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HIERARCHICAL EXAMINATION OF SUCCESS FACTORS ACROSS ERP LIFE-CYCLE

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Abstract

This study investigates critical success factors (CSF) in implementing Enterprise Resource Planning (ERP) systems. It reviews 94 such factors discussed in journals, conference proceedings and books, published for the most part in the last decade, covering the full lifecycle of ERP systems. Questionnaires exploring these 94 factors were submitted to hundreds of respondents, divided into five groups. The authors of the study hypothesize that the 94 success factors can be grouped, in overall and in each phase of ERP life cycle, under several extracted construct emerged from a statistical extraction method accompanied by business logic coming up with a term that best describes the content domain of the attributes that weight highly on relevant construct. This study presents an examination process of validity, principal component, similarity, reliability and multicollinearity analyses for hierarchical formations of success factors for the entire ERP life cycle and for each one of the six ERP life cycle phases (planning, implementation, stabilization, backlog, new module and major upgrade). This research exhibits for each ERP life cycle phase the main sub factors that explain the main themes of ERP implementation for the most. Special attention is given to: (a) earlier research on CSFs for ERP implementations, (b) hierarchical formation of parent and sub-factors in overall and in each phase of ERP life cycle and (c) representative meanings of critical success factors needed to be considered and how they should be managed across the ERP life cycle.

Keywords: Enterprise Resource Planning, Critical Success Factors, Life cycle, Principal component analysis, Formative model.

1. INTRODUCTION

Organizations perceive ERP as a vital tool for organizational competition as it integrates dispersed organizational systems, and enables flawless transactions and production. Successful implementation of an ERP system can reduce costs such as inventory, production, shipping, labor and IT maintenance, and thus lead to greater effectiveness and a better competitive edge in terms of improved strategic initiatives and responsiveness to customers (O'Leary 2000, Rashid & Hossain & Patrick 2002, Sandoe & Corbitt & Boykin 2001, Seethamraju & Seethamraju 2008). As a result ERP is perceived as playing an important role in today's enterprise management by contributing to business vision and strategy along with day to day operational, managerial, organizational and technical issues. Therefore ERP system is becoming the backbone of many organizations (Al-Mashari & Al-Mudimigh & Zairi 2003, Parthasarathy & Anbazhagan & Ramachandran 2007).

An important topic in the ERP implementation literature is to identify or develop critical success factors. Some articles generate a list of the critical success factors and others analyze data regarding these factors (Moon 2007). However, some studies criticize the current literature for providing different sets of critical success factors. In addition, few studies on critical success factors for ERP implementation have presented in-depth analyses of sub factors (Nah & Zuckweiler & Lau 2003, Ngai & Lau & Wat 2008).

2. LITERATURE REVIEW

Esteves and Pastor (2006) noted that the CSF approach has been applied to many aspects of information systems, and more recently to ERP system implementations in order to identify and develop the factors determining the success or failure of an ERP implementation based on the study of prior implementation experiences and empirical study. These studies of the critical success factors affecting ERP implementation have examined different dimensions. Some have explored sociological and technological features while others have looked at tactics and strategy (Chiasson and Davidson 2005). These studies of the critical success factors affecting ERP implementation have examined different dimensions. Some have explored sociological and technological features while others have looked at tactics and strategy (Chiasson and Davidson 2005). Figure 1 summarizes these CSF dimensions.

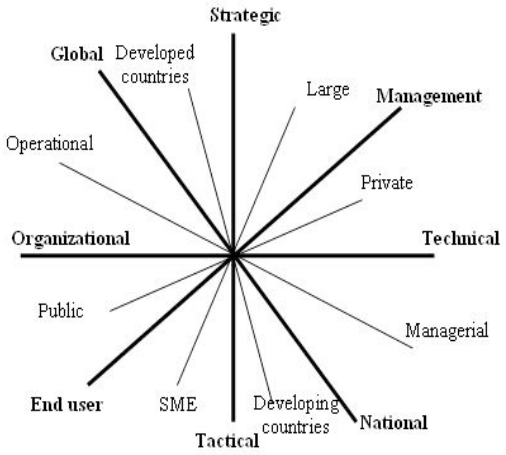

Figure 1- critical success factors dimensions

Table 1 presents several dimensions and examples of critical success factors studies based on these dimensions.

Dimension	Examples of studies
Global – National	Colmenares 2004, Grant 2003, He & Brown 2005, Soja 2004
Organization – End user	Amoako-Gyampah 2004, Esteves & Pastor 2000, Skok & Legge 2002
Operational – Managerial	Al-Mudimigh et al. 2001,Amoako-Gyampah 2004, Murray & Coffin 2001
Public sector – Private sector	Chang & Gable 2001, Gable & Trimbell 2002
LEs – SMEs	Buonanno et al. 2005, Rao 2000, Wu & Wang 2003
Developed–Developing countries	Huang & Palvia 2001, Ngai et al. 2008

Table 1 – Examples of studies conducted on different dimensions

This research of hierarchical formation of ERP success factors is based on 94 success factors identified through an exhaustive and comprehensive literature review. The full list of these success factors for ERP systems is presented, only in post research hierarchical formation format, in Table A-1 in the appendix.

