

IMPLEMENTATION PROCESS OF ENTERPRISE RESOURCE PLANNING (ERP): EMPIRICAL VALIDATION

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ABSTRACT

Implementing an Enterprise Resource Planning (ERP) system project is a difficult and high cost proposition as it places tremendous demands on organization's time and resources. The ERP implementation literature contains many case studies of organizations that have implemented ERP systems successfully. However, many organizations do not achieve success in their ERP implementation projects. Much has been written about implementation and the critical success factors for ERP implementation projects. But there very few studies have scientifically developed and tested constructs that represent ERP implementation process stages and ERP success.

Based on a survey of 53 organizations in Australia, the results suggest that a 20 item instrument that measures seven dimensions of ERP implementation process stages is well - validated. It is found that the respondents perceive that all the implementation stages in the study propose are important to achieve success in ERP implementation. However, the implementation planning and installation are found to be statistically significant for the success of ERP implementation project. The results presented in this study are valuable to researchers and practitioners interested in implementing Enterprise Resource Planning systems.

Keywords: ERP, Implementation, Constructs development, ERP Success

1. INTRODUCTION

The business environment is changing dramatically and in order to stay competitive in the market, organizations must improve their business practices and procedures. Organizations within all departments and functions upgrade their capability to generate and communicate accurate and timely information. The organizations that have successfully implemented the ERP systems are reaping the benefits of having integrating working environment, standardized process and operational benefits. There has been horror stories of improper ERP implementation that has taken the companies to bankruptcy and in several cases organizations decided to abandon the ERP implementation projects. Not all ERP implementations have been successful. Some of the reasons cited in the literature are lack of support of top management support, resistance from employees, poor selection of ERP systems and vendor etc. Majority of these studies have used case studies to conclude their findings and very few have used the empirical to study the ERP implementation process and its success. This research is an attempt to extend the ERP implementation research by defining the conceptual domains constructs and operational measures specific to ERP implementation and success measure to advance ERP research. The objective of this paper is to develop an instrument for measuring ERP implementation process stages and success. We follow two step processes; first, we identify 5 constructs covering ERP implementation process and success. Second, because the constructs are latent variables, we apply a rigorous procedure for ensuring the psychometric adequacy of the resulting new multi-item measurement scales.

In the first section of this paper, literature review is discussed. Brief overview of the model development is presented in the second section. Third and fourth section provides detail on the preliminary scale development methodology and field database. Section 5 describes and reports on results. In the last, we conclude with a discussion of the implications of our results and usage of the scales, review the limitations of our study, and offer some concluding thoughts.

2 LITERATURE REVIEW

The implementation consists of the configuration of the ERP system and the introduction of corresponding organizational and technical changes, like the definition of new responsibilities or the design of new interfaces (Keller & Teufel, 1998). Implementation is defined for the purposes of this study as the process starting after the decision to acquire an ERP system has been made and ending when the ERP system has been released into use with full planned functionality and scope.

ERP implementation models have been based on either systems of development life cycle approach or innovation and/or diffusion, but these models lack in empirically validating the impact of these models on the implementation success. This study helps to fill the gaps and proposes a framework which comprises implementation of ERP systems and empirically testing constructs of this model every vendor has its own model, and large companies have their own practices. Several models on the implementation of ERP have been developed by the academicians, practitioners, consultants and vendors. Some framework/models were developed for a particular industry. However, the studies on validating these models are few in numbers. We conducted a cross-disciplinary literature review on ERP implementation, MIS, strategic management, innovation diffusion, and operations to develop a framework, construct definitions, and item generation for this study. This process yielded the baseline model depicted and a set of initial measurement scales for twelve theoretically important critical success factors.

