FUNDAÇÃO GETULIO VARGAS
ESCOLA DE ADMINISTRAÇÃO DE EMPRESAS DE SÃO PAULO

SANDRO SEIBT CARVALHO

An analysis of critical success factors in ERP Implementation

SÃO PAULO
2011

SANDRO SEIBT CARVALHO

An analysis of critical success factors in ERP Implementation

Dissertação apresentada a Escola de Administração de Empresas de São Paulo da Fundação Getúlio Vargas, como requisito para obtenção do título de Mestre em Administração de Empresas no curso de Mestrado Profissional em Administração

Campo de conhecimento:

Administração, Análise e Tecnologia da Informação

Orientador: Prof. Dr. Otavio Prospero Sanchez

SÃO PAULO
2011

Seibt Carvalho, Sandro.
An Analysis of Critical Success Factors in ERP Implementations / Sandro Seibt Carvalho. - 2011.
53 f.

Orientador: Otávio Próspero Sanchez
Dissertação (mestrado) - Escola de Administração de Empresas de São Paulo.

1. Sistemas de informação gerencial. 2. Planejamento da produção. 3. Administração de projetos. 4. Sucesso. I. Sanchez, Otávio Próspero. II. Dissertação (mestrado) - Escola de Administração de Empresas de São Paulo. III. Título.

CDU 65.012.2

SANDRO SEIBT CARVALHO

An analysis of critical success factors in ERP Implementation

Dissertação apresentada a Escola de Administração de Empresas de São Paulo da Fundação Getúlio Vargas, como requisito para obtenção do título de Mestre em Administração de Empresas no curso de Mestrado Profissional em Administração

Data da aprovação:

_____/_____/_____

Banca Examinadora:

_____

Prof. Dr. Otavio Prospero Sanchez

(Orientador)

Fundação Getúlio Vargas

_____

Prof. Dr. Alberto Luiz Albertin

Fundação Getúlio Vargas

_____

Prof(a). Dra. Rosa Maria Moura

INSPER

ACKNOWLEDGMENTS

I want to thank everyone that helped during my research. To all the respondents, because without them I wouldn't have any relevant data to analyze. They were so quick to answer back and showed true interest in this research. I also want to take to everyone that helped me to get in contact with the respondents and provided me with useful information.

To my advisor that had patience with my mistakes and delays and helped a lot with the statistical analysis. This project wouldn't be finished without his help. To the members of the thesis committee, for investing their time and for giving their advice on this work.

To my family, for the support and help through the years, for all the investment they've made in my education.

To my wife. She is the one that kept me going when I thought about quitting and the one that helped me when the time was running out. I'm very thankful for all her attention and love during these years of studying.

ABSTRACT

This thesis focuses on the different perspectives regarding CSF (Critical Success Factors) in ERP (Enterprise Resource Planning) implementations. Current literature focuses on the CSF from an upper management perspective and rank the CSF based on that point of view. This thesis will present the ERP implementation project team perspective on the main CSF and will use a case study to assess if upper management and the implementation team share the same view. Also this thesis will propose a relation between ERP implementation success and the researched CSF, using PLS (partial least square) to analyze project team's answer to a questionnaire developed to measure ERP implementation success.

Key-words: Critical Success Factors, ERP implementation, Success, Project team, PLS.

RESUMO

Essa tese foca em diferentes perspectivas sobre CSF (Fatores Críticos de Sucess) em implementações de ERP (Enterprise Resource Planning). A literatura atual foca nos CSF sob o ponto de vista da alta gerência da organização e classifica esses CSF baseado nessa visão. Essa tese irá apresentar a visão do time de implementação de ERP sob os principais CSF e irá utilizar um estudo de caso para avaliar se a alta gerência e o time de implementação compartilham a mesma visão. Além disso ess tese irá propor uma relação entre o sucesso na implementação de ERP e os CSF pesquisados, usando o método PLS (Partial Least Squares) para analisar as respostas do time de implementação a um questionário desenvolvido para medir sucesso na implementação de ERP.

Palavras-chave: Fatores críticos de sucesso, implementação de ERP, Successo, Time de projeto, PLS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

BPR = Business Process Reengineering

CEO = Chief Executive Officer

CSF = Critical Success Factors

ERP = Enterprise resource planning

IS = Information System

MRP = Material Requirements Planning

MRPII = Manufacturing Resource Planning

PLS = Partial Least Squares

PMO = Project Management Office

INDEX

1 INTRODUCTION

The state of the art software package for business today is known as ERP (Klaus, Rosemann and Gable, 2000). The Enterprise Resource Planning package promises integration, enhanced flow of information and quick response for the organization. As a complex Information System (IS), however, implementing an ERP is not simple, neither is the realization of its benefits after the implementation.

This dissertation will verify in a case study the success factors in an ERP implementation from the ERP implementation team perspective. The revised literature focuses on the important factors from a high management perspective and this study is looking to confirm if the ERP implementation team, which are the ones responsible for executing the ERP system and vision in the company, share the same Critical Success Factors (CSF) as the company's executives. This dissertation will use a real case to study the impact of those CSF on an ERP implementation. The case had characteristics consistent with the implementations in the revised bibliography.

This dissertation is focused on the success of the implementation, instead of the success of the ERP system itself, since most of the revised literature uses this metric when measuring the CSF. Another reason for choosing that path is due to the difficulty in measuring the success of a complex IS like an ERP. There are several cases of companies that went through a complicated implementation but had good business benefits as well as companies that had great implementations but could not identify the benefits on installing the system (Markus and Tanis, 2000). In the ERP implementation success session this dissertation will cover some different methodologies to measure ERP success. This research will interview the ERP implementation team, so it needs a metric to relate the CSF to the project management metrics.

This dissertation focuses on Critical Success Factors. Several authors (Somers and Nelson, 2001; Akkermans and Van Helden, 2002; Soja, 2006; García-Sánches and Pérez-Bernal, 2007) tested the importance of CSF in their work. The Factors session will cover those factors in more detail and will focus on explaining each of them, what is their importance, how the previous researches analyzed them and what is expected for them in this research.

The second chapter briefly presents ERP and introduces the research question. The following chapter presents the CSF literature review followed by the research objective and justification. The literature review covers ERP topics that are relevant for this research, like complexity and definitions of IS success and ERP implementation success, but most part of the literature review is about the reviewed CSF and how they influence ERP implementation success. The methodology chapter covers the research methods that are used here. In summary, a questionnaire will be passed to each team member of the ERP implementation project where they will rate components of the CSF that will latter be analyzed against the project completion metrics, also rated by the project team, in a exploratory factor analysis to compare the results from the ERP implementation team perspective with the literature results. The final chapter summarizes the results presented.

2 ENTERPRISE RESOURCE PLANNING

The ERP software originated from the Material Requirements Planning (MRP) and Manufacturing Resource Planning (MRPII). MRP main function was to calculate more efficient materials needed in the production process. During the 1970s, the second generation (MRPII) started to aggregate new functions, like sales planning from which the Master Production Schedule (MPS) derived, but it continued not having the integration between business functions (Klaus, Rosemann and Gable, 2000), marketing data was usually not accessible by sales, as well as inventory was kept away from finance, since several different systems coexisted to handle that data and integration between those systems was either rudimental or non-existent. During the following years, the MRP continued to evolve to consolidate other technical business functions, like engineering and quality and in the 1990s the first called ERP packages started to appear in the market, with German software company SAP leading the business with its R/3 software.

ERP is offered by some of the following software vendors worldwide: SAP, Oracle, Infor, Sage Group and Microsoft. The market size for ERP in 2011 is estimated to be US$47.6 billion dollars with 11% growth year-over-year (Jacobson et al., 2007). Fundamentally, ERP can be seen as a development objective to map all business process and data from a company into a single integrate IT structure. Moreover, ERP was defined by a variety of authors with the same essence: It is a key IT element that delivers a complete solution to business (Klaus,

Rosemann and Gable, 2000). Based on that perspective the ERP is more than a simple software, its deep interaction with the enterprise process makes it essential to run the business. An ERP package must support all business functions, especially procurement, material management, production, logistics, maintenance, sales, distribution, financial accounting, asset management, cash management, controlling, strategic planning, human resources and quality (Klaus, Rosemann and Gable, 2000).

ERP is portrayed as a complex system, which derives from both the increasingly complexity in the company business process (Karimi et al., 2007) and the software complexity, which requires the ERP system to be properly administered (Klaus, Rosemann and Gable, 2000). A failure to reconcile the technical difficulties and the business problems can lead to adverse outcomes in ERP implementations (Davenport, 2000). One approach usually taken to overcome this is to concentrate efforts on the project management part of the project, but some degree of improvisation, politics and technical expertise are also needed (Akkermans and Helden, 2002). The high failure rate on ERP implementations can be ascribed to the complexity of the ERP system, but the complexity can also turn an earlier failure in a later success and vice-versa (Liang, 2007). ERP implementation has famous cases where multinational companies had to pull back on ERP implementations. FoxMeyr Drug went bankrupt in 1996 and sued their ERP supplier SAP, blaming them for the bankruptcy. Dell abandoned a SAP implementation after several delays. For them, SAP was not friendly to all the changes they needed in the system. Implementing complex systems causes massive changes that need to be careful managed to get the benefits out of it (Ehie and Madsen, 2005).

The extent of the ERP implementation is followed by an increase of its complexity as well as the information intensity and business process complexity (Karimi et al., 2007). Implementing one, or few modules is very different than implementing several modules. The ERP implementation complexity is closely related to the project scope and to the business process that it affects.