Another stream of ERP research has been to examine the impact of critical success factors in the context of the life cycle (Al-Mashari et al. 2003, Esteves & Pastor 2006, Nah & Kuanget & Lau 2001, Palaniswamy 2002, Parr & Shanks 2000, Shanks et al. 2000, Somers & Nelson 2001). ERP life cycle, widely cited in the literature, includes four fundamental phases: planning, implementation, stabilization of the ERP system into normal operation and enhancement in which the business process is continuously improved and additional user skills are delivered. The authors posit that one should break the enhancement phase into three specific phases that can be more detailed and adequately describe the selective phases that organization may go through.

Motiwalla and Thompson (2009) have defined these three sub phases of enhancement: backlog, new module and major upgrade. While new module and major upgrade phases are quite understood, one should be clear with the definition of the backlog phase. Although ERP systems offer broad functionality for supporting all the core functions of an organization, it has been found that many expected benefits from ERP are not realized and, due to environmental changes, users' requirements for ERP system will also change and be increased along the utilization (Gargeya & Brady 2005). Therefore, there is still a need to continuously adapt and enhance an ERP after its' implementation to meet users' dissatisfaction regarding expectations and requirements backlog due to the gap between them and the actual functionality and benefits delivered by the ERP (Motiwalla &Thompson 2009).

Sun and Yazdani and Overend (2005) and Srivastava and Teo (2004) posited that few small and medium sized enterprises (SMEs) have the resources to adequately address every CSF as they should. As a result SMEs are forced to make implementation compromises according to resource constraints, which increase the risks involved in the implementation process. Thus, splitting the parent factors into more detailed sub factors is needed.

Thus, there is a need to address the sub factors of each parent factor to deliver a more qualitative analysis of the impact of each factor on ERP implementation success. This study provides a deeper empirical examination in order to enhance overall understanding of the implementation process and presents a thorough and comprehensive framework of critical success factors in terms of both the macro and micro implementation. Therefore, the joint study of success factors along the different ERP life cycle phases can promote better understanding of steps towards ERP implementation and a greater degree of success.

3. RESEARCH METHODOLOGY

In this study, the authors hypothesize that the 94 success factors can be grouped under several extracted constructs (i.e. parent factors) emerged from a statistical extraction method accompanied by business logic coming up with a term that best describes the content domain of the attributes that weight highly on relevant factor. Our main goal is to deliver practical guidelines concerning which the parent CSFs and the sub CSFs need to be considered and how one should manage them. This leads to the second goal; namely an analysis of how these sub factors should be utilized in the different implementation phases to exploit the parent factors to their full potential.

3.1 Data sample

The authors have developed a structured questionnaire exploring these 94 factors which was examined by experienced ERP consultants for completeness and clarity in a series of interviews. One advantage gained through the process of research measurement validation, according to Punch (2003), is a better

understanding of the time needed for respondents to fulfil the questionnaire in a qualitative and trustworthy manner. Based on the large number of factors and the quite long time needed to fulfil the questionnaire in first place, among other insights arose throughout this process, the authors have decided on splitting the questionnaire into five shorter questionnaires. In each questionnaire the maximum number of factors is 45 while each factor is included in at least two questionnaires as illustrated in Figure 2. The questionnaires were developed based on a structured interview method that ensures reliably aggregated answers that can be compared with confidence.

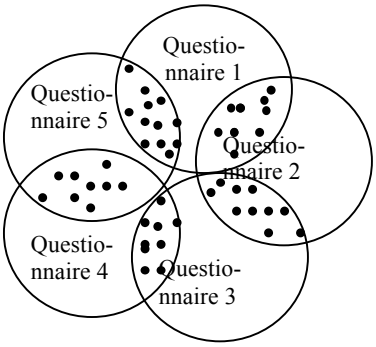

Figure 2 Mapping of questionnaires and items. Dots represent

These five questionnaires, containing 30, 41, 33, 40 and 44 factors, respectively, were developed and mailed, from April to September 2009, using Qualtrics web site which provides survey platform for designing, distributing and evaluating survey. The 478 potential respondents, working in SMEs organizations in which an ERP system was implemented and are located in the middle-east, were selected to review the questionnaire based on one fundamental criterion of using an ERP system at each working day for at least half an hour. The respondents were classified into five groups while each group of respondent was asked to review a specific questionnaire. 137 responses were returned with a response rate of 28.7%. Of these, 24 were returned blank or incomplete, resulting in net mailing of 113 respondents, representing a net response rate of 23.6%. The respondents were asked to assess the sub factors importance in each ERP life cycle phase resulting in six different assessments. Due to the low response rate the authors have conducted second round of interviews, from January to May 2010, only this time based on many attendees gatherings at which the respondents have reviewed the specific given questionnaire without being influence by other respondents. For both periods the authors have put much effort and thought on dividing the respondents to similar groups according to respondents' characteristics such as age, gender, experience in ERP, ERP modules usage among other.

Due to the aforementioned method, this study has collected an overall number of 395 complete questionnaires by the five groups of with a total number of 64, 85, 71, 83 and 92 questionnaires returned, respectively. The questionnaires assessment was based on a 5-point Likert scale (plus "irrelelevant"). Table 2 presents a general view of the respondents' assessment for one factor.