Esteves and Pastor (2001) proposed ERP implementation process comprises of adoption decision, acquisition, implementation, use and maintenance, evolution and retirement phases. Markus and Tanis (2000) implementation model is based on the four phases namely: (a) Chartering- decisions defining the business case and solution constraints (b) Project- getting system and end users up and running (c) Shakedown—stabilizing, eliminating “bugs”, getting to normal operations (d) Onwards and upward – Maintenance systems, supporting users, getting results, upgrading system extensions. According to Chang and Gable (2000), improved understanding of ERP life-cycle issues is required for both fruitful research and effective implementation of ERP. The stages of their model are the following three: pre-implementation, implementation and post-implementation, involving respective activities such as (a) requirements definition, business case and software selection; (b) gap analysis, custom modification, project and change management; and (c) roll out, upgrades and payback review. Shanks (2000) proposed to distinguish between planning, implementing, stabilization and improvement. The ERP lifecycles described above can be consolidated and simplified to four phases: business engineering, system selection, system implementation, and system use and change. Bacncroft (1996) proposes an ERP lifecycle with a concentration on the early stages that includes focus, as it is to be, constructing, testing, and actual implementation. Gable (1998) suggests a lifecycle approach that consists of; the consulting process, selecting the ERP software, implementing the software and learning and knowledge transfer. Mandal & Gunasekaran (2003) described ERP implementation experience using a case study. The case study reveals some of the intricacies during the planning and implementation stages that may occur in a company. The success of ERP implementation depends on closely following pre-implementation, implementation and post-implementation stages. Al-Mashari (2002); proposed an integrative framework for ERP implementation based on an extensive review of factors and the essential elements that contribute to success in the context of ERP implementation. Rajagopol (2002) taps on innovation diffusion theory

and combines a process model and a causal model to frame ERP implementations. While the framework offers rich insights into ERP assimilation, it does not completely address the extended scope of ERP. ERP assimilation provides an empirical finding about the various ERP systems and their role in enhancing performance in an organization. According to Umble, Haft, Umble, (2003) every discontinuous process has three stages: initiating tasks, proper process, and terminating tasks. All projects start from some initiative. After initiative occurs, evaluation stage follows. This stage can include evaluation of business processes, requirement analysis, evaluation of different products.

Regarding ERP implementation success, the amount of prior research is limited to a handful of articles. Dong (2000) proposed a conceptual model for exploring impact of top management on ERP software implementation effectiveness. Rosemann and Wiese (2000) adapt the balanced scorecard approach to the evaluation of implementation and use of ERP software. Somers and Nelson (2001) explored the ERP success from the end-user point of view and proposed a socio-technical model for examining ERP software implementations. Hitt (2002) investigated the effects of ERP software implementation and use through statistical analysis of financial data. The findings shows that firms that invest in ERP tend to show higher performance across a wide variety of financial metrics and that even though there is a slowdown in business performance and productivity shortly after the implementation. Tan and Pan (2002) proposing models for the assessment of ERP success and article by Markus et al. (2000) proposing metrics for the measurement of ERP success, can be considered of a particular importance for the study at hand. White (1984) defined successful ERP implementation along two dimensions: (1) improved performance and (2) user satisfaction (Al-Mashari, 2002, Yusuf, 2004).

Even though some of these models are very detailed, their suitability is questionable because all of their stages can't be found from all implementation projects. Others cover only a part of implementation processes or might be too coarse for detailed reports. A new model has to be created to be able to carefully analyze an ERP system implementation process, in order to gain the big-picture. While many conceptual models of the ERP implementation have been developed but there has been a lack of research to extend and test these models. The model developed and validated in this paper is a contribution to the existing literature.

3 MODEL DEVELOPMENT AND CONCEPTUAL DOMAINS FOR ERP IMPLEMENTATION PROCESS

The proposed model is comprised of four phases namely, analysis, installation, final preparation and go live. The activities for each phase were determined based on the literature review and discussion with panel of experts. The proposed activities of each phase of ERP implementation process are empirically tested through a survey sent to Australian companies, and the results are presented in section 5. Most of the activities developed were agreed by the respondents and in a few cases additional items were suggested.

Drawing from multiple literature bases, we introduced an integrative, conceptual framework of what we call "integrated ERP implementation," which is comprised of a set of theoretically important constructs. This framework has been developed based on the project life cycle approach, in which the ERP implementation project goes through different phases before it goes live. There are number of factors that affect the ERP implementation process are termed in this study as implementation critical success factors. Upon the completion of ERP implementation project, performance is measured by a mix of outcomes.

Since the model constructs are latent variables, which cannot be measured directly, multi-item scales, each composed of a set of individual items, were needed to obtain indirect measures of each construct.

The items listed in this section represent the scales as drawn from the practitioners, and refined through an expert judge-based manual sorting process. These scales were further refined (and some items were dropped) as a result of an empirical test of a survey instrument containing these initial scales.

3.1 Implementation planning

It is the first phase of ERP implementation in which initial implementation plan is prepared, team members are selected (which could be new or roll over from the acquisition team), project scope and initial objectives are defined. In this phase as well the implementation strategies and outcomes are identified as well.

3.2 Installation

It is the second phase of Implementation process, activities such as hardware and network is installed according to the requirements of ERP system, configuration of ERP is conducted, system customization is performed and change management plan is executed.

