

ORGANIZATIONAL AND TECHNOLOGICAL CRITICAL SUCCESS FACTORS BEHAVIOR ALONG THE ERP IMPLEMENTATION PHASES

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Abstract: This paper analyzes the evolution of organizational and technological critical success factors along the ERP implementation phases. The identification of factors leading to success or failure of ERP systems is an issue of increasing importance, since the number of organizations choosing the ERP path keeps growing. Our findings suggest that while both good organizational and technological perspectives are essential for a successful ERP implementation project, their importance shifts as the project moves through its lifecycle.

1 INTRODUCTION

During the last years some studies have been published in relation to the Critical Success Factors (CSFs) topic in ERP implementations.. The identification of factors leading to success or failure of ERP implementations is an issue of increasing importance, since the number of organizations choosing the ERP path keeps growing.

In this paper we attempt to analyze how the organizational and technological perspectives are perceived along the ERP implementation phases. Specifically, we have analyzed how the unified model of CSFs for ERP implementation projects presented by Esteves and Pastor (2000) fits into a organizational-technological framework. In our study, to evaluate organizational and technological perspectives, we have used their CSFs unified model. Understanding the CSFs that help to lead to successful implementations of Information Systems (IS) has been a key interest for practitioners as well as many IS researchers (Haines and Goodhue 2000).

This paper is organized as follows. First, we present the unified model of CSFs and the SAP implementation methodology. Then we describe the research framework for evaluating CSFs relevance. Next, we discuss the relevance of each CSF taken into account organizational and technological perspectives. Finally we discuss the results and further work.

2 UNIFIED MODEL OF CSFS FOR ERP IMPLEMENTATIONS

The CSF approach has been applied to many aspects and tasks of information systems, and more recently to ERP systems implementations, (e.g. Dolmetsch et al. 1998, Holland et al. 1999, Parr et al. 1999, Nah et al. 2001). Based in a set of studies published by several authors, containing commented lists of CSFs in ERP implementations, Esteves and Pastor (2000) unified these lists and created a CSFs unified model

	Strategic	Tactical
Organizational	<ul style="list-style-type: none"> • Sustained management support • Effective organizational change management • Good project scope management • Adequate project team composition • Comprehensive business process reengineering • Adequate project champion role • User involvement and participation • Trust between partners 	<ul style="list-style-type: none"> • Dedicated staff and consultants • Strong communication inwards and outwards • Formalized project plan/schedule • Adequate training program • Preventive trouble shooting • Appropriate usage of consultants • Empowered decision-makers
Technological	<ul style="list-style-type: none"> • Adequate ERP implementation strategy • Avoid customization • Adequate ERP version 	<ul style="list-style-type: none"> • Adequate infrastructure and interfaces • Legacy systems knowledge • Formalized testing plan • Adequate data migration process

Figure 1: The critical success factors unified model for ERP implementations

for ERP implementation projects. The unified model is represented in figure 1. The advantage of this model is that it unifies a set of studies related with lists of CSFs identified by other authors; the CSFs are categorized in different perspectives and, each CSF is identified and defined.

In the authors' view, the nature of the ERP implementation issues includes strategic, tactical, organizational and technological perspectives. Therefore, we propose that the CSFs model should have these four perspectives. The organizational perspective is related with concerns like organizational structure and culture and, business processes. The technological perspective focuses on aspects related to the particular ERP product in consideration and on other related technical aspects, such as hardware and base software needs. The strategic perspective is related with core competencies accomplishing the organization's mission and long-term goals, while the tactical perspective affects the business activities with short-term objectives.

2.1 CSFs Relevance

In 1988, Pinto and Prescott (1988, p. 5), claimed that "the majority of the studies in the critical success factor research stream have been theoretical and have assumed a static view of the importance of various factors over the life of a project. In other words, a critical success factor was assumed to have the same degree of importance throughout the life of the project". Therefore, Pinto and Prescott (1988) examined changes in the criticality of project CSFs over the life cycle of a project. They concluded that the relevance of CSFs is subject to change at

different phases of the project life cycle. They stated that "this finding implies that future use of critical success factor analysis and implementation, regardless of the area to be examined, may be contingent on other organizational phenomena, such as project (or organizational) life cycle" (Pinto and Prescott, p. 17).