Due to the importance and complexity, ERP implementations are far from being an easy task to run. High cost implementations varying from few millions to hundreds of million dollars; and time consuming projects, going from six months to five years (Motwani et al., 2005) are associated with the ERP implementations, but ERP implementations are notorious for taking longer and costing more than what was projected. ERP implementations should not be viewed

only as an IT solution but rather as a system that would transform the company in a more efficient and effective organization (Ehie and Madsen, 2005).

3 CRITICAL SUCCESS FACTORS

Critical Success Factors are point of focus for the managers and their importance is underlined by Bullen and Rockart (1981, p. 12):

> Critical success factors are the relatively small number of truly important matters on which a manager should focus her attention. For this reason, the term "critical success factors" is aptly chosen. They represent the few "factors" which are "critical" to the "success" of the manager concerned. There are, in every manager's life, an incredible number of things to which her attention can be diverted. The key to success for most managers is to focus their most limited resource (their time) on those things which really make the difference between success and failure.
> In general, there are, for any manager, only a very limited number of critical success factors.

While ERP implementations differ from traditional systems in aspects like scale, scope and complexity, the theoretical development of CSFs in ERP implementations remains embryonic. (Somers and Nelson, 2001).

CSF are classified in a hierarchical model, starting by industry specific CSF that "affect each organization in an industry in the development of its strategy, objectives, and goals. No organization can afford to develop an strategy which does not provide adequate attention to the principal factors which underlie success to that activity" (Bullen and Rockart, 1981, p. 19). The industry specific CSF are followed by lower level CSF with the lowest level being individual CSF.

For ERP implementations several papers discuss the importance of specific CSF. Holland an Light (1999) divided the CSF into strategic and tactical, forming a list of 12 CSF intended to help managers to develop implementation strategies. Sommers and Nelson (2001) propose a list of 22 CSF derived from literature review and later ranked by 86 top level IS executives. Akkermans and van Helden (2002) continued Sommers and Nelson's research and proposed that the factors influenced each other, forming a cycle of good or poor performance. Al-Mashari, Al-Mudmig and Zairi (2003) propose a taxonomy of critical factors, divided into 3

groups and conclude that leadership and commitment are the most essential element for success in an ERP implementation. Ehie and Madsen (2005), through the use of exploratory factor analysis, found 8 factors that explained 86% of the variance in 36 ERP implementations. Garcia-Sanchez and Perez-Bernal (2007) selected 14 CSF for their study of ERP implementation in Mexican companies. Their selection took into consideration the most significant CSF in their revised literature.

There are different approaches for classifying the CSF in the revised literature, most of them, however rely on questionnaires sent to senior mangers that intend to classify or to confirm the classification of a presented list of CSF. That is the case for Holland and Light (1999), Sommers and Nelson (2001), Akkermans and van Helden (2003), Nah, Zuckweiler and Lau (2003), Ehie and Madsen (2005) among others. The existent reviewed literature provided enough data to compile a list of major CSF and to guide this dissertation.

4 OBJECTIVE AND JUSTIFICATION

Critical Success Factors for ERP implementations are being studied for over a decade. Most studies, though, look at the CSF from the perspective of the high management team. What about the view from other stakeholders? Do they think about CSF in the same way?

The objective of this research is to compare two points of view about Critical Success Factors, the implementation team and the high management in the reviewed literature points of view, and to propose a relation between the critical success factors and ERP implementation success

This research tries to identify the CSF based on a specific audience: The ERP implementation team. It is important to identify the stakeholder of the CSF as noticed by Finney and Corbett (2007, p. 343)

> As well, it has been revealed that there has been no research conducted to date that has considered the key ERP implementation CSF from the perspectives of key stakeholders. This is a significant finding. While several studies have attempted to interview representatives from various stakeholder groups, they have not reported findings so that individual views of different stakeholder groups are identified.

This is in line with Rockart (1979) initial view of CSF, where “information needs will vary from manager to manager and that these needs will change with time for a particular manager”. The factors are very connected to the audience, as they should watch them carefully and this research tries to compare the different stakeholders and their CSF. As one of the objectives of this dissertation is to compare CSF from different points of view, the main research question for it is:

Does the ERP implementation team share the same critical success factors as the high management in the reviewed literature?

Since the ERP implementation team is the one responsible for bringing the ERP vision to life, this dissertation will check if they share the same CSF as the company's high management. As noted by Wood and Caldas (2001, p. 389), “Many organizations seem to perceive ERP implementation merely as another IT project, and not as a major organizational transformation”. This indicates that there is a disconnection between the ERP vision and the way it is implemented.

Finally, most studies focused on looking at several different companies for the data collection. This study will look inside one company only. With that we can get more valuable information to explain discrepancies (if we find them during the data analysis) than with a larger number of companies, since there are more qualitative information available from the selected company that, in other studies, were merely hypothesis to explain some variances. An example is García-Sánches and Pérez-Bernal (2007) explanation for the fact that Business Process Reengineering is more important in Mexico than in the US. They only give an insight on why that happened.

5 LITERATURE REVIEW

5.1 ERP IMPLEMENTATION SUCCESS

At a first look the ERP benefits are huge and the ERP success among companies endorses that vision, but quantifiable ERP benefits are hard to find as research shows that only a small percentage of firms were able to get a positive Return of Investment (ROI) from their ERP

implementations (Stratman, 2007). That challenge created the need to search for alternatives on measuring ERP success, looking into qualitative benefits like improvement of organization, visibility, centralization, efficiency, among others. The implementation process was the next on the list to be evaluated. The biggest caveat is that the usual methodology for project evaluation, based on costs vs. benefits, used for most IT projects even today, is not fit to measure the success of a project as big as an ERP implementation (Teltumbde, 2000). In the past most IT projects were efficiency based, removing workforce, making a transaction faster or automating a decision and those savings were easy to quantify. ERP projects usually change the entire organization, making even the costs very hard to measure. It is not unusual to see projects that do not take organizational costs, which are usually related to the time the organization takes to adapt to the new system and it is when we can see lost of efficiency, into consideration. At the same time several benefits, like standardize a process between two departments are also not measured.

Regarding the financial benefits, current literature is controversial on the returns generated by ERP implementations (Ranganathan and Samarah, 2003; Hendricks, Singhal and Stratman, 2007). The first show the financial returns on stock value for companies that implemented ERP projects with large physical scopes and the second analyzed ERP and other enterprise systems implementation and, for the specific ERP case, was unable to find improvements in stock returns.

To solve this problem, the first step is to understand how the ERP implementation creates value to the company. Barua et al. (1995) studied the impact of external variables like market conditions to the first order variables generated by ERP benefits. The study concludes that any attempt to correlate a first order input variable, in this case the ERP implementation, with higher level outputs, financials indicators for example, will not reveal an association with high statistical significance. To avoid this type of mismeasurument we need a research model that includes the intermediate benefits or intermediate variables that are really affected by the ERP and we need to measure those variables at the lower organizational level. By doing that we will capture the first level influence of the ERP implementation, as it can get lost as we go upward the organization structure.

Frameworks for measuring Information Systems (IS) success are available, one of the most used being the Delone McLean IS Success Model (Delone and McLean, 1992). It gives a

causal framework to valuate IS systems. Since this research focus on evaluating the success in the implementation phase, we need to adapt and look for alternate frameworks. As noticed by Delone and McLean (2003) when they revised their success model, user satisfaction is the most commonly used and developed success measure, but when used alone may not fully measure IS success, or in our case ERP implementation success.

Another approach to evaluate the success of an IS, measuring not only the implementation success but the short and long-term success of the entire system, is to break it down in three parts and measure each of them using different variables, as proposed by Markus and Tanis (2000):
Project Metrics: This are the classic schedule, budget and scope metrics;
Early Operation Metrics: How business performs right after the implementation, it should include more operational metrics, depending on the company;
Long-term Business Results: Metrics more related to strategic goals, like customer satisfaction and others.

The division of the IS success in three different phases brings some challenges, as pointed by Markus et al. (2000). The first challenge is that the success (or failure) of only one of the phases does not mean that the entire IS system has failed. There were cases where Implementation failure still lead to long-term business result success. The second is that the baseline used to compare the progress of most of those metrics are the adopters objectives with the IS system, which means that even a success on achieve it still can lead to failure as those metrics would reflect subjective judgments of success made before the implementation.

Looking at only the ERP implementation portion of the IS success model from Markus and Tanis, the basic project metrics represent a good model for the success of that phase.

5.2 FACTORS

This section will cover the existent research on CSF that are present in ERP implementations. It is based on 3 papers: Esteves-Sousa and Pastor-Collado (2000), Nah, Zuckweiler and Lau (2003) and Finney and Corbett (2007). These papers present a compilation of other studies that included CSF, adding up to 67 papers. All papers coded the CSF, grouping similar concepts in categories and presented them in an aggregate form. Tables 1 to 6 does the same between the 3 papers, combining similar concepts from each paper, which are shown in their

respective columns, into categories (called CSF Naming). Higher relevancy was given to CSF that appeared with more frequency on the revised literature, which is shown by the total frequency column and they were also grouped in 6 topics.

The analysis of each CSF will take into consideration the ideas presented by the original papers, including concepts from other papers researched. By doing that this revision will keep the level of detail extracted from the literature, but will keep the CSF grouped in high level constructs, as follows:

- Organizational Support

This topic refers mainly to how the ERP implementation is supported by the organization at its highest level. When combining both CSF one can see organization support as the leadership commitment incorporated in a high level executive that has technical and managerial skills need for the project success (Finney and Corbett, 2007).