Sub Factor: Full time team members		Description: Team members need to be fully released from other duties during the ERP implementation project and not distracted by other roles.			
The importance of 'Full time team member' in					
Planning	Implementation	Stabilization	backlog	new module	major upgrade

Table 1 - A general view of assessment given by the respondents

Due to the aforementioned method, this study has collected an overall number of 90,606 assessments for all sub factors across the ERP life cycle. If these 94 factors were assessed by all 395 respondents across six ERP life cycle phases then the overall number of assessments was 222,780 (94*6*395). Since the respondents reviewed part of the 94 factors, due to the consideration of the time needed to fulfil the questionnaire in a qualitative and trustworthy manner, the full potential of assessments was not reached. The overall assessments obtained in this study are presented in Table 3.

Number of sub factors	94
Minimal number of reviews for each sub factor	41
Maximal number of reviews for each sub factor	52
Overall number of assessments for all sub factors across the ERP life cycle	90,606

Table 3 The overall assessments obtained in this study

In order to assure full and reliable assessments by the respondents, they were given a special guidance document describing in detail the meaning of all the ERP life cycle phases that an organization needs to face, and the exact meaning of each sub factor in each phase of ERP life cycle.

3.2 Data analysis strategy

According to Petter and Straub and Ray (2007) researches must not ignore the relationship between measurement items and constructs. Diamantopoulos and Siguaw (2006) presented implications for practising researchers seeking to develop multi-item measures which assist in the design and validation of formative and reflective measurement models. According to their study the authors posit that a formative measurement model may be more appropriate than a reflective model based on the following theoretical considerations. First, the measurement items describe and define the constructs rather than vice versa. Second, a change in the items is assumed to result in a change in the construct under study. Third, the domain represented by the construct is sensitive to the number and types of measurement items selected to represent the construct, items are not interchangeable and as a result adding or removing an indicator can change the conceptual domain of the construct. Fourth, measurement items are not evoked by the underlying construct and hence have no preconceived pattern of inter-correlation as they can theoretically possess high inter-correlation, low, or not to at all.

Petter et al. (2007) posit that principal component analysis, rather than common factor analysis, should be applied to evaluate reduced dimensionality of the measures since the formative constructs' objective is to retain unique variance of each measure and not just the shared variance among measures.

The analysis process was designed to validate and empirically evaluate the causal relationships among sub factors and to propose a hierarchical formation of parent and sub-factors across the ERP life cycle. Three tests were conducted: (a) validity examination (b) principal component analysis, (c) reliability analysis and (d) Multicollinearity analysis.

3.2.1. Validity analysis

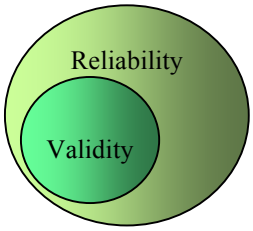

Figure 3 Reliability and validity containing relationship.

Although a test is proven to be reliable, its results may not be valid since stable results do not necessarily share validity. A visual representation of this argument is shown in Figure 3. Given that formative constructs are defined by the measurement items that form them, it is absolutely imperative to establish content validity as important aspects can be left out, and this will result in a misspecification of the constructs. To establish content validity, two common methods, mentioned by Petter et al. (2007), were used: literature review to scope the domain of the construct and expert panels. Thus, beyond the literature review, the research measurement instrument was pilot examined for completeness and clarity in a series of interviews with two experienced ERP consultants. Based on their comments, a second examination was conducted in which 15 different respondents were interviewed and asked to assess the meaning of the factors presented in each phase across the ERP life cycle. After validation by the two sequential surveys it was administered to the respondents.

3.2.2. Principal component analysis

Principal component analysis identifies groups of items based on multi item correlations. The use of principal component analysis can help reduce a large number of items into a few constructs by testing for a shared element, as it is a good method for exploring broad questions about the relationship between items in large sets of data (Hatcher 1994).

A construct is based on a linear combination of the correlation between the basic items (i.e. sub factors). Therefore each construct is developed based on those items that exhibit higher correlations. In order to obtain a general picture of the validity of the proposed clusters the authors examined the critical success factors in light of the entire ERP life cycle. The authors used SPSS software (version 17.0) and its Data Reduction Factorization Analysis procedure in order to explore the ERP success constructs (parent) in three stages: (a) creation of a correlation matrix between all sub-factors, (b) construction of parent factors based on the correlation matrix and (c) sub factor rotation, using varimax rotation method, which ensures an orthogonal approach toward these sub factors to obtain minimal constructs that are internally correlated.

3.2.3. Reliability test

The reliability test determines the extent to which the measurements resulting from a test are the result of characteristics of the features being measured. The authors used an internal consistency method that is closely associated with the reliability test and enables an empirical analysis of the measurement reliability. Internal consistency was measured by Cronbach's Alpha. Hair et al. (1995) indicate that the lowest acceptable value ranges between 0.60 and 0.70 while Fornell and Larcker (1981), Nunnally (1978) recommend a Cronbach's Alpha limit of 0.70 for reasonably high reliability of the research measures and constructs.

3.2.4. Multicollinearity test

Unlike reflective measurement items where multicollinearity between construct items is desirable, illustrated by high Cronbach's alpha or internal consistency scores, excessive multicollinearity in formative constructs can destabilize the model. If measures are highly correlated, it may suggest that multiple indicators are tapping into the same aspect of the construct. Therefore, in order to ensure that multicollinearity is not present, multicollinearity test is performed using the variance inflation factor statistic (VIF). Although general statistics theory posit that multicollinearity occurs if the VIF value is higher than 10, the authors test multicollinearity for a strict VIF threshold of 3.3 due to model destabilization consideration (Diamantopoulos & Siguaw 2006).