3.3 Final Preparation

In this phase data from legacy system is imported to the new system, data is converted and system testing is performed. Moreover, the users are trained on the system.

3.4 Go Live

Going Live is the point in time in the ERP implementation, when the system is first used for actual production. In this phase, ERP system goes lives, progress is monitored and user feedback is reviewed.

3.5 ERP Implementation success

It is the satisfaction with the initial project requirements for going live, such as meeting deadlines, staying within budget and system performing as expected (Robey, Ross and Boudreau, 2000). It is argued that single item measures of ERP implementation does not accurately reflect the actual state of affairs. Success is a multi- dimensional construct and therefore, ERP implementation success is measured using several surrogates. In the proposed conceptual model a measure of success are included: the first is ERP acquisition success and the implementation success. Three descriptive statements are developed to measure the acquisition process success, which are adopted from the literature. The ERP implementation success is measured using the:

- a. The ERP system implementation was completed within time schedule.
- b. The ERP system implementation was completed within budget.
- c. Users are satisfied with the ERP system.
- d. Users find it easy to access information through the ERP system.

4.0 SCALE DEVELOPMENT FOR ERP IMPLEMENTATION PROCESS AND SUCCESS MEASURES

Scale development, or the design and re-refinement of multi-item scales employed to measure the constructs are vital to empirical research in management information systems (Stratman and Ruth, 2002). Establishing the validity of the scales is dependent first upon establishing that they are reliable measures

(Churchill, 1995). One of the goals of this research study is to create reliable and valid multi-item scales for measuring the 5 constructs described in Section 3. The content validity of these constructs was tentatively established by extensive literature reviews and interviews with managers and customers of technology-mediated services.

4.1 Item generation

The construct brief discussion provided in Section 3 are necessary, but not sufficient, to advance our understanding of the process and success of ERP implementation. Thus, the first step in constructing new multi-item measurement scales is to generate sets of items that tap into the latent constructs and permit us to accurately and reliably assess these constructs from management' perspectives (Churchill, 1995). Some of the constructs involved in this research have been operationalized in previous studies and scales were available for these constructs. However, none of the existing scales was exactly appropriate for re-application in the context of ERP implementation.

4.2 Iterative item refinement

To refine the scales, we adapted (Stratman and Ruth , 2002) widely used methodology for instrument development. This method recognizes that the complexity inherent in many business processes cannot be adequately measured by a single scale. Multi-item measures can reduce measurement error by providing a more robust construct of complex variables through averaging several individual items. The challenge is to develop a set of items that capture the essence of the construct with the desired reliability and validity. Churchill (1995) recommends an iterative process consisting of several steps.

After the initial item pool of process activities was generated, and then the items were purified. This purification step is designed to remove the potential for measurement error from the new construct to improve their reliability. Collecting data from an initial sample of respondents helps to address these issues. Specifically, a manual factor technique (Menor, 2000) was used to establish tentative scale reliability and validity, as well as to assess potential problems with the unidimensionality of the constructs. The manual sorting procedures was conducted iteratively, using independent panels of expert judges for each round. The judges had recent industry experience with the implementation and use of ERP software in a business environment.

Each expert judge was given a questionnaire containing short descriptions of each of the proposed constructs, together with a randomized list all of the items generated from the literature. In each round, the panel of expert judges was asked to assign each item to one of the identified constructs. Items that were not consistently grouped into their target construct during this process were considered for rewording or elimination. Note that this sorting procedure follows the technique described in (Moore and Benbasat, 1991), which differs from the traditional Q-sort technique (Stephenson, 1953) in that there are no restrictions on the number of items which may be placed in any of the defined construct categories.

To assess the pretest scale reliability of the quantitative judgments made by the questionnaire respondents, item placement ratios (Moore and Benbasat, 1991) measure was used as indicator to measure the observed proportion of agreement between judges that is greater than would be expected from chance. The item placement ratios assess both the validity of the generated items and the reliability of the proposed measurement scales. If there is a high degree of inter-judge agreement, then the percentage of items place in the target construct will also be high. In addition, scales based on a high degree of construct validity and also exhibit the potential to be reliable.

In table 1 (available from author) we present the final round item-placement ratios for the constructs using (Moore and Benbasat, 1991) format, which provides additional insight into the performance of the proposed measurement scales. Each of the process activities and success measure is listed on the rows of the table.