- Project Management

A good definition of Project Management was given by Nah et al in Finney and Corbett (2007, p. 336):

> Project management refers to the ongoing management of the implementation plan. Therefore, it involves not only the planning stages, but also the allocating of responsibilities to various players, the definition of milestones and critical paths, training and human resource planning, and finally the determination of measures of success.

Most authors agree that project management is indispensable in all IS projects. Controlling budget, scope and time is mandatory for the success an ERP implementation. Besides that, project management spans throughout the entire project, from earlier evaluation until after the go-live phase. In the ERP case in particular, the vast combination of hardware, software, human and political issues, makes ERP projects inherently complex, requiring new project management skills (Somers and Nelson, 2001).

- Human Resources

Human resources are widely cited in the studied literature. For Davenport (2000) the team is so important that he divides the ERP implementation in two phases: preparing the people and preparing the technical system. Most of the CSF have some human component to it, but this

group relates to characteristics of the ERP implementation team alone and the consultants that are part of the implementation project.

Assembling the team and preparing it before the project starts is crucial. Having the correct mix of experienced and new employees, business analysts and consultants is desired and this diversity can reduce the effects of the ERP complexity in the project implementation.

- Communication & Training

These two concepts were grouped for similarities in the way both are implemented during an ERP project. They both target external audiences and are critical in increasing awareness about the project. There is also some overlapping between both activities, as sometimes during training a good amount of communication also happens and vice-versa. One common characteristic for both is their presence doesn't guarantee success, but their absence is a good sign of failure (Al-Mashari, Al-Mudmig and Zairi, 2003)

- Business Processes

The ERP implementation alone is not enough as it deals with the core process of the company, it involves unpacking the "best practices" embedded in the system and the challenge of aligning existing system process with the embedded system process may put the implementation at risk (Liang, 2007). The less preferable way to match those process is by customizing the ERP application, but customization increases the scope of an ERP project and adds time and cost to the implementation (Somers and Nelson, 2001). Some degree of reengineering is expected, which requires and understanding of the current process in the company. These processes are embedded in the existing legacy systems (Al-Mashari, Al-Mudmig and Zairi, 2003) and they will determine the amount of change required and will be the starting point in the implementation (Holland and Light, 1999). When the business processes part of the implementation is ignored disasters may occur, as noted by Akkermans and Helden (2002). The way the ERP implementation is going to change the company's business process is deep and it is critical to manage the 3 factors in this group: Business Process Reengineering, Customization and Legacy Systems.

- ERP Selection

The ERP selection process is the first phase of the ERP implementation process. The two CSF in this category represent two phases in the selection process that depend from each other and will influence the project's direction. Decisions made in this phase can constrain the project going forward in an irreversible way, since by choosing a vendor the company is also committing to the vendor's ERP vision.

The reasons behind the adoption of the ERP can be divided in three main groups: substantive, institutional and political (Caldas and Woods, 2001). The organization culture and strategy should guide the ERP selection and reasoning would say that substantive factors (i.e. need to grow, reduce costs) should be high on the list of factors that influence ERP adoption but the ERP is better understood when one takes into consideration the other two factors. One example by Holland and Light (1999) is to implement only a reduced version of an ERP system if your company is resistant to change and after that add modules as needed. This approach is not unusual as ERP systems are composed of several different modules and companies can introduce them slowly if needed.

Next, for each high level construct, CSF will be detailed and their influence will be discussed.

Table 1 – CSF Construct: Organizational Support

CSF Naming	Esteves-Sousa and Pastor-Collado (2000)	Nah, Zuckweiler and Lau (2003)	Finney and Corbett (2007)	Total Freq.
Top Management Support	Sustained Management Support	Top Management Support	Top Management Commitment and Support	43
Champion	Project Champion Role	Project Champion	Project Champion	19

Top Management Support

Top of the list in several articles (Abinnour-Helm et al., 2002; Plant and Willcocks, 2007;Liang et al., 2007; Ehie and Madsen, 2005), sometimes called sponsor, sometimes top management support, they all refer to a strong leadership within the organization that buys the ERP project and helps during all phases of the project.

A strong sponsor helps in the implementation process by removing political barriers, by setting the example and keeping the company motivated during the usually painful process. After the implementation top management plays a significant role in assimilating the ERP innovation in the organization (Liang et al., 2007).

It is only with strong leadership in upper management that the necessary organizational changes can be completed and the full capabilities of the ERP system will be exploited. The

leadership also helps propagating the ERP system best practices and innovation, leading to the expected benefits (Al-Mashari, Al-Mudmig and Zairi, 2003). Top management advocacy and support is understood as a symbol of enterprise priority and may reinforce commitment of all employees (Nah, Zuckweiler and Lau, 2003), also by propagating the benefits, top management plays an important role in the ERP assimilation process, since low-level non-operational managers are usually reluctant on the ERP changes as they can't see the benefits that can arise from the ERP (Cooper and Zmud, 1990), in sum, upper management support is needed to get everyone on board with the changes.

Successful implementation of ERP is intricately tied to top management setting the strategic direction of the implementation process. A mere lip service or lukewarm support from top management is the "kiss of death" for any ERP implementation (Ehie and Madsen, 2005).

Champion

By having an executive level manager as the project champion, senior management can monitor the implementation performance and receive the necessary feedback, as the champion is directly responsible and accountable for the project outcome. To make ERP succeed, it is necessary to form a steering committee or group of "super users" where senior management from across different functions should participate in (Somers and Nelson, 2001).

It is expected the project champion to have both the position and the skills necessary to handle organizational change (Esteves-Sousa, Pastor-Collado, 2000), that means that the champion is usually a senior executive with powers to enable the necessaries changes, as Nah, Zuckweiler and Lau (2003, p. 17) explain:

> the role of a project champion is unique in that it is transformational—the champion not only promotes highly the ERP implementation and its associated changes throughout the organization, but also manages resistance to change. As one CIO put it, the project champion "must own (the system) and push forward (the implementation)."

Table 2 – CSF Construct: Project Management

CSF Naming	Esteves-Sousa and Pastor-Collado (2000)	Nah, Zuckweiler and Lau (2003)	Finney and Corbett (2007)	Total Freq.
Project	Good Project Scope Management Formalized Project Plan/Schedule	Project Management	Project Management Project Cost Planning and Management Implementation Strategy and Timeframe	50
Changes	Effective Organizational Change Management	Change Management Culture and Program	Change Management Managing Cultural Change	48
Implementation	Adequate ERP implementation strategy Preventive Troubleshooting	Software Development, Testing and Troubleshooting	Troubleshooting and Crisis Management IT Infrastructure System Testing	33
Metrics		Monitoring and Evaluation of Performance	Post-Implementation Evaluation	13

Project

Managing the ERP implementation as a project is a standard (Holland and Light, 1999) in the industry and one of the reasons is that most ERP implementations are measured against time, budget and scope (Nah, Zuckweiler and Lau, 2003).

The scope of the project should be clearly established and controlled (Nah, Zuckweiler and Lau, 2003; Steves-Sousa and Pastor-Collado, 2000) with good control on requested changes, as any scope change must be assessed in terms of the additional time and cost it will require to be implemented (Sumner, 1999 in Nah, Zuckweiler and Lau, 2003).

Only by having project management one should already expect to achieve the project management metric goals, but what other research has shown is that the complexity of the ERP systems makes project management one of the main factors, but not the only one. Ehie and Madsen (2005) show in their study that project management, although the top on the list, is responsible for 20.95% of the ERP implementation success variance.

Changes

In an ERP implementation a good deal of change in the way the company works will happen. Managing this type of change is a widely cited factor in this analysis. Companies need to adopt a comprehensive approach toward the large-scale changes associated with ERP implementations (Somers and Nelson, 2001) and need to formally implement a change management program (Finney and Corbett, 2007).

A second aspect of change is also present in enterprise-wide projects: Organizational change, which includes cultural, organization and people changes (Nah Zuckweiler and Lau, 2003). The project team must be aware of the cultural differences and preferences (Finney and Corbett, 2007) that will exist in the company. As summarized by Esteve-Sousa and Pastor-Collado (2000, p. 5-6):

> Organizational change refers to the body of knowledge that is used to ensure that a complex change, like that associated with a new big information system, gets the right results, in the right timeframe, at the right costs. The change management approach will try to ensure the acceptance and readiness of the new system, allowing the organization to get the benefits of its use. A successful organizational change approach relies in a proper integration of people, process and technology.

Implementation

Finney and Corbett (2007) cite implementation in three different CSF: the first one is related to testing that must be done prior to implementation, the second one emphasizes the need to be flexible in ERP implementation due to unforeseen circumstances, the third one relates to the current IT infrastructure and the often need to upgrade it to support the new system. Steves-Sousa and Pastor-Collado (2000) bring the attention to the strategy used during the implementation, big bang or phased approach. Although that should be a management decision, the big-bang strategy is the one with higher risk, with consultants usually advising against it due to the high potential for business disruption (Markus and Tanis, 2000).

Nah, Zuckweiler and Lau (2003) stress on the activities that happen just before the implementation: for them it is more important to solve all software problems before the implementation go-live. That may not be enough as Motwani (2005) exemplifies:

> We (Company A) tried to prepare ourselves for the implementation in every means possible. Thousands of hours of training classes were

> completed and selected individuals were polled for their opinion of readiness for the "go-live" date. However, upper management ultimately made the decision to throw the "ON" switch before the employees believed in or understood the software. The result was extremely costly, not only in dollars, but also in lost customers and customer service.