4. RESULTS

The following analyses have been performed several times, first for the entire ERP life-cycle as an overall and sequentially for each one of the six ERP life-cycle phases.

4.1 Principal component analysis

The principal component analyses for the different groups and the entire ERP life-cycle have revealed several constructs, all of which share common domain as presented in Table 4. The overall weight values for all sub factors within the constructs and for all respondents groups are not shown here due to space constraints.

Group 1	Group 2	Group 3	Group 4	Group 5
Vendor	Project team competence	Data Management	Vendor	Project team competence
Project Management	Top management support	Education and training	Project management	Top management support
Data Management	Education and training	Package selection	Implementation strategy	ERP System

Change management	ERP System	Software development	Software development	Implementation strategy
Organizational characteristics	Package selection	Change management		Environment
	Monitoring management	Organizational characteristics		
	User involvement	Monitoring management		
	Environment	User involvement		
	Project team competence	Data Management		

Table 4 Constructs derived through principal component analysis for the entire ERP life-cycle

Since the measurement items (i.e. sub factors) were examined by two different groups of respondents, as presented in Figure 2, and grouped under different instances of constructs through two principal component analyses, the authors have performed similarity examination between these constructs. Similarity rate is measured by counting the congruent sub factors among the constructs that were theoretically found to describe similar domains. This examination reveals high similarity rate of constructs' items.

4.2 Post principal component analysis

4.2.1 Constructs' reliability test

As mentioned earlier, the reliability test was performed using an internal consistency test. All the derived constructs were found reliable according to the following Cronbach's alpha values, presented in Table 5 in relation to a reliability threshold (0.60) defined Hair (1995), while most of them were found reliable in relation to a strict threshold (0.70) defined by Fornell & Larcker (1981) and Nunnally (1978).

Construct	Minimal reliability	Maximal reliability
Careful package selection	0.660 (N=3)	0.757 (N=3)
Change management.	0.673 (N=5)	0.720 (N=4)
Data Management	0.663 (N=6)	0.716 (N=5)
Education and training	0.671 (N=4)	0.738 (N=3)
Environment	0.679 (N=5)	0.712 (N=5)
Implementation strategy	0.685 (N=17)	0.754 (N=13)
ERP System	0.674 (N=7)	0.705 (N=6)
Monitoring management	0.711 (N=3)	0.743 (N=3)
Organizational characteristics.	0.719 (N=5)	0.732 (N=4)
Project Management	0.701 (N=14)	0.733 (N=11)
Project team competence	0.674 (N=8)	0.714 (N=7)
Software development	0.716 (N=6)	0.776 (N=4)
Top management support	0.651 (N=10)	0.729 (N=8)
User involvement and participation	0.691 (N=4)	0.730 (N=3)
Vendor	0.705 (N=6)	0.719 (N=6)

Table 5 Minimal and maximal reliability values of constructs

Most of the sub factors showed a reduction in Cronbach's alpha of parent factors if deleted; i.e. deleting them from the measurement instrument lowers its reliability. However, few sub factors, if deleted, indicated an increase, although not significant, in the Cronbach's alpha value. The combination of the least

significant increase in Cronbach's alpha if these few sub factors are deleted and their high levels of correlations with all other sub factors, led to the decision to keep them grouped under its construct.

4.2.2 Constructs' multicollinearity test

In order to ensure that multicollinearity is not present so multiple indicators are not tapping into the same aspect of the construct, multicollinearity test was performed using the variance inflation factor statistic (VIF) for each derived construct. Most of the cases did not show VIF values higher than the defined threshold of 3.3. For the few cases of higher VIF values the authors have performed two examinations. First, removing correlated items if content validity is not affected using stepwise regression. Second, collapsing correlated items into different construct under which it was grouped by another group of respondents, or into new composite construct in case it was not grouped. Constructs in which multicollinearity was found and their measurement items that were found intra-correlated with other items are presented in Table 6.

Construct found for multicollinearity	Measurement items found correlated
Implementation strategy	Deep understanding strategy
	Suitability of software and hardware considerations
	Planning required upgrades and computer compatibility
Organizational characteristics	Interdepartmental communication
Vendor	Professional training services
Software development	Developing a plan for migrating and cleaning up data

Table 6 Constructs in which multicollinearity was found and its' correlated measurement items.

All of the correlated measurement items found were grouped under different construct.. A VIF statistic was tested again to ensure that multicollinearity is not present for the new construct under which the formerly correlated measurement is grouped. All of the following VIF tests did not show multicollinearity.

5. DISCUSSION

The study hypothesize that the 94 success factors can be grouped under several extracted constructs, as an overall and in each phase of the innovative ERP life cycle defined, are accompanied by business logic coming up with a term that best describes the content domain and take into consideration the different aspects of enhancement phases and more adequately describe the selective phases that organization go through. The evaluation of the parent and sub factors hierarchy was based on analysis of the multi item correlations between these 94 sub factors using principal component, validity, reliability and multicollinearity analysis. The hierarchical formation of constructs (i.e. parent factors) and its' measurement items (i.e. sub factors) for the overall ERP life cycle is presented in Table A-1 in the appendix. The other six hierarchical formations of constructs and their measurement items for each phase in the innovative ERP life cycle are presented in Tables A-2 through A-7 in the appendix.