Subsequent studies on CSF approach have addressed not solely the identification of CSFs but also their relevance along the project life cycle. However, the number of these types of studies is still very limited with most studies only focusing on CSF identification. The assumption that CSFs relevance varying along the implementation phases is slightly different from some studies that try to define CSFs for each phase of the project life cycle. Pinto and Prescott (1988) use the same set of CSFs and examined their relevance along the project phases while some studies define different sets of CSFs for each project phase. These approaches are different although some researchers are empirically using the same assumption stated by Pinto and Prescott (1988) since they are providing what they call "the most critical" or "most relevant" or "the top" CSFs which means they are only defining the most relevant CSF but probably they are always using as a reference the same set of CSFs.

With regarding to the research approach, to study CSFs relevance researchers have used surveys and case studies using interviews. The typical procedure is to ask participants to rank the most relevant CSFs in each project phase and then create a list of the most relevant CSFs in each project phase or, they ask participants to evaluate CSFs relevance using a Likert scale. Some authors have studied CSFs along different IS project types: information centers (Magal et al. 1988), IS implementation

projects (Pinto and Slevin 1988), Cooper and Zmud (1990), ERP lifecycle (Somers and Nelson 2001, Nah et al. 2001).

3 THE ASAP IMPLEMENTATION METHODOLOGY

In 1996, SAP introduced the Accelerated SAP (ASAP) implementation methodology with the goal of speeding up SAP implementation projects. ASAP was advocated to enable new customers to utilize the experience and expertise gleaned from thousands of implementations worldwide. This is specifically targeted for small and medium enterprises adopting SAP. The key phases of the ASAP methodology, also known as the ASAP roadmap, are:

- **Project preparation** – the purpose of this phase is to provide initial planning and preparation of SAP project. The steps of this phase help identify and plan the primary focus areas to be considered such as: objectives, scope, plan and definition of project team.
- **Business blueprint** - the purpose of this phase is to create the business blueprint, which is a detailed documentation of the results gathered during requirements workshops/meetings. It will allow the implementation project team to clearly define their scope, and only focus on the SAP processes needed to run the organization business.
- **Realization** - the purpose of this phase is to implement business and processes requirements on the business blueprint. The objectives are final implementation in the system, an overall test, and the release of the system for production (live) operation.
- **Final preparation** – the purpose of this phase is

to complete the final preparation, including testing, end user training, system management and cut over activities, to finalize the readiness to go live. The final preparation phase also serves to resolve all open issues.

- **Go live & support** - the purpose of this phase is to move from a pre-production environment to live production operation. A support organization must be set up for end users to provide long-term support. This phase is also used to monitor system transactions and to improve overall system performance. Finally the completed project is closed.

The structure of each phase is the following: each phase is composed of a group of work packages. These work packages are structured in activities, and each activity is composed of a group of tasks. An example of two work packages of ASAP, project kickoff and quality check, is described in table 1. For each task, a definition, a set of procedures, results and roles are provided in the ASAP roadmap documentation. According to a survey of Input company (Input 1999), organizations have been more satisfied with SAP tools and methodologies than with those of implementation partners. Implementations where ASAP or Powered by SAP methodologies were used averaged only 8 months, compared to 15 months for standard implementations.

4 OUR PROPOSED CSF RELEVANCE SCHEME

CSFs can either be ongoing, or they can be temporal (Khandewal and Ferguson 1999). Khandewal and Ferguson (1999) assert notwithstanding the earlier