The combination of preparation and improvisation (Akkermans and Helden, 2002) is needed from the project team for a successful implementation.

Metrics

Project metrics and evaluations are important, as noted by Al-Mashari (2003, p. 361-362):

> Measuring and evaluating performance is a very critical factor for ensuring the success of any business organization and indeed for making IT systems such as ERP pay back. [...]
> A stage of performance review and evaluation is based on the premise that the evaluation and performance monitoring of ERP systems implementation can in turn lead to the achievement of all the business desired goal and objectives.

Monitoring the performance, tracking milestones, using project management's scope, cost and time metrics and other business metrics (Nah, Zuckweiler and Lau, 2003) allied with a strong post-implementation survey (Finney and Corbett, 2007) makes the use of metrics a critical success factor.

Table 3 – CSF Construct: Human Resources

CSF Naming	Esteves-Sousa and Pastor-Collado (2000)	Nah, Zuckweiler and Lau (2003)	Finney and Corbett (2007)	Total Freq.
Composition	Adequate Project Team Composition Dedicated Staff and Consultants	ERP Teamwork and Composition	Balanced Team Project Team: The Best and Brightest Team Morale and Motivation	59
Consultants	Appropriate Usage of Consultants Trust Between Partners		Consultant Selection and Relationship	21
Team Power	Empowered Decision Makers		Empowered Decision Makers	6

Composition

ERP is designed, implemented, tested and supported by different people in the organization. It is important that they are organized in a strong team with an executive sponsor, project leader, process owners, super users, vision and planning teams and implementation teams (Abdinnour-Helm et al., 2003). Since ERP is not all about IT, having the right mix of people in the implementation team is important. As noted by Esteves-Sousa and Pastor-Collado (2000, p.6),

> ERP projects typically require some combination of business, information technology, vendor, and consulting support. The structure of the project team has a strong impact in the implementation process. Two important factors are the integration of third-party consultants within the team and the retention within the organization of the relevant ERP knowledge.

In a good ERP implementation the project team will be composed of key users from different business areas and functional IT members, both internal and consultants. It is a difficult decision for most companies, but they must get their best employees to join the implementation team, which, in turn, can be fully dedicated to the ERP implementation or can be a part time effort. Ehie and Madsen (2005) could not find evidence that having a fully dedicated team was a critical factor and this is not the case with most companies, as resources are scarce and usually work with more than one project at the time, although Somers and Nelson (2001) still reiterate the importance of a balanced and competent project team. The same with Finney and Corbert (2007), who separate this CSF into three: Balanced team, the need to have the brightest people on the team, and the need to keep a high morale, all three important characteristics in the team composition.

Consultants

The use of external consultants is a reality for most companies, since they usually have knowledge about the specificities of the ERP that may not be available internally in the company. As noted by Somers and Nelson (2001, p. 4):

> Many organizations use consultants to facilitate the implementation process. Consultants may have experience in specific industries, comprehensive knowledge about certain modules, and may be better able to determine which suite will work best for a given company

Although many organizations use consultants, it is important to establish a knowledge transfer mechanism where the consultants' skills and expertise are acquired and transferred (Al-Mashari, Al-Mudmig and Zairi, 2003; Somers and Nelson, 2001; Motwani, 2005) to the company.

The number of consultants needed will vary from company depending on the maturity of the internal employees and the company must create an environment where trust exists between the parties involved in the implementation (Esteves-Sousa and Pastor-Collado, 2000).

Team Power

These CSFs relates to the project team capacity to make quick and necessary decisions regarding the ERP implementation. This factor may be overlooked by if included in other category (Finney and Corbett, 2007), which is the case with Nah, Zuckweiler and Lau (2003) that collapses this CSF within team composition.

Sometimes, allowing power to the team to make decisions goes against some other practices that are used in project management. One example is the steering committee as explained by Somers and Nelson (2001 p.3-4):

> A steering committee enables senior management to directly monitor the project team's decision making by having ratification and approval rights on all major decisions, thereby ensuring that there are adequate controls over the team's decision making processes.

As we cans see, Somers and Nelson propose that the steering committee should monitor the team's decisions, removing power from the team and moving it to a more strategic position. Since not all decisions are strategic only, one should be careful when assigning roles to a committee to not remove too much power from the team.

Table 4 – CSF Construct: Communication & Training

CSF Naming	Esteves-Sousa and Pastor-Collado (2000)	Nah, Zuckweiler and Lau (2003)	Finney and Corbett (2007)	Total Freq.
Training	Adequate Training Program User Involvement and Participation		Training and Job Redesign	31

CSF Naming	Esteves-Sousa and Pastor-Collado (2000)	Nah, Zuckweiler and Lau (2003)	Finney and Corbett (2007)	Total Freq.
Communication	Strong Communication Inwards and Outwards	Communication	Communication Plan Client Consultation	22

Training

The role of training is well known (Sommers and Nelson, 2001) and, although it is present in the reviewed literature, sometimes it is collapsed into other CSF (Nah, Zuckweiler and Lau, 2003; Ehie and Madsen, 2005). It is viewed more as a factor that will avoid failure in the project than a factor that will compensate for lack of another factor. Al-Mashari, Al-Mudmig and Zairi (2003, p.359) shares that view:

> Inadequate training has been one of the significant reasons of many ERP systems failure (Gupta, 2000). In ERP implementation projects, despite millions of dollars and hundreds of deployment hours, many projects fail because of the lack of adequate training (Kelley et al., 1999).

More than only training, most papers recommend the creation of a training plan (Ehie and Madsen, 2005; Motwani, 2005; Al-Mashari, Al-Mudmig and Zairi, 2003; Finney and Corbett, 2007), which consists of a detailed view of all trainings necessary during the lifetime of the project and extending into the life of the ERP system. This plan will formalize and put the adequate importance on continuous training, as "Companies should provide opportunities to enhance the skills of employees by providing training opportunities on a continuous basis" (Somers and Nelson, 2001).

Training for the IT project team is also crucial (Nah, Zuckweiler and Lau, 2003) as it is the already mentioned knowledge transfer from the consultants to the IT employees (Somers and Nelson, 2001).

Communication

More than just another factor, communication is what keeps everything together (Somers and Nelson, 2000). Failure on communications on the project team may lead to inconsistent designs, or deviate the project from its path, costing money and time and that may be hard to recover.

Communications between the team and the sponsors are also key to have the support needed during the project. Good project managers will always keep the top-management aware of what is happening, that makes the buy-in easier and keep leadership aligned with the project objectives (Markus et al, 2000). Finney and Corbett (2007) considered communication with the client so important that it got its own CSF stating that clients must be informed of the project to avoid misconceptions. The way communication should work was well summarized by Steves-Sousa and Pastor-Collado (2000, p. 6):

> Communication should be of two kinds: 'inwards' the project team and 'outwards' to the whole organization. This means not only sharing information between the project team but also communicating to the whole organization the results and the goals in each implementation stage. The communication effort should be done in a regular basis during the implementation phase.

During the Business Process Reengineering (BPR) phase, communications will keep the company employees aware of the changes, facilitating the assimilation of the new process and making the changes easier to deal with. For broader communications a communication plan should be in place, which should be a guide for all team members during the project. This plan should detail several areas, including rationales for the ERP implementation, detail of the business process management changes and establishment of contact points (Al-Mashari et al, 2003).

For Akkermans and Helden (2002) the ERP implementation is about integration of business processes and for that reason interdepartmental communication and collaboration within the project team are the core process for project progress. Attitudes of other team members, as project managers or even the champion were identified as root cause driving performance off of that process.

Table 5 – CSF Construct: Business Processes

CSF Naming	Esteves-Sousa and Pastor-Collado (2000)	Nah, Zuckweiler and Lau (2003)	Finney and Corbett (2007)	Total Freq.
Reengineering	Comprehensive Business Process Reengineering Adequate Software Configuration	BPR	BPR and Software Configuration	38
Customization	Avoid Customization		Vanilla ERP	17
Legacy Systems	Adequate Legacy Systems Knowledge	Appropriate Business and IT Legacy Systems	Legacy Systems Consideration Data Conversion and Integrity	13

Reengineering

While implementing the ERP the company will have to make choices in either to change their business process or change the ERP system. Later in this section this paper will present a CSF related to customizing the ERP system and how that should be avoided. With that in mind, the ERP implementation presents a good opportunity to review and revisit the company's business process. Esteves-Sousa and Pastor-Collado (2000) call the reengineering an alignment between business process and the ERP business model, with most of the researched literature agreeing that the company's process should be changed to fit the ERP business model (Nah, Zuckweiler and Lau, 2003; Somers and Nelson, 2001; Finney and Corbett, 2007; Holland and Light, 1999).

The ERP system is built to support generic business process, crafted from academic theory and professional experience in the so-called "best practices" (Markus and Tanis, 2000). The generic business process should be configured to fit business process while simultaneously fitting the business to the ERP system (Abdinnour-Helm, 2003). This synchronous fit gives a range of combinations the company can choose from while configuring and reengineering the

system, which can help explain why only 5% of the Fortune 1000 companies modify the ERP to fit their business (Somers and Nelson, 2001).