This examination process of validity, principal component, similarity, reliability and multicollinearity analyses for the entire ERP life cycle and for each one of the six ERP life cycle phases enables the assessment of: (1) the general hierarchical formation of ERP success factors and (2) the main sub factors that explain the main themes of ERP implementation for the most. Moreover, from the authors' point of

view, the possible modifications should not be accepted and should be referred within the original generated construct in order to provide it the deserved sensitive treatment, although they do have some relevance in reference with the alternative constructs.

6. CONCLUSION

This study can serve as a checklist that covers all possible important success factors associated with ERP implementation as an overall and in each phase of ERP life cycle. The main objective was increasing understanding of the factors affecting not only initial ERP implementation but also long term implementation by taking into account future enhancements: backlog, new modules and major upgrades.

The creation of a hierarchy of parent and sub factors has several benefits and applications. First, it is framed in terms of practical guidance that is meaningful to practitioners and avoids simplistic overemphasis on a single factor. Furthermore, it explicitly recognizes the role of factors outside and inside the organization's direct control. This hierarchy can help practitioners assess a large number of potential problems that may arise in future deliveries, and analyze plans, intentions and decisions in light of changing internal and external conditions. It can also assist practitioners in tracing problems back to earlier phase requirements and decisions. Based on the detailed investigation of the exact meaning of each sub factor that an ERP adopting organization has to face across the ERP life cycle, this research delivers practical guidelines to the ways in which critical success factors should be managed during the difficult ERP implementation process. Representative examples are presented in appendix B. As a result ERP implementation should be considered as a sociological-organizational-technical-managerial-strategic-operational process sharing a macro-implementation perspective rather than a technical-innovative process along with a micro-implementation perspective (Al-Mudimigh et al. 2001). More ERP life cycle focused research efforts are necessary to validate the critical success factors along the ERP life cycle in order to achieve a successful implementation. Moreover, the generalizability is an important aspect in the trustworthiness of this study that the authors are doubtful about. The sample for this study contained respondents mainly from SMEs and therefore this research, although it is not generalized, delivers strong indication about the reality of the ERP implementation for SMEs. More research efforts are necessary to investigate the hierarchical formation that explains the main themes of ERP implementation is large enterprises as well.

7. LIMITATIONS

It could be claimed that the heterogeneity of the sample is a limitation. Previous studies have shown however that most of the top priority issues for the different groups were rated similarly (Chang 2004). Yet, the present study did not include organizational size since most of the respondents' experience relates to SMEs organizations. However, SMEs organizations are likely to face much greater constraints than large enterprises in terms of resources that can be committed to all stages and information gathering in order to reduce uncertainty, whereas the complexity and extent of IT functionality and integration requirements are often similar (Bernroider & Leseure 2005, Srivastava & Teo 2004). Another limitation is that this research only surveyed respondents working in the local market. Nevertheless, these respondents are making use of ERP system delivered by main global ERP vendors. Moreover, the differences in the scope of the implementation in general and differences due to organizational, technological and environmental factors make it difficult to present a global perspective on implementation.

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Appendix A –

Vendor	Education and training
ERP vendor characteristics	Education and training to technical staff
Partnership with vendor	Education and training to end users
Vendor support	Education on future business processes
Use of vendors' tools	Developing a clear education and training plan
Keeping suppliers and customers informed	**Top management support**
Project Management	Management and project steering committees
Scope creep Management	Willingness to become involved
Knowledge transfer management	Developing an understanding of the needs, capabilities & IT limitations
Management of conflicts	Exhibiting strong commitment
Management of legacy systems	Resolving political conflicts
Clear and defined project plan	Business vision
Planning required upgrades	Willingness to adopt modern technologies
Management of expectations	Allocating valuable resources
Management of risks	**User involvement**
Project tracking	User participation in the overall process approach
Total quality management approach	User uses the system according to guidance
Interdepartmental communication	Users' trust
Professional training services	Using ERP to fulfill cross functional areas
Setting realistic deadlines	**ERP System**
Change management	Level of Customization
Change management program	System flexibility to changing conditions
Understanding the political structure	System integration
User participation in defying new processes	Systems reliability
Understanding the organizational culture	System interoperability
Project team competence	System cross functionality
Team finest cross functional knowledge	System support
	Suitability of software and hardware considerations
Good relations between project team and users	**Environment**
Team morale and motivation	Opportunities for growth
Full time team members	Competition in industry
Balanced and cross functional project team	External pressure

Staff retention	Competitors' adoption of ERP
Empowered decision makers	Uncertainty about environment
Deep understanding strategy	**Data Management**
Organizational characteristics	Data analysis Plan
Former major change experience	Data model is compatible with data requirements
Having in place advanced technology	Data quality control
Former major IT change experience	Developing a plan for migrating and cleaning up data
Interdepartmental coordination	Data conversion Plan
Implementation strategy	Data accuracy
Use of consultants	**Package selection**
Decision making process style	Careful and professional package selection process
Focused performance measures plan	Fit between ERP and business process, information needs and strategic goals
Planning the cost of ERP implementation	Planning the package selection process
Regard as a technological ,business ,and organizational project	**Software development**
Alignment between business strategy and IT strategy	Developing a plan for testing interfaces with integrated legacy systems
Ensuring fair time to fulfill the implementation	Developing proper troubleshooting tools
Business change is first to be considered	Working closely with vendors and consultants to resolve software problems and troubleshooting errors
Architecture choices	Developing proper troubleshooting skills and techniques for the IT workers
Open and honest communication	Planning and Establishing Software development, testing and troubleshooting architecture
Functional requirements are clearly defined before deciding on ERP adaptation	**Monitoring management**
Continues focus on organizational resistance	Monitoring and evaluation of performance metrics
Level of implementation acceleration	Monitoring progress against clear milestones
Project champion	User acceptance feedback management