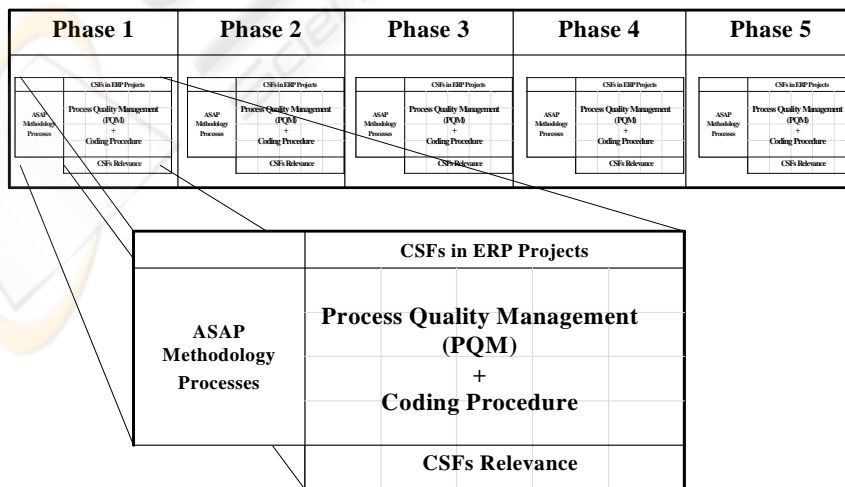


Figure 2: Research framework followed

statement that the CSFs can either be ongoing, or temporal that all CSFs can be defined in a way that they are temporal. For example, formal plan and schedule for the ERP implementation project can be defined as a temporal CSF. This CSF will then be considered having been achieved as soon as a project plan is developed. The assumption is that once the project plan is developed the ongoing updating of this plan would be an integral part of the project plan. All CSFs would thus belong to a point in time, although they may differ in their degree of temporality. Therefore, it is important to know these points in time where CSFs are more relevant. Next, we describe our research framework for evaluating CSFs relevance along SAP implementation phases and the relevance scheme obtained.

4.1 Research Framework for Evaluating CSFs Relevance

We have used the Process Quality Management (PQM) method (Ward 1990) to relate the CSFs with the ASAP processes. The PQM method developed by IBM is "designed to assist the management team reach consensus on the most critical business activities, i.e. those whose performance will have the biggest impact on the success or failure of the enterprise" (Ward 1990). PQM uses the concept of CSFs (Rockart 1979) to encourage management teams to focus their attention on the critical issues of the business, and then to base the IT strategy on these. Next, we describe the following steps of the PQM method, as we have applied them in our research case (see figure 2):

- **First step:** define the mission. We define the following mission: "To implement the ERP system, according to the organization's business and organizational needs" and then "to show that the ERP implementation will add value through the satisfaction of the organization requirements

previously defined". This mission reflects the intention of the whole group of people involved in an ERP implementation project;

- **Second step:** define CSFs. We will use the CSFs unified model proposed by Esteves and Pastor (2000);
- **Third step:** define the processes. In our case, the processes are those defined in the ASAP methodology;
- **Fourth step:** establish the relationship of CSFs versus ASAP processes. This is done through the creation of the matrix presented in figure 2 and table 1. For each one of the five SAP implementation phases a matrix was created.

Next, we describe how the matrix of CSFs versus ASAP processes was created.

According to Hardaker and Ward (1987), "the object is to single out the processes that have a primary impact on this particular CSF". What we are looking for are those essential activities and not all of them. The matrix in table 1 has been built in the following way. We focused on each CSF and asked this question: Which ASAP processes must be performed especially well for us to be confident of achieving this CSF? Then, we looked at all the processes and decided which ones were important for that CSF. Each time we established a relationship between a CSF and a process, we marked a '1' in the corresponding cell of the matrix (see table 1). A second process was used to validate and to get more reliability in the research. We used a coding procedure to analyze the ASAP documentation. The coding procedure consisted in coding line-by-line all the ASAP processes using a predefined list of codes, in this case the list of CSFs. Next, we present part of the full matrix of CSFs versus ASAP processes built for the first phase of ASAP, the project preparation phase.