Customization

The organization should try to adopt the process and options built into the ERP, rather to seek to modify it (Esteves-Sousa and Pastor-Collado, 2000). The minimal customization strategy is an important approach to keep the ERP scope under control (Somers and Nelson, 2001). With customization the company creates its own code in the ERP software, which will increase the cost of implementing the ERP system and will push the vendor away since it will have difficulties to support that custom code (Plant and Willicocks, 2007).

Somers and Nelson (2001, p. 4) summarize the rationale behind minimal customization:

> (...) customizations are usually associated with increased information systems costs, longer implementation time, and the inability to benefit from vendor software maintenance and upgrades, customization should only be requested when essential or when the competitive advantage derived from using non-standard processing can be clearly demonstrated. Management has the ultimate choice of changing the process to fit the system or the system to fit the process.

Legacy Systems

For Nah, Zuckweiler and Lau (2003) this was the only CSF that was not cited by more than 6 articles, which may indicate that this was the least important CSF in their study or that it was a neglect or hard to identify CSF. Later their research confirmed that this CSF was rated the least important by the interviewed CEOs, confirming the first hypothesis.

Legacy systems influence the amount of organizational change required when implementing an ERP system (Nah, Zuckweiler and Lau, 2003). They also are a good indicator of the nature and scale of potential problems (Finney and Corbett, 2007) and finally must be taken into consideration when deciding to keep, replace or build an interface between the new and legacy system (Esteves-Sousa and Pastor Collado, 2000).

Holland and Light (1999, p.31) summarizes the role of the legacy system in the ERP implementation:

> Legacy systems encapsulate the existing business processes, organization structure, culture, and information technology. Therefore, they cannot be controlled by a company in the same way as the other variables in the model. Inevitably, they determine the amount of organizational change required to successfully implement an ERP system and will dictate the starting point for implementation.
> By evaluating existing legacy systems, you can define the nature and scale of problems that you will likely encounter. This should then influence your choice of ERP strategy.

Most models ignore the legacy systems and underestimate the importance of the current model in the choice of the ERP implementation strategy (Holland and Light, 1999). The complexity added by legacy systems is shown by Motwani et al (2005) where one of the companies in the case study had 30 different legacy systems to deal with during the ERP implementation and another had a legacy system written in an old language for which finding support was very difficult

Table 6 – CSF Construct: ERP Selection

CSF Naming	Esteves-Sousa and Pastor-Collado (2000)	Nah, Zuckweiler and Lau (2003)	Finney and Corbett (2007)	Total Freq.
Planning		Business Plan and Vision	Vision and Planning Build a Business Case	25
Selection	Adequate ERP Version		Selection of ERP	8

Planning

Planning in advance and the pre-implementation attitudes have great influence in the ERP implementation process and outcomes (Abdinnour-Helm et al, 2003). The first part of this phase is to articulate a clear vision, goals and objectives for the organization, providing a clear link between business goals and objectives (Finney and Corbett, 2007; Holland et al, 1999). The company should also build a business case to justify the investment (Nah, Zuckweiler and Lau, 2003; Finney and Corbett, 2007), but the influence that this phase has over the employees and even the team members is considerable, as noted by Abinnour-Helm, et al (2003, p.262):

> Herold et al. (1995) propose that the time period prior to physical implementation, a pre-implementation phase, is worthy of additional research attention because of its role in shaping the attitudes of those who will be charged with the implementation. They further suggest

> that since early, pre-implementation attitudes toward a technology may be the "starting point" for attitudes which shape future implementation phases, and because these early attitudes may be central in shaping behaviors early on (e.g., spreading of negative rumors, involvement in early planning and design phases, resistance to informational attempts), it is important to understand the nature and origins of such attitudes.

So upper management must consider these impacts, and get more employees involved in this early phase of the project. By assessing the employees attitudes and planning ahead, organizations can tailor their implementation efforts to increase the probability of success.

Selection

The ERP selection is choosing the ERP that will implement the vision shaped in the planning phase. If we consider it a technical decision it must take in consideration some factors as underline by Al-Mashari, Al-Mudmig and Zairi (2003): ERP vendor previous implementations data, human resources available, not allowing vendor to dictate the business process a priori, analyze the several business scenarios, eliminate clear losers immediately, use experienced negotiators and keep focus on the business plan. For smaller companies, achieving the best fit between the software and the business process is the main criterion (Klaus, Rosemann and Gable, 2000) due mainly to budget restrictions and the need for standardization.

The selection process also affects the way the ERP system success is measured. The reason why a particular company adopts the ERP is closely related to the way it is going to measure the ERP success after the implementation (Markus and Tanis, 2000). This is one of the reasons why measuring ERP success is so hard and also the reason why the adoption criteria is so important. It will guide the ERP implementation completely making each implementation unique and even hard to repeat in a different company or division in the same company.

6 METHODOLOGY

6.1 DATA COLLECTION

The research model proposed is based on the reviewed literature CSF. A 50-question questionnaire (see Appendix A) was developed based on the CSF that were identified with more than one question relating to each CSF (Ehie and Madsen, 2005). The questions were

based on the researched characteristics of each CSF, in a way that the respondent would be able to relate to an specific action or step in that was present during the implementation, like the presence of knowledge transfer from the consultants during the project, instead of the broader CSF term consultants. The questionnaire has 3 control questions: One for the role in the project, to differentiate possible differences from a role perspective. One for the participation in the project, to differentiate a team member that was present since the beginning from a team member that joined the team in the final stages of the project. Another for the physical location of the team member, to differentiate between members that was physically in the same location as the other members of the team from one that was remote to it.

The dependent variable was a mix of the three project success metrics: cost, scope and budget, which are measurable variables; and an intangible variable, measuring the team member perception of success regarding the project, since we understand that even with measurable project success metrics the user perception can differ (Markus and Tanis, 2000).

From the reviewed literature we expect that the CSF will directly influence the critical success factors as shown in Figure 1 below. The PLS relation will show how each factor explains the results and from the results an empirical relation will be built.

Figure 1 – ERP implementation relation

6.2 THE COMPANY

The questionnaire was sent to 38 project members of an ERP implementation that took place in a multinational manufacturing company in Brazil from 2007 to 2009. That company has implemented ERP system in its subsidiaries for an extended period of time (5 years) in a "phased rollout" fashion (Markus and Tanis, 2000). This dissertation focuses in a case study of only one company to reduce the variance existent between different companies. As recommended by Eisenhardt (1984) this company was chosen sice it had a team big enough for the statistical analysis and, as it will be shown next, was very similar to companies studied in the reviewed literature.

For this company, the ERP implementation started by top management and post-implementation survey with the project sponsors showed they were satisfied with the implementation. The implementation included three plants and two distribution centers, involved a dedicated team that had up to sixty people working on the implementation and had more than two years in duration. The chosen ERP was Oracle, which was the ERP used by the company worldwide. This company is in line with the characteristics of the majority of companies in the reviewed literature (Ehie and Madsen, 2005; Holland and Light, 1999; Plant and Willicocks, 2007) with the exception that it implemented Oracle, where most of the companies choose SAP.

All categories of CSF were observed during diligences in the chosen company. It had strong top management and sponsors, the ERP project was mandatory from the corporation and had the full support from all the plant managers involved as well as the company's CEO that approved the extra budget for the project. The team was very familiar with project management concepts and the company had a Project Management Office (PMO) and its own project management methodology. The sponsors and executives were also very familiar with it and required that all project management steps and procedure were followed during the project. The company chose the best employees and created a dedicated project team for the implementation, showing that human resources was considered very important when dealing with an implementation as big as this one. They made sure that they had the employees with the right knowledge of the company's process in the team as well as experienced consultants. The project was extensively communicated throughout the company and training was mandatory for everyone using the new system. The implementation changed the company's

process and an extensive BPR was made to standardize the process between all plants as much as possible. The ERP selection process was quick and top down. The chosen ERP was already in use in other plants in the world and the organization was very familiar with it.

The data analysis section will discuss in further detail the data about the company and will compare it with the revised literature, explaining similarities and specificities from the chosen company.

6.3 DATA ANALYSIS

For this dissertation, partial least squares (PLS) analysis will be used to confirm the data fit to the proposed relation and to reduce the amount of factors, grouping the similar questions into consolidated factors as we expected in the theory revision. Table 7 summarizes how each question should relate to each of the CSF, based on the intention of each question and the revised literature, but the final statistical result may be slightly different than what was expected as no CSF is guaranteed a place in the resultant theory, no matter how well it is measured (Eisenhardt, 1989). Also, as noted by García-Sánches and Pérez-Bernal (2007), the cultural differences between the American companies and the Latin companies can lead to slightly different results. In their particular case, the importance of the factors differed from their study to the others. That is also going to be tested, as this research will compare project team perceptions with high management's.

Table 7 – CSF Constructs in the questionnaire

Critical Success Factor	**Questions**
Organizational (O)	
1 - Top Management Support	1, 2, 3
2 - Champion	4, 5, 6
Project Management (P)	
1 - Project	7, 8, 10, 11
2 - Changes	9, 12, 13, 14
3 - Implementation	18, 19, 20, 21, 22
4 - Metrics	15, 16, 17
Human Resources (H)	

Critical Success Factor	Questions
1 - Composition	23, 24, 25, 26, 27
2 - Consultants	28, 29
3 - Team Power	30, 31
Communication and Training (C)	
1 - Training	32, 33, 34
2 - Communication	35, 36, 37, 38, 39
Business Process (B)	
1 - Reengineering	40, 41, 42
2 - Customization	43
3 - Legacy Systems	44, 45
ERP Selection (E)	
1 - Planning	46, 47, 48
2 - Selection	49, 50

The response rate totaled 25 responses, which represents a 66% response rate. Tables 8 to 10 show the answers for the control questions. We can see that respondents' role in the project was balanced, that most of them worked for more than 2 years in the project, which indicates that most people were part of the project from the beginning. Lastly, most of the team worked together at all times during the project, there was a "war room" for the project team, but some members were not working there at all times.