Table A-1: 94 critical success factors grouped under 15 categories/headings for the overall life cycle

Vendor	**Education and training**
ERP vendor characteristics	Education and training to technical staff

Partnership with vendor	Education on future business processes
Vendor support	Developing a clear education and training plan
Use of vendors' tools	**Top management support**
Project Management	Management and project steering committees
Scope creep Management	Willingness to become involved
Management of conflicts	Developing an understanding of the needs, capabilities & IT limitations
Management of legacy systems	Exhibiting strong commitment
Clear and defined project plan	Resolving political conflicts
Management of expectations	Business vision
Monitoring progress against clear milestones	Willingness to adopt modern technologies
Planning and Establishing Software development, testing and troubleshooting architecture	Allocating valuable resources
Interdepartmental communication	**User involvement**
Professional training services	User participation in the overall process approach
Setting realistic deadlines	Users' trust
Change management	User participation in defying new processes
Change management program	**ERP System**
Understanding the political structure	Level of Customization
Understanding the organizational culture	System flexibility to changing conditions
Project team competence	System integration
Team finest cross functional knowledge	Systems reliability
Good relations between project team and users	System interoperability
Team morale and motivation	System cross functionality
Balanced and cross functional project team	Suitability of software and hardware considerations
Empowered decision makers	**Environment**
Deep understanding strategy	Opportunities for growth
Organizational characteristics	Competition in industry
Former major change experience	External pressure
Having in place advanced technology	Competitors' adoption of ERP
Former major IT change experience	Uncertainty about environment
Interdepartmental coordination	**Data Management**
Implementation strategy	Data analysis Plan
Decision making process style	Data model is compatible with data requirements

Planning the cost of ERP implementation	Data quality control
Regard as a technological ,business ,and organizational project	Developing a plan for migrating and cleaning up data
Alignment between business strategy and IT strategy	Data conversion Plan
Business change is first to be considered	Data accuracy
Open and honest communication	**Package selection**
Functional requirements are clearly defined before deciding on ERP adaptation	Careful and professional package selection process
Level of implementation acceleration	Fit between ERP and business process, information needs and strategic goals
Use of consultants	Planning the package selection process
Project champion	

Table A-2: 71 critical success factors grouped under 13 categories/headings for the planning phase

Vendor	**Education and training**
Partnership with vendor	Education and training to technical staff
Vendor support	Education and training to end users
Use of vendors' tools	Developing a clear education and training plan
Keeping suppliers and customers informed	**Top management support**
Project Management	Management and project steering committees
Scope creep Management	Willingness to become involved
Knowledge transfer management	Exhibiting strong commitment
Management of conflicts	Resolving political conflicts
Clear and defined project plan	Willingness to adopt modern technologies
Management of risks	Allocating valuable resources
Project tracking	**User involvement**
Total quality management approach	User participation in the overall process approach
Professional training services	Users' trust
Change management	Using ERP to fulfill cross functional areas
Change management program	**ERP System**
Understanding the political structure	Level of Customization
User participation in defying new processes	System flexibility to changing conditions
Understanding the organizational culture	System integration

Project team competence	Systems reliability
Team finest cross functional knowledge	System interoperability
Good relations between project team and users	System cross functionality
Team morale and motivation	System support
Full time team members	Suitability of software and hardware considerations
Balanced and cross functional project team	**Environment**
Staff retention	Opportunities for growth
Empowered decision makers	Competition in industry
Deep understanding strategy	External pressure
Organizational characteristics	Uncertainty about environment
Former major change experience	**Data Management**
Having in place advanced technology	Data analysis Plan
Former major IT change experience	Data model is compatible with data requirements
Interdepartmental coordination	Data quality control
Implementation strategy	Developing a plan for migrating and cleaning up data
Use of consultants	Data conversion Plan
Decision making process style	Data accuracy
Focused performance measures plan	**Software development**
Regard as a technological ,business ,and organizational project	Developing a plan for testing interfaces with integrated legacy systems
Alignment between business strategy and IT strategy	Architecture choices
Ensuring fair time to fulfill the implementation	Developing proper troubleshooting tools
Business change is first to be considered	Working closely with vendors and consultants to resolve software problems and troubleshooting errors
Open and honest communication	Developing proper troubleshooting skills and techniques for the IT workers
Functional requirements are clearly defined before deciding on ERP adaptation	Planning and Establishing Software development, testing and troubleshooting architecture
Continues focus on organizational resistance	**Monitoring management**
Level of implementation acceleration	Monitoring and evaluation of performance metrics
Project champion	Monitoring progress against clear milestones
	User acceptance feedback management

Table A-3: 78 critical success factors grouped under 14 categories/headings for the implementation phase

Vendor
Partnership with vendor
Vendor support
Use of vendors' tools
Keeping suppliers and customers informed
Project Management
Scope creep Management
Knowledge transfer management
Management of conflicts
Management of legacy systems
Management of expectations
Management of risks
Interdepartmental communication
Change management
Change management program
Understanding the political structure
Understanding the organizational culture
Project team competence
Team finest cross functional knowledge
Good relations between project team and users
Team morale and motivation
Full time team members
Balanced and cross functional project team
Staff retention
Empowered decision makers
Organizational characteristics
Former major change experience
Having in place advanced technology
Former major IT change experience
Interdepartmental coordination
Implementation strategy
Use of consultants
Decision making process style