Table 1: Example of the matrix CSFs versus ASAP processes for project preparation phase

ASAP Processes		CSFs in ERP implementations																					
		Sustained management support	Effective organizational change management	Good project scope management	Adequate project team composition	Comprehensive business process redesign	User involvement and participation	Adequate project sponsor role	Adequate project manager role	Trust between partners	Dedicated staff and consultants	Strong communication	Formalize project plan/schedule	Adequate training program	Preventive trouble shooting	Usage of appropriate consultants	Empower decision makers	Adequate ERP implementation strategy	Avoid customization	Adequate ERP version	Adequate infrastructure and interfaces	Adequate legacy systems knowledge	
W	Project Kickoff																						
A	Kickoff Meeting																						
T	Prepare for kickoff meeting						1					1											
T	Conduct kickoff meeting	1				1	1				1												
T	Company wide project introduction						1				1	1											
A	Project team standards meeting																						
T	Prepare for standard meeting						1					1											
T	Conduct standard meeting						1			1	1												
W	Quality Check																						
A	Perform quality check and approval																						
T	Conduct quality check						1																
T	Signoff project preparation phase	1					1																
	Number of CSFs occurrences	2					1	7			1	3	3										

4.2 CSFs Relevance

Table 2 represents the CSFs relevance for each CSF in each implementation phase. The values were calculated in the following way. We have built a matrix of CSFs versus ASAP processes such as the one in table 1 for each implementation phase, and for each CSF we sum the number of occurrences of that CSF. For instance, the sum of 2 in the CSF Sustained Management Support means that we defined 2 relationships between this CSF and 2 ASAP tasks. Then, we converted the number of occurrences (raw scores) into a normative scale of ten scores. In a scale of this kind, results from 1-3 are considered irrelevant, from 4-7 normal relevance, and 8-10 they are considered of high relevance. In our case, we see that almost all the factors are higher than 4. Thus, their relevance is normal or high in most cases. We do not pretend to

say that a CSF with a low summation it is not important; what we say is that it is less relevant in that period of the project. CSFs have all the same importance. Therefore, all of them should be carefully respected and analyzed.

One of the main results from table 2 is that organizational CSFs have more relevance along the ERP implementation phases than technological ones. Once again, there is the need to focus more on people and process than on technology itself. This is not new, and other studies have proved the same aspect in other types of IS implementation projects. This aspect is very important since as Felix and Harrison (1984) quoted, “technical problems can usually be detected and repaired before the system is put in jeopardy. The cost may be high in terms of either budget or schedule, but the repair can be made. Organizational and personnel problems often cannot be redressed, and continue to jeopardize the success of the system itself”.

Table 2: CSFs relevance along the SAP implementation phases.

Perspectives		Critical Success Factors	SAP Implementation phases				
			1	2	3	4	5
Organizational Perspective	Strategic	Sustained management support	8	6	5	5	8
		Effective organizational change management	6	9	5	5	6
		Good project scope management	5	3	4	4	4
		Adequate project team composition	4	4	4	4	4
		Comprehensive business process redesign	4	7	4	3	4
		User involvement and participation	5	9	10	8	6
		Adequate project sponsor role	7	6	4	5	7
		Adequate project manager role	10	9	9	10	10
	Tactical	Trust between partners	6	4	4	4	6
		Dedicated staff and consultants	5	5	4	4	6
		Strong communication inwards and outwards	7	7	6	8	9
		Formalized project plan/schedule	8	7	7	7	7
		Adequate training program	5	5	5	7	4
		Preventive trouble shooting	4	4	8	8	7
		Usage of appropriate consultants	6	9	9	6	4
		Empowered decision makers	4	5	4	5	4
Technological Perspective	Strategic	Adequate ERP implementation strategy	5	4	4	4	6
		Avoid customization	4	4	5	3	4
		Adequate ERP version	4	3	3	3	4
	Tactical	Adequate infrastructure and interfaces	6	6	7	7	4
		Adequate legacy systems knowledge	4	4	4	4	4
		Formalized testing plan	4	4	8	6	4
		Adequate data migration process	4	4	5	6	4

Next, we describe each CSF relevance along the SAP phases, classified by organizational and technological perspectives.

4.2.1 Organizational Perspective

Sustained management support is more relevant at the beginning and at the end of the implementation. The reason is that at the beginning senior management should help in the rollout of the project, analyze the business benefits, define the mission and scope of the project and provide the resources needed for the project. At the end, there is the need to encourage the system usage and help in the commitment of user involvement.

Effective organizational change management and business process redesign are more relevant in the second phase. In this phase the business blueprint is defined, and the business processes are analyzed, redesigned (some) and documented. There is the need to understand how the organization intends to run its business within the SAP system and the changes in the organization.