The respondents were divided in 16 men and 9 women, with 23 Brazilians and 2 International members. Only 2 respondents took more than 1 day to finish the questionnaire, with 18 below 10 minutes, an average of 299 minutes and one median of 6 minutes.

Table 8 – Control question; Q1: What was your role in this project?

Response	# responses	% of total
I was a manager, responsible for a business area	9	36%
I was a key user	10	30%

Response	# responses	% of total
I was an IT employee	6	24%
I was an external consultant	0	0%
Other (not listed)	0	0%

Table 9 – Control question; Q2: For how long were you involved in this project?

Response	# responses	% of total
Less than 6 months	1	4%
6 months to 1 year	3	12%
1 year to 2 years	4	16%
More than 2 years	17	68%

Table 10 – Control question; Q3: About your location DURING the project

Response	# responses	% of total
I was working at the same location with the majority of the project team (70% of the time)	19	76%
I was working in a different location (70% of the time)	4	16%
I was NOT working in only one location most of the time	2	8%

Table 11 shows the descriptive statics for the dependable variables. Variable 3, the scope related variable has the smallest range from the all variables, it ranges from 4 to 5, which may indicate the confidence from the implementation team that they delivered a good ERP, with all needed functionality, but they were not so confident about the other variables. That behavior was constantly noticed in the project team, although they sometimes complained about changes in scope, they clearly felt that meeting the scope requirements was a major goal and did so despite deviation in cost and schedule as they felt these variables were out of their control.

Table 11 – Descriptive Statistics for the Dependent Variables

Variable	Mean	Std Deviation	Min	Max
1. The project final cost meets the project expectations.	3,46	1.10	1	5
2. The project was completed as scheduled.	3,56	1.00	1	5
3. The delivered system functionality is coherent with the project scope.	4,24	0,44	4	5
4. The project was a success.	4,24	0,66	2	5

Reliability for the questionnaire was measured using Crombach Alpha and the result was .97, a very high result, indicating the reliability of the questionnaire. Table 12 shows the descriptive statistics for the factors. The two items with higher mean value were “Extensive System Testing” and “Have the project team solely designated to the ERP implementation” with 4,67 and 4,64 in a 1 to 5 scale. This may indicate that the team was proud of its existence and that they give credit for everything turning out OK to the extensive testing. The fact that the company moved employees from their regular functions to work solely on the ERP implementation plan gave the employees a sense that the implementation team was exclusive and important and the extensive testing the system went through, when most errors were caught was seen as an arduous work, but with relevant results, since they did not have high impact bugs and errors in the system after the go-live. The item with the smallest mean value was “Flexible implementation plan”. Its low mean value may be an indication that that factor was missing during the implementation, since the respondents were instructed to give a low score to items that were not present in the project. In fact the company implemented its ERP rollout in a thigh fashion, so there was not much flexibility in the implementation.

Table 12 – Descriptive Statistics for the Factors

Variable	Mean	Std Dev	Minimum	Maximum
P3_4	3.4	0.96	1	5
P2_2	3.64	0.99	1	5
H1_5	3.67	0.96	2	5
H2_2	3.75	0.85	2	5
H2_1	3.76	1.01	1	5

Variable	Mean	Std Dev	Minimum	Maximum
H1_4	3.8	0.82	1	5
E2_2	3.8	1.04	1	5
E2_1	3.8	0.87	2	5
C1_1	3.8	0.87	2	5
P3_2	3.88	0.97	1	5
B1_2	3.88	1.01	1	5
P1_2	3.88	1.01	1	5
C1_3	3.88	0.88	1	5
P3_5	3.92	0.86	2	5
C2_5	3.92	0.86	2	5
P4_3	3.96	0.98	1	5
E1_1	3.96	0.84	1	5
H3_2	4	0.65	2	5
C1_2	4.04	0.98	2	5
B2_1	4.08	0.57	3	5
O2_1	4.08	1.12	2	5
H1_1	4.08	0.95	1	5
B3_1	4.12	0.97	2	5
P2_1	4.13	0.68	2	5
P4_2	4.13	0.8	2	5
C2_3	4.16	0.94	2	5
P4_1	4.16	0.94	2	5
C2_1	4.16	0.8	2	5
B3_2	4.16	0.85	2	5
O1_2	4.24	0.72	2	5
B1_1	4.24	0.52	3	5
O2_2	4.24	0.72	2	5
E1_3	4.24	0.52	3	5

Variable	Mean	Std Dev	Minimum	Maximum
P1_1	4.24	0.97	1	5
P3_1	4.24	0.52	3	5
O1_1	4.25	1.03	2	5
P2_4	4.28	0.61	3	5
C2_4	4.28	0.54	3	5
E1_2	4.32	0.56	3	5
P1_3	4.32	0.85	2	5
C2_2	4.32	0.75	2	5
H3_1	4.32	0.56	3	5
O1_3	4.36	0.91	2	5
P1_4	4.36	0.49	4	5
O2_3	4.4	0.71	2	5
B1_3	4.44	0.71	2	5
H1_3	4.44	0.71	2	5
P2_3	4.52	0.51	4	5
H1_2	4.64	0.49	4	5
P3_3	4.67	0.48	4	5

PLS was applied to the proposed relation but it showed low level of significance, mainly because of the low number of responses gathered. Hair et al. (1998) and Costelo and Osborne (2005) suggest a minimum of 20 responses per independent variable, which would require 120 responses for this relation, it was then adjusted as follows:

- The Project Management construct was dropped since it had very low significance in the relation (R^2 = -0.016). That was a surprise, since Project Management rank very high in most of the revised literature. As mentioned before, the project team was very familiar with project management concepts, and that may explain why they underestimate its importance. With most of the team having several years of experience and with the company's structured project management procedures that construct was very natural to the team. Also, the coefficients for this construct

presented high cross loading with other constructs, which indicate that it was not a valid construct.

- The Human Resources construct presented very low coefficients weights and high cross loadings and was also dropped from the relation. The surprise here is that the team presented itself as a very proud team and this construct should have been more important. One explanation is that the construct involves more than only the team members; it involves users, consultants and empowering the team. The team related coefficients ranked very well, as we can see by question H1_2, but the non-team related ranked poorly, as we can see by H1_5 (presence of all affected employees in the implementation) and H2_2 (support of external consultants).
- The Dependent variable was best described by using the success coefficient alone and the other three were dropped.
- With four constructs the relation still lacked significance, but it was clear that the Business Process Construct was the most significant of all. Looking at the revised literature, the relation was re-organized to a staged model (Ehie and Madsen, 2005) influenced by Al-Mashari, Al-Mudmig and Zairi (2003) taxonomy of factors. This culminated in a relation where only Business Process explains success, ERP selection and Communication & Training explain Business Process and Organizational explains Communication & Training as shown in Figure 2.
- Finally, cross loading problems were reviewed and some coefficients were dropped from the relation, resulting in a relation with good fit and coherent with the revised literature.

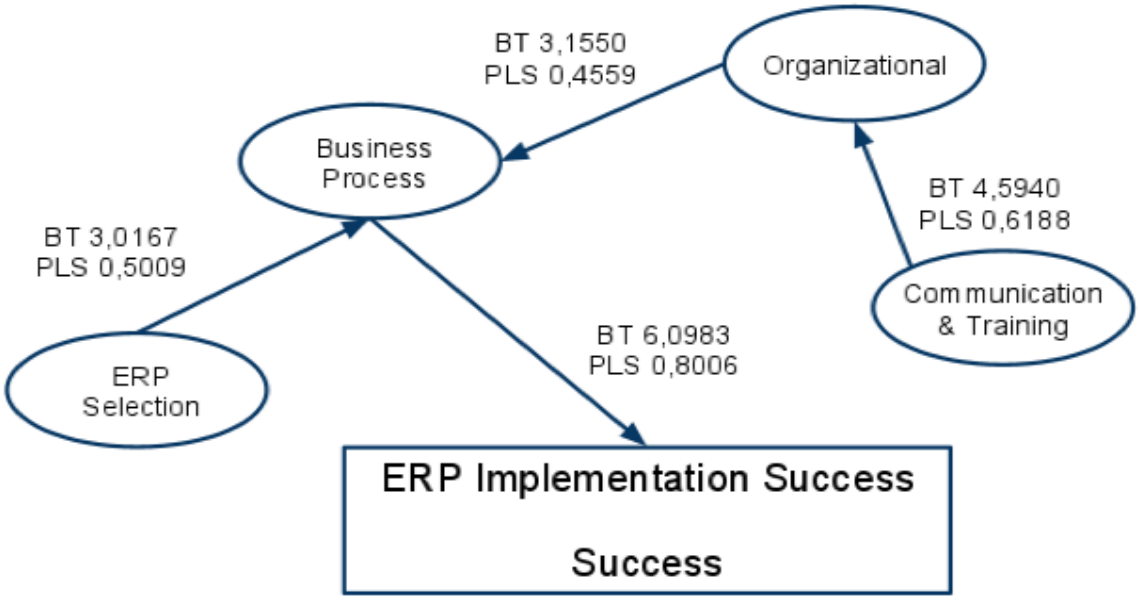

Figure 2 – ERP Implementation Empirical Relation with Bootstrapping (BT) and PLS coeficients.

