software selection through fuzzy ANP. 45, (2007)
38. Das Neves, D., Fenn, D., Sulcas, P.: Selection of enterprise resource planning (ERP) systems. *South African Journal of Business Management* 35, 45 (2004)
39. Frano, J.: ERP System Acquisition Project Planning. In: *Toolkit, I. (ed.) ERP*, vol. 2010, pp. (2008)
40. Jutras, C., Castellina, N.: *ERP Plus in process industries Managing Compliance in the Pursuit Profits*. (2010)
41. INEGI: *Censos Económicos 2004*. INEGI, México (2009)
42. Razmi, J., Sangari, M.S.: A hybrid multi-criteria decision making model for ERP system selection. In: *International Conference on Information and Automation and Simulation for Sustainability*, pp. 489-495. (2008)
43. Lall, V., Teyarachakul, S.: Enterprise Resource Planning (ERP) System Selection: A Data Envelopment Analysis (DEA) Approach. *Journal of Computer Information Systems* 47, 123-127 (2006)
44. Karaarslan, N., Gundogar, E.: An application for modular capability-based ERP software selection using AHP method. *International Journal of Advanced Manufacturing Technology* 42, 1025-1033 (2009)
45. Perera, H.S.C., Costa, W.K.R.: Analytic Hierarchy Process for Selection of ERP Software for Manufacturing Companies. *Vision (09722629)* 12, 1-11 (2008)
46. Nikoukaran, J., Hlupic, V., Paul, R.J.: Criteria for simulation software evaluation. In: *Proceedings of winter simulation conference*, pp. 399-406. (1998)
47. Reuther, D., Chattopadhyay, G.: Critical factors for enterprise resource planning system selection and implementation projects within small to medium enterprises. *International Engineering Management*, vol. 1, pp. 851-855 (2004)
48. Carvallo, J.P., Franch, X., Quer, C.: Determining Criteria for Selecting Software Components: Lessons Learned. *Software, IEEE* 24, 84-94 (2007)
49. Dimitrova, V.A.: Application of the Analytic Network Process (ANP) in a framework of ERP systems implementation success. In: *4th International IEEE conference "Intelligent Systems"*, pp. 20-19-20-24. (2008)
50. Jadhav, A., Sonar, R.: A Hybrid System for Selection of the Software Packages. *IEEE*, pp. 337-342. (2009)
51. Bernroider, E.W.N., Sudzina, F., Pucihar, A.: European criteria for assessing enterprise resource planning (ERP) systems: Preliminary results from multiple empirical studies In: *BLED Proceedings*. pp. 19. Association for Information Systems, (2009)
52. Fan, L., Jinliang, C.: Influencing factors on ERP system selection. *IEEE*, pp. 671-673. (2010)
53. Ya-Yueh, S.: A Study of ERP Systems Selection via Fuzzy AHP Method. *IEEE*, pp. 1-4. (2010)
54. Petri, C.A.R., Wolfgang: *Petri Net*. Scholarpedia T1 - Petri net 3, 6477 (2008)
55. Wooldridge, M.: *An introduction to multi agents systems*. John Wiley & Sons Ltd (2002)