Adequate project team composition has the same relevance along all the phases since they play an important part in the whole project. ASAP

methodology does not focus too much on this CSF since it assumes that the right people were chosen.

Good project scope management is relevant at the beginning when managers define the scope and in the last phase because the scope is usually revised and changed according to the results of the go live system tests.

Adequate project sponsor role is more relevant at the beginning when people need to be motivated to start the project and to obtain the necessary resources and in the last phase when project sponsor needs to encourage the use of the system.

Adequate project manager role is relevant in all phases. It is less relevant in the second and third phases than in with the others because these phases are dedicated to business modelling and configuration tasks and here the role of the project manager is to guarantee that everything goes according to the plan.

Trust between partners is relevant at the beginning when all the stakeholders involved in the project should share their goals and knowledge and at the end when they have to analyze and again share their knowledge to finish the project with success.

User involvement and participation is relevant in the phases where their know-how is important to

achieve a good customization of the system to organizational needs. They participate in the definition of business requirements, help in the analysis of the ERP configuration and in conversion of data and the testing of the system.

Dedicated staff and consultants is more relevant in the last phase where there is the need to dedicated more effort in order to the system go live and also be available to help users answering their questions and reduce their doubts about the new system.

Appropriate usage of consultants is relevant especially in the second and third phases. On the second phase the knowledge of consultants is important to improve the business processes, and on the third phase consultants product knowledge on the ERP system parameterization.

Empowered decision makers is more relevant in the second and fourth phases because there is the need to take quickly decisions related with the business processes redesign (second phase) and the adequate customization of ERP system (fourth phase) in order to accomplish project plan/schedule on time.

Adequate training program is more relevant in phase 4 because it is when the training program of end users starts, but in the previous phases there are also training concerns related with project team training and to prepare end user training.

Strong communication inwards and outwards is more relevant at the first two phases where there is strong need of communication between senior management and the project team in the definition of project plan and scope, and in the last phase where there is the need of a strong communication with the whole organization to start the go & live of the SAP system.

Formalized plan and schedule relevance decreases during the implementation project. The reason is that at beginning it is important starting planning as early as possible. However, along the project, modifications to accomplish the results expected.

Preventive troubleshooting is more relevant in the last three phases, especially in the fourth phase during which issues arise when the production system is being tested and old data converted to the new system.

4.2.2 Technological Perspective

Avoid customization is more relevant in phase 3, when the SAP system is configured and more than 8.000 tables must be parameterized. The software configuration should follow the business requirements defined in the previous phase.

Adequate ERP implementation strategy is more relevant at the first phase because is in this phase that the SAP implementation strategy should be decided.

Adequate ERP version has the same relevance along all the phases. From the beginning until the end of the project implementation, SAP recommends that the project team follows the upgrade of SAP releases and should consider the adoption of new ones.

Adequate infrastructure and interfaces is more relevant in phases 3 and 4, when there is the need to configure the infrastructure for the production operation (go live). In these phases are also configured the interfaces with other systems, and the creation of reports and forms.

Adequate legacy systems knowledge is less relevant at the first phase because this phase is related with the preparation of project implementation. In phase 3 the need of knowledge of legacy systems is more relevant in order to minimize the effort of configuration, to help in conversion of data and the creation of interfaces.

Formalized testing plan is more relevant in phase 3 and 4 because in these phases the system needs to be tested after the parameterization process. The test should include not only functional testing but also the user's acceptance testing.

Adequate data migration process is more relevant in phase 4 because it is in this phase that data is migrated to the ERP system. The data migration process may be done using automatic procedures, or manually, or a mix of both. Finally, users must certify that they accept the data migration results.

5 DISCUSSION AND FURTHER RESEARCH

Based upon the schema presented in table 2, we analyzed the evolution of organizational and technological CSFs along the ERP implementation phases (see table 3). Our findings suggest that while both organizational and technological perspectives are essential for a successful ERP implementation project, their relevance shifts as the project moves through its lifecycle. Organizational issues are most important at the beginning, while technological issues gain in importance towards the middle as figure 3 shows. The organizational perspective has a high or normal relevance along the ERP implementation phases while the technological perspective starts by low and normal relevance and gradually increases to normal and high relevance.