The final relation was able to explain 64.1% of the Success variance, an acceptable amount for social science studies. Tables 13 shows the overview data from the relation, including average variance extracted (AVE) for convergence, composite reliability for internal consistency, R square for variability and cronbach's alpha for reliability. Table 14 provides data for the Foenell-Larcker (1981) criterion. Table 15 shows all indicator's loadings, with very little cross-loading, providing discrimination validity for the relation and table 16 provides bootstrapping for all factors, testing for significance. A summary of how the relation was evaluated (Hair, Ringle and Sarstedt; 2011) is shown as follows.

- Internal consistency reliability: Composite reliability was higher than 0.7 for all constructs (Table 13).
- Indicator reliability: Indicator loadings were higher than 0.71 (Table 15).
- Convergent validity: The AVE is higher than 0.5 for all constructs (Table 13).
- Discriminant validity:
    - Fornell-Larcker (1981) criterion, the square root of AVE for each construct was higher than the highest correlation with any other construct (Table 14).
    - Indicators loadings were higher than all its cross loadings (Table 15).
- From a 5000 bootstrap sample all indicators where significant (Table 16)
- R^2 for all the constructs are moderate to substantial (Table 13).
- Crombach's alpha are over 0.7 for all constructs (Table 13).

Table 13 – Overview of the empirical relation

Construct	**AVE**	**Composite Reliability**	**R Square**	**Cronbachs Alpha**
Business Process	0.6587	0.8525	0.6138	0.7464
Communication & Training	0.7272	0.9301	0.0000	0.9077
ERP Selection	0.5972	0.8807	0.0000	0.8374
Organizational	0.7168	0.9265	0.3829	0.9029
SUCCESS	1.0000	1.0000	0.6409	1.0000

Table 14 – Construct Correlations and AVE Square Root Comparison

	Business Process	Communication & Training	ERP Selection	Organizational	Success
Business Process	**0.812**				
Communication & Training	0.751	**0.853**			
ERP Selection	0.656	0.521	**0.773**		
Organizational	0.626	0.619	0.339	**0.847**	
Success	0.801	0.544	0.399	0.520	**1.000**

Note: bold values are AVE square root

Table 15 – Indicator's Loadings

	Business Process	**Communication & Training**	**ERP Selection**	**Organizational**	**Success**
Success	0.8006	0.5435	0.3989	0.5197	**1**
B1-2	**0.7737**	0.5574	0.5657	0.2398	0.5406
B1-3	**0.862**	0.5313	0.5746	0.6663	0.826
B3-2	**0.7966**	0.7825	0.455	0.5466	0.52
C1-1	0.5018	**0.7932**	0.562	0.2648	0.3046
C1-2	0.5649	**0.8508**	0.483	0.5077	0.3699
C2-1	0.8345	**0.8253**	0.453	0.5311	0.5528
C2-3	0.6227	**0.8726**	0.3906	0.596	0.4687

	Business Process	Communication & Training	ERP Selection	Organizational	Success
C2-5	0.6354	**0.9169**	0.4231	0.6086	0.545
E1-1	0.5772	0.2923	**0.8347**	0.0899	0.3168
E1-2	0.4374	0.5327	**0.7493**	0.3799	0.2347
E1-3	0.5126	0.4627	**0.7131**	0.287	0.3076
E2-1	0.5995	0.4471	**0.8229**	0.4141	0.4497
E2-2	0.1678	0.1607	**0.7363**	-0.0322	0.0121
O1-1	0.4873	0.3899	0.2779	**0.8689**	0.4053
O1-2	0.5373	0.6962	0.2481	**0.8258**	0.4828
O1-3	0.6525	0.6709	0.346	**0.8842**	0.5427
O2-1	0.4979	0.4133	0.2794	**0.8981**	0.3673
O2-3	0.3945	0.2607	0.279	**0.7476**	0.3198

Table 16 – Bootstrapping

	T Statistics
BP –> SUCCESS	6.0983
COM –> ORG	4.5940
ERP –> BP	3.0167
ORG –> BP	3.1550

To compare the reviewed literature responses with the project team responses first they need to be ranked. Reviewed responses will be racked according to the number of times each one is cited in the reviewed literature, which can be found in the 5th column of Tables 1 to 6. Project team responses will be racked according to the average rating for each construct, combining information from Table 7 and Table 12.

Table 17 – CSF Ranks from different perspectives

Rank	From the Implementation Team perspective	From the Reviewed Literature
1	**Top Management Support**	**Composition**
2	Champion	**Project**
3	**Project**	**Changes**
4	**Reengineering**	**Top Management Support**
5	**Planning**	**Reengineering**
6	**Communication**	Implementation
7	Team Power	Training
8	**Changes**	**Planning**
9	Legacy Systems	**Communication**
10	**Composition**	Consultants
11	Metrics	Champion
12	Customization	Customization
13	Implementation	Metrics
14	Training	Legacy Systems
15	Selection	Selection
16	Consultants	Team Power

Looking at the 10 first CSF seven are shared between the two perspectives. Although not at the same order and with 10 being a somewhat arbitrary number this analysis helps to demonstrate that the team and the high management share the same CSF from a broader perspective. One interesting comparison is between the 1st CSF on both lists. From the implementation team perspective, the most important CSF is related to top management, and from the top management perspective the most important CSF is related to the implementation team. This shows that the CSF really depend on the audience and also shows a connection between the implementation team and high management, at least for this particular company.

One CSF that brings attention is the Champion CSF. It was rated the second most important for the implementation team, but only the 11th from the high management one. Since the

champion role is one of high responsibility, usually occupied by a high level executive (Somers and Nelson, 2001) it is possible that top level executives don't want that responsibility over the project. The project team, on the other hand, realizes how important it is to have someone from outside the team to escalate, communicate and report problems and progress. That indicates one of the few misalignments between management and project team

7 DISCUSSION

This thesis had as objective to compare two points of view on the same subject: Critical success factors for ERP implementations. The most discussed view is the one from upper management and this work wanted to compare this view with the view from the team that is implementing the ERP. A case study was chosen to provide data to create a theoretical relation of ERP implementation success. Unfortunately the project team from the chosen company did not have too many participants, which influenced the significance of the proposed relation. The proposed questionnaire was also too long and respondents probably experienced fatigue while answering it.

The response rate was higher than expected and it reduced the negative effects of the small respondents universe. It was noticeable from the responses and from perceptions gathered from the project team members that they valued the team and their work and that they did not give too much importance to items that were not closely related to the ERP, like Project Management, and also recognized that they delivered the needed scope, but in detriment of schedule and cost. This finding points to the need from higher management to keep tighter control in schedule and cost but let the project team be responsible for managing the scope, which is their main strength.

The empirical relation was different from the proposed one, but was still in line with the reviewed literature. From a management perspective, the relation should help in visualizing how the different CSF interact with each other to influence the outcome. The low number of respondents had a negative impact in the relation's significance even with a good response rate. Further research could avoid this problem by selecting more than one case to study. More research on the project team is also needed to understand some results, especially Project Management's CSF lack of relevance. As for the selected company, it was in line with the average company in the literature that removes some variance and focuses the differences in the interviewed audience.

For the research question this study shows that most CSF are shared among the project team and the leadership, but the project team gives more importance to leadership since they can help remove obstacles and are the clients of ERP projects and the top management gives more importance to the team and to project related activities since that is where their primary interest lies. The empirical relation shows that Business Process Re-engineering was the most important construct and that Project Management did not influence success as much. Reasons were already discussed, but it is worth to note the maturity level this particular team had regarding big ERP implementations and projects. This probably influenced their vision about Project Management and reinforced the importance of BPR in an ERP implementation project, which was in line with the reviewed research, where BPR always placed very high in the CSF lists (Finney and Corbett, 2007). More research on the differences between experienced and non-experienced project teams may be needed to better understand these differences.

REFERENCES

ABDINNOUR-Helm, S., LENGNICK-Hall, M.L., LENGNICK-Hall, C.A., 2003. Pre-implementation attitudes and organizational readiness for implementing an enterprise resource planning system. *European Journal of Operational Research* 146 (2), pp.258–273.

AKKERMANS, H., and Van HELDEN, K., 2002. Vicious and virtuous cycles in ERP implementation: a case study of interrelations between critical success factors. *European Journal of Information Systems*, 11, pp.35–46.

AL-MASHARI. M., AL-MUDIMIGH, A. and ZAIRI, M., 2003. Enterprise Resource Planning: A Taxonomy Of Critical Factors. *European Journal of Operational Research*, 146(2), pp.352–364.

BARUA, A., KRIEBEL, C. H. and MUKHOPADHYAY, T., 1995. Information Technology and Business Value: An Analytic and Empirical Investigation. *Information Systems Research* (6:1), 1995, pp.3–23.

BULLEN, C. V. and ROCKART, J. F., 1981. A Primer on Critical Success Factors. *Center for Information Systems Research,* Working Paper No. 69, Sloan School of Management, M.I.T., Cambridge, MA.

CALDAS, M., and WOODS, T., 2001. Reductionism and Complex Thinking in ERP Systems Implementations. *RAC*, v. 5, n. 2, Maio./Ago. 2001, pp.91–111.

COOPER, R. B. and ZMUD, R. W., 1990. Information Technology Implementation Research: A Technological Diffusion Approach. *Management Science*, 36, 2, pp.123–139.