Education and training
Education and training to technical staff
Education and training to end users
Developing a clear education and training plan
Top management support
Management and project steering committees
Willingness to become involved
Exhibiting strong commitment
Resolving political conflicts
Willingness to adopt modern technologies
Allocating valuable resources
User involvement
User uses the system according to guidance
Users' trust
Using ERP to fulfill cross functional areas
ERP System
Level of Customization
System flexibility to changing conditions
Systems reliability
System interoperability
System cross functionality
System support
Environment
Opportunities for growth
Competition in industry
External pressure
Data Management
Data model is compatible with data requirements
Data quality control
Developing a plan for migrating and cleaning up data
Data accuracy
Software development
Developing a plan for testing interfaces with integrated legacy systems

Focused performance measures plan	Developing proper troubleshooting tools
Planning the cost of ERP implementation	Working closely with vendors and consultants to resolve software problems and troubleshooting errors
Regard as a technological ,business ,and organizational project	Developing proper troubleshooting skills and techniques for the IT workers
Alignment between business strategy and IT strategy	**Monitoring management**
Ensuring fair time to fulfill the implementation	Monitoring and evaluation of performance metrics
Business change is first to be considered	Monitoring progress against clear milestones
Open and honest communication	Continues focus on organizational resistance
Level of implementation acceleration	Project tracking
Project champion	User acceptance feedback management

Table A-4: 70 critical success factors grouped under 14 categories/headings for the stabilization phase

Vendor	**Education and training**
ERP vendor characteristics	Education and training to technical staff
Partnership with vendor	Education and training to end users
Vendor support	Education on future business processes
Use of vendors' tools	Developing a clear education and training plan
Keeping suppliers and customers informed	**Top management support**
Project Management	Willingness to become involved
Management and project steering committees	Exhibiting strong commitment
Scope creep Management	Resolving political conflicts
Knowledge transfer management	Allocating valuable resources
Management of conflicts	**User involvement**
Management of legacy systems	User participation in the overall process approach
Clear and defined project plan	User uses the system according to guidance
Planning required upgrades	Users' trust
Management of expectations	Using ERP to fulfill cross functional areas
Management of risks	**ERP System**
Total quality management approach	System flexibility to changing conditions
Interdepartmental communication	System integration
Change management	Systems reliability
Change management program	System interoperability

Understanding the political structure	System cross functionality
User participation in defying new processes	System support
Understanding the organizational culture	**Environment**
Project team competence	Competition in industry
Team finest cross functional knowledge	External pressure
Team morale and motivation	Competitors' adoption of ERP
Full time team members	Uncertainty about environment
Balanced and cross functional project team	**Data Management**
Staff retention	Data analysis Plan
Empowered decision makers	Data model is compatible with data requirements
Implementation strategy	Developing a plan for migrating and cleaning up data
Use of consultants	Data conversion Plan
Decision making process style	Data accuracy
Focused performance measures plan	**Software development**
Planning the cost of ERP implementation	Developing a plan for testing interfaces with integrated legacy systems
Regard as a technological ,business ,and organizational project	Developing proper troubleshooting tools
Alignment between business strategy and IT strategy	Working closely with vendors and consultants to resolve software problems and troubleshooting errors
Ensuring fair time to fulfill the implementation	Developing proper troubleshooting skills and techniques for the IT workers
Business change is first to be considered	Planning and Establishing Software development, testing and troubleshooting architecture
Architecture choices	**Monitoring management**
Open and honest communication	Monitoring and evaluation of performance metrics
Functional requirements are clearly defined before deciding on ERP adaptation	Continues focus on organizational resistance
Level of implementation acceleration	Monitoring progress against clear milestones
	User acceptance feedback management

Table A-5: 74 critical success factors grouped under 13 categories/headings for the backlog phase

Vendor	**Education and training**
ERP vendor characteristics	Education and training to technical staff

Partnership with vendor	Education and training to end users
Vendor support	Education on future business processes
Use of vendors' tools	Developing a clear education and training plan
Keeping suppliers and customers informed	**Top management support**
Project Management	Willingness to become involved
Scope creep Management	Developing an understanding of the needs, capabilities & IT limitations
Knowledge transfer management	Resolving political conflicts
Management and project steering committees	Willingness to adopt modern technologies
Management of conflicts	Allocating valuable resources
Management of legacy systems	**User involvement**
Clear and defined project plan	User participation in the overall process approach
Planning required upgrades	Users' trust
Management of expectations	Using ERP to fulfill cross functional areas
Management of risks	**ERP System**
Project tracking	Level of Customization
Total quality management approach	System flexibility to changing conditions
Interdepartmental communication	System integration
Professional training services	Systems reliability
Setting realistic deadlines	System interoperability
Change management	System cross functionality
Change management program	System support
Understanding the political structure	**Environment**
User participation in defying new processes	Opportunities for growth
Understanding the organizational culture	Competition in industry
Project team competence	External pressure
Team finest cross functional knowledge	Uncertainty about environment
Good relations between project team and users	**Data Management**
Team morale and motivation	Data analysis Plan
Full time team members	Data model is compatible with data requirements
Balanced and cross functional project team	Data quality control
Staff retention	Developing a plan for migrating and cleaning up data
Empowered decision makers	Data accuracy
Deep understanding strategy	**Package selection**