Table 3 – CSFs relevance along the SAP implementation phases

ERP implementation phase	Relevance Value	Perspective	
		Organizational	Technological
Project planning	Low	5	5
	Normal	7	2
	High	4	0
Business blueprint	Low	4	6
	Normal	8	1
	High	4	0
Realization	Low	7	3
	Normal	5	3
	High	4	1
Final preparation	Low	5	4
	Normal	7	3
	High	4	0
Go Live	Low	6	6
	Normal	7	1
	High	3	0

Next, we analyze our findings phase by phase:

- **Project preparation** – In this phase, organizational factors have more relevance than technological factors. Adequate project manager role, sustained management support and formalized plan/schedule are the most relevant strategic factors while adequate infrastructure and interfaces is the most relevant technological factor. The main reason for these CSFs relevance is due to the fact that this phase is dedicated mostly to define and organize the project.
- **Business blueprint** – Organizational factors are still the most relevant factors on this phase. However, organizational factor types change. Adequate project manager role is the most relevant in all phases, but sustained management support relevance decreases, organizational change, user involvement and participation, and usage of appropriate consultants arise as the most relevant organizational factors. Regarding technological factors, adequate infrastructure and interfaces is the most relevant one. This phase is mainly dedicated to the business analysis and modelling.
- **Realization** – In general we evidenced that organizational factors relevance decreases and technological factors gain relevance. Adequate project manager role, user involvement and participation, and usage of appropriate consultants are still the most relevant organizational factors, while formalized testing plan and adequate infrastructure and interfaces are the most relevant technological factors. This relevance is according to the fact that in this phase the ERP system is parameterized.

Therefore most of the technological tasks are done in this phase.

- **Final preparation** – Organizational factors increase a little their relevance while technological factors decrease their relevance. Adequate project manager and user involvement and participation remain the most relevant organizational factors. Strong communication inwards and outwards gains relevance in this phase. Adequate infrastructure and interfaces stills the highest relevant technological factor. This phase is dedicated to the system testing and users training. The final adjustments to the system are done in this phase.
- **Go live & support** – Again, organizational factors still have more relevance on this phase, while technological factors loose significantly their relevance. Adequate project manager role and strong communication inwards and outwards are the most relevant organizational factors. Regarding technological factors all have a normal relevance in this phase. This phase is dedicated to the system go live. Therefore is important to communicate and involve everyone in this process to achieve success.

These findings have implications in the way organizations should manage their ERP implementation projects. Some of these implications are:

- Organizations should consider organizational factors early in the project lifecycle, during project preparation and business blueprint and at the end.
- The transition from organizational to technological issues must be carefully managed

since it means changing the relevance of CSFs. Therefore, it should exist a careful monitoring of these new CSFs.

- ERP project monitoring and controlling involves a dynamic multi-success-factor management since the most relevant CSFs may change along the project.
- The adequate project manager role is the most relevant CSF along all the ERP implementation phases. Therefore, organizations must put special attention on the selection, motivation and retention of this person and try to select the most adequate person for this role.
- Project managers must have adequate skills for both dealing with organizational and technological issues, or at least he/she counts on other people that support he/she in this shift along the project.

In this study we used all the CSFs proposed in the CSFs unified model for ERP implementations and the ASAP methodology. However, we have developed a general criticality indicator that can be applied to any ERP implementation methodology (see Esteves and Pastor 2001). We are aware that CSFs vary from implementation to implementation. However, this does not mean that organizations should forget the less critical CSFs; Instead, organizations must still control and monitor them to minimize projects risks. In fact, the CSFs from the unified model should all be treated as perceived project risks. We are now trying to validate these preliminary findings using the case study method and interviews with people of various roles that have been involved in ERP implementation projects. We also want to analyze the implications of studying vertical implementation cases such as higher education ERP implementation projects. Finally, we also will compare our findings with other studies of ERP implementation projects in general in order to identify similarities and discrepancies that may help improve our work.

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