COSTELLO, A. B. and OSBORNE, J., 2005. Best practices in exploratory factor analysis: four recommendations for getting the most from your analysis. *Practical Assessment Research & Evaluation*, 10, pp.1–9.

DAVENPORT TH., 2000. *Mission Critical: Realizing the Promise of Enterprise Systems*. Boston, MA, Harvard Business School Press. 335 p.

DELONE, W.H. and MCLEAN, E.R., 1992. Information systems success: The quest for the dependent variable. *Information Systems Research*, 3, 1, pp.60–95.

_____. 2003. Model of Information Systems Success: A Ten-Year Update. *Journal of Management Information Systems*, 19 (4), Spring, pp.9–30.

EHIE, I. and MADSEN, M., 2005. Identifying critical issues in enterprise resource planning (ERP) implementation. *Computers in Industry,* 56 (2005), pp.545–557.

EISENHARDT, K. M., 1984. Building Theory from Case Study Research. Academy of Management. *The Academy of Management Review*, October, 14, 4, pp.532–550.

ESTEVES, J. and PASTOR, J., 2000. Towards the Unification of Critical Success Factors for ERP Implementations. *10 th Annual BIT Conference*, Manchester, UK., November

FINNEY, S. and CORBETT, M., 2007. ERP implementation: a compilation and analysis of critical success factors. *Business Process Management*, 13(3), pp.329–347.

FORNELL, C. and LARCKER, D. F., 1981. Structural Equation Models with Unobservable Variables and Measurement Errors. *Journal of Marketing Research* (18:2), pp.39–50.

GÁRCIA-SÁNCHES, N. and PÉREZ-BERNAL, L., 2007. Determination of Critical Success Factors in Implementing an ERP System: A Field Study in Mexican Enterprises. *Information Technology for Development*, Vol. 13 (3), pp. 293–309.

HAIR J. F., ANDERSON R. E., TATHAM R. L. and BLACK W. C., 1998. *Multivariate Data Analysis*. Prentice–Hall, Englewood Cliffs, NJ. 889 p.

HAIR J. F., RINGLE, C. M. and SARSTEDT, M., 2011. PLS-SEM: Indeed a silver bullet. *Journal of Marketing Theory and Practice*, vol 19. (2) Spring 2011, pp.139–151.

HENDRICKS, K. B., SINGHAL, V. R. and STRATMAN, J. K., 2007. The Impact of Enterprise Systems on Corporate Performance: A Study of ERP, SCM and CRM System Implementations. *Journal of Operations Management,* 25(1), pp. 65– 82.

HOLLAND, C. P., LIGHT, B., 1999. A critical success factors model for ERP implementation. *IEEE Software*, May/June 16(3), pp.30–36.

JACOBSON, S., SHEPHERD, J., D'AQUILA, M., and CARTER, K., 2007. *The ERP Market Sizing Report, 2006–2011*. Boston: AMR Research. 33 p.

KARIMI, J., Somers, T.M. and BHATTACHERJEE, A., 2007. The impact of ERP implementation on business process outcomes: a factor-based study. *Journal of Management Information Systems*, Vol. 24 No. 1, pp.101–34.

KLAUS, H., ROSEMANN, M. and GABLE, G.G., 2000. What is ERP?. *Information System Frontiers,* 2 (2), pp.141–162.

LIANG, H., SARAF, N., HU, Q. and XUE, Y., 2007. Assimilation of enterprise systems: The effect of institutional pressures and the mediating role of top management. *MIS Quarterly*, March, 31(1), pp.59–87.

MARKUS, M.L. and TANIS, C., 2000. The enterprise systems experience – from adoption to success. In: Zmud, R.W. (ed.). *Framing the Domains of IT Research: Glimpsing the Future Through the Past*, Pinna ex Educational Resources, Cincinnati, OH, pp.173–207.

MARKUS, M.L., AXLINE, S., PETRIE, D., and TANIS, C., 2000. Learning From Adopters Experiences with ERP: Problems Encountered and Successes Achieved. *Journal of Information Technology*, 15, pp.245–265.

MOTWANI, J., SUBRAMANIAN, R. and GOPALAKRISHNA, P., 2005. Critical factors for successful ERP implementation: exploratory findings from four case studies. *Computers in Industry,* 56, pp.529–544.

NAH, F., K. ZUCKWELLER. and J. LAU., 2003. ERP Implementation: Chief Information Officers' Perceptions of Critical Success Factors. *International Journal of Human-Computer Interaction*, 16(1), pp.5–23.

PLANT, R. and WILLCOCKS L., 2007. Critical Success Factors in International ERP Implementations: A Case Research Approach. *The Journal of Computer Information Systems*, 47, 3, pp.60–70.

RANGANATHAN, C. and BROWN, C.V., 2006. ERP investments and the market value of firms: Toward an understanding of influential ERP project variables. *Information Systems Research*, 17, 2, 145–161.

ROCKART, J. F., 1979. Chief executives define their own data needs. *Harvard Business Review*, Vol. 57 Issue 2, pp.81–93.

SHANG, S. and SEDDON, P., 2000. A comprehensive framework for classifying the benefits of ERP systems. In: Proceedings of AMCIS2000, vol. II, pp.1005–1014

SOMERS, T. and NELSON, K., 2001. The impact of critical success factors across the stages of enterprise resource planning implementations. *Proceedings of the 34th Hawaii International Conference on System Sciences HICSS*. pp.1–10.

STRATMAN, J. K., 2007. Realizing benefits from enterprise resource planning: Does strategic focus matter? *Production and Operations Management,* 16(2), pp.203–214.

TELTUMBDE, A., 2000. A framework of evaluating ERP projects. *International Journal of Production Research,* 38, pp.4507–4520.

APPENDIX A: QUESTIONNAIRE

Let us know a little about you and you role in the ERP implementation project you participated

What was your role in this project?

1. I was a manager, responsible for a business area
2. I was a key user
3. I was an IT employee
4. I was an external consultant
5. Other (not listed)

For how long were you involved in this project?

1. Less than 6 months
2. 6 months to 1 year
3. 1 year to 2 years
4. More than 2 years

About your location DURING the project:

1. I was working at the same location with the majority of the project team (70% of the time)
2. I was working in a different location (70% of the time)
3. I was NOT working in only one location most of the time

Using the scale below, please rate the following outcomes of the ERP implementation.

0. Don't Know
1. Disagree Strongly
2. Disagree
3. Neutral
4. Agree
5. Agree Strongly

1. The project final cost meet the project expectations.

2. The project was completed as scheduled.
3. The delivered system functionality is coherent with the project scope.
4. The project was a success

Using the same scale opine, for each statement bellow, how you rate its importance to achieve the three outcomes above.
If you think a statement does not match (or was not present at all) during the implementation rate it as not important even if you personally think it is important for an ERP implementation.

1. Strong presence of a company's executive in all phases of the project (O1-1)
2. Help and commitment from company's leaders (O1-2)
3. Company's willingness to allocate resources for the project (O1-3)
4. Have a business executive level individual as the project champion (O2-1)
5. Champion help on monitoring the project (O2-2)
6. Champion accountability regarding the project (O2-3)
7. Get formal sign-off from project champion (or steering committee) during the project phases (P1-1)
8. Proper integration of people, process and technology (P1-2)
9. Formal change management process (P2-1)
10. Have a detailed project plan (P1-3)
11. Have the right ERP implementation strategy (P1-4)
12. Track implementation cost very closely (P2-2)
13. Having a strong and present steering committee (P2-3)
14. Controlling project scope (P2-4)
15. Actively monitoring and tracking of milestones (P4-1)
16. Project evaluation after project completion (P4-2)
17. Develop performance measures for system (P4-3)
18. Troubleshooting errors during the implementation phase (P3-1)
19. Adequate development procedures (P3-2)
20. Extensive system testing (P3-3)
21. Flexible implementation plan (P3-4)
22. IT infrastructure ready to support implementation (P3-5)

23. Carefully pick the employees for the ERP project team (H1-1)
24. Have the project team solely designated to the ERP implementation (H1-2)
25. Have a cross-functional project team (H1-3)
26. Employees alignment with the project (H1-4)
27. Include all direct affected employees in the implementation (H1-5)
28. Knowledge transfer from consultants to the company (H2-1)
29. Support of external consultants (H2-2)
30. Have project team members take ownership (H3-1)
31. Project team is empowered to make necessary decisions (H3-2)
32. Train employees extensively (C1-1)
33. Team (includes everyone involved in the project) motivation (C1-2)
34. Train technical staff to support new system (C1-3)
35. Communicate effectively with employees about the project (C2-1)
36. Alignment between ERP process and business process (C2-2)
37. Properly communication within the project team and key individuals (C2-3)
38. Effective communication plan (C2-4)
39. Communication abut project progress with stakeholders (C2-5)
40. Map out business processes (B1-1)
41. Willingness to change business process to fit ERP process (B1-2)
42. Standardize the business processes to the extent possible (B1-3)
43. Avoiding customization (B2-1)
44. Knowledge about the existing systems (B3-1)
45. Ensure accuracy and no loss during the data conversion process (from old to new system) (B3-2)
46. Evaluate the ERP package before the implementation (E1-1)
47. Have a clear vision for the ERP implementation project (E1-2)
48. Have a business plan aligned with the ERP project (E1-3)
49. The chosen ERP system was the right one for the company (E2-1)
50. Well done ERP selection process (E2-2)