Implementation strategy	Careful and professional package selection process
Use of consultants	Fit between ERP and business process, information needs and strategic goals
Decision making process style	Planning the package selection process
Focused performance measures plan	**Software development**
Planning the cost of ERP implementation	Developing a plan for testing interfaces with integrated legacy systems
Regard as a technological ,business ,and organizational project	Developing proper troubleshooting tools
Alignment between business strategy and IT strategy	Working closely with vendors and consultants to resolve software problems and troubleshooting errors
Ensuring fair time to fulfill the implementation	Planning and Establishing Software development, testing and troubleshooting architecture
Business change is first to be considered	**Monitoring management**
Interdepartmental coordination	Monitoring and evaluation of performance metrics
Functional requirements are clearly defined before deciding on ERP adaptation	Monitoring progress against clear milestones
Project champion	User acceptance feedback management

Table A-6: 80 critical success factors grouped under 14 categories/headings for the new module phase

Vendor	**Top management support**
ERP vendor characteristics	Willingness to become involved
Partnership with vendor	Business vision
Vendor support	Willingness to adopt modern technologies
Use of vendors' tools	Allocating valuable resources
Project Management	**ERP System**
Knowledge transfer management	System flexibility to changing conditions
Management of conflicts	System integration
Management of legacy systems	Systems reliability
Clear and defined project plan	System support
Planning required upgrades	Suitability of software and hardware considerations
Management of risks	**Environment**
Total quality management approach	Opportunities for growth
Professional training services	Competition in industry

Setting realistic deadlines	External pressure
Project team competence	Competitors' adoption of ERP
Team finest cross functional knowledge	**Data Management**
Education and training to technical staff	Data analysis Plan
Good relations between project team and users	Data quality control
Team morale and motivation	Data accuracy
Full time team members	**Package selection**
Balanced and cross functional project team	Careful and professional package selection process
Staff retention	Fit between ERP and business process, information needs and strategic goals
Empowered decision makers	Planning the package selection process
Deep understanding strategy	**Software development**
Implementation strategy	Developing a plan for testing interfaces with integrated legacy systems
Use of consultants	Developing proper troubleshooting tools
Decision making process style	Working closely with vendors and consultants to resolve software problems and troubleshooting errors
Focused performance measures plan	Developing proper troubleshooting skills and techniques for the IT workers
Planning the cost of ERP implementation	Planning and Establishing Software development, testing and troubleshooting architecture
Alignment between business strategy and IT strategy	**Monitoring management**
Ensuring fair time to fulfill the implementation	Monitoring and evaluation of performance metrics
Business change is first to be considered	Monitoring progress against clear milestones
Open and honest communication	Project tracking
Functional requirements are clearly defined before deciding on ERP adaptation	
Level of implementation acceleration	

Table A-7: 58 critical success factors grouped under 12 categories/headings for the major upgrade phase

Appendix B –

Sub factor: Minimal customization
Short description: Consisting mainly on best practices with minimal package customization.
Planning:

1. Getting a critical decision of adopting an approach of making minimal package customization.

Implementation:

1. Supervision of the approach of minimal customization and controlling the critical and unavoidable customizations
2. Adopting without any further modification to the system all the simplified business processes that could be implemented and still meet about 80% (or more) of business requirements.
3. Reviewing users' requests to either higher level of business-system fit by further customize or additional functionality through bolt-on applications.

Stabilization:

1. Coping with end users claims ,at stabilization phase, for important functionality that requests major customization

Backlog:

1. Sticking to a policy of not customizing not crucial requirements that are given by default and are fulfilled at 80%.
2. Continues analysis of the possibility to convert current customized processes to best practice process (either by changing organizational process or by getting a build in similar process in new ERP package version) or by implementing additional functionality through bolt-on applications.

New module:

1. Taking into account, in deciding the future new modules delivery plan, the current and future resemblance of the planned module processes to the organizational processes

Major upgrade:

1. Taking into account, in deciding the future new infrastructure, the potential of eliminating current customizations and developments that were needed at that time.

Sub factor: Empowered decision makers

Short description: The project team decision should be empowered to make quick and effective decisions

Planning:

1. Empower the project manager to make important decisions regarding budgets, timeframes, goals, and delivery
2. Empower the project team to have access to main business processes
3. Empower the project manager to appoint business POCs.

Implementation:

1. Empower the project team to streamline customized business processes
2. Empower the project team to reinforce training programs to insure system acceptance

Stabilization:

1. Empower the project team to force business processes using the ERP implemented system to overcome user resistance to change.
2. Empower the project team to shut down legacy systems.
3. Empower the project team to be make decision regarding the short term program improving only the critical issues
4. Empower the project team to be make decision regarding the mid and long term programs improving the other necessary issues and their priorities as well.

Backlog:

1. Empower corporate middle management decision makers.
2. Empower corporate personnel decision makers (depends on big-bang/skeleton implementation approach
3. Empower customers and suppliers decision makers

New module:
1. Empower corporate personnel decision makers.
2. Empower customers and suppliers decision makers
Major upgrade:
1. Empower corporate IT personnel decision makers

Table B -1 representative meanings of critical success factors needed to be considered and how they should be managed across the ERP life cycle