5.0 FIELD SURVEY

Satisfied by the apparent reliability and parsimony of our new measurement scales, we moved into the next phase of testing our survey instrument in a field setting. For this phase, the mail survey was targeted at decision makers within the Australian Companies that have implemented Enterprise resource Planning system. The questionnaire used in this study attempted to measure the model discussed in section 3. Prior to piloting the questionnaire, (Churchill, 1995) instrument development methodology was adopted to generate the pool of items for each construct. Manual sorting procedure was conducted using industry experts experienced in ERP systems. Hensley, (1991) advocates this approach for new scale development.

Initial survey instrument was pilot tested during mid of 2003 and it was further refined to be ready after a pilot survey was undertaken. The final survey was sent out to the respondents in November - December, 2003 and comprised of 18 questions in eight sections. Data used to test the implementation process stages and success instrument were obtained from 53 respondents from Australia. Each respondent company had implemented ERP system and the respondents had experience in either been involved in ERP implementation of their organization. The questionnaire was mailed to the 500 organizations and 53 usable surveys were received making the response rate to be around 11%. Most of the items in this study were itemized using Likert- Scale, in which respondents were asked to indicate their level of importance for each of the construct items (process activities) using their response on a seven point scale.

The measurement analysis emphasizes explanations of the reliability and validity of the new instruments for measuring these constructs. The validity and reliability measure indicate that the instrument has the potential for use in further studies.

5.1 Reliability Analysis

Reliability is one of the most critical elements in assessing the quality of the construct measures, and it is a necessary condition for scale validity. A statistically reliable scale provides consistent and stable measures of a construct. Composite reliability estimates are used to assess the inter-item reliability of the measures. Estimates greater than .70 are generally considered to meet the criteria for reliability. Some items may be removed from the construct scales if their removal results in increases in the reliability estimate, however, care must be taken to ensure that the content validity of the measures is not threatened by the removal of a key conceptual element.

As shown in the table below that reliability of each factor is above .73. In table 1, are listed the composite reliability estimates for each of the measurement scales.

Constructs	Items	Alpha
Implementation Planning phase	4	.87
Installation phase	6	.81
Final Preparation phase	4	.73
Go Live phase	4	.78
Implementation success	4	.90

Table 1: ERP implementation process phases and success constructs (items) and reliability values

5.2 Factor Analysis

An exploratory factor analysis was conducted on the different measures to purify the instrument. Factor analysis was also used to identify underlying factors or the dimensional composition of instrument. The data from 53 responses were examined using principal component method. At this stage, items with factor loading of less than 0.5 on each factor or above 0.5 on additional factors should be deleted to purify the measure.

Four items were used in the survey to measure respondent's agreement with the activities for ERP Implementation planning (first phase of implementation process). The four-factor loading yielded a range between .83 and .87. These combined into a single factor with eigenvalue of 2.88 accounting for 72.15 per cent of variance.

Table 2 (available on request) depict that five activities for Installation Phase of ERP implementation process are loaded clearly on one factor. The analysis of 5 items considered important for Installation with eigenvalue of greater than 3, which accounted for 53 per cent of variance. All items factor loadings yielded clear results with statistics ranging from .69 to .78.

Table 3 (available on request) portrays analysis of the 4 items measuring the final preparation phase of ERP implementation process with Eigenvalue of 2.23 that accounted for 56 per cent of variance. The mean scores from 6.28 to 6.45 on a 7-point Likert scale. It can be seen the reliability coefficient for this construct is .73, indicating the construct is reliable.

Table 4 (available on request) illustrates that the five items measuring the Go Live phase of ERP implementation process and found one factor with eigen value 2.44 that accounted for 61 per cent of variance. The reliability was then assessed by computing the Cronbach alpha coefficient, a measure of internal consistency. The alpha coefficient was .78, indicating its acceptability. An examination of the inter-item correlations indicated the alpha could not be improved deletion of any items.

Table 5 (available on request) the mail survey included four items on ERP implementation success that were generated from the literature review and from an input provided by the panel members. Respondents agreed to the items that measure ERP implementation success. The four items measuring success of ERP implementation found one factor with an eigen value of 3.09, which accounted for 77 per cent of variance. The four factor loadings yielded clear results ranging from .84 to .95.

5.3 Content Validity

The content validity of a questionnaire refers to the representative of item content domain. It is the manner by which the questionnaire and its items are built to ensure the reasonableness of the claim of content validity. The conceptualization of survey instrument constructs are based on preliminary literature review to form the initial items, the personal interviews with practitioners and experts used for scale purification suggest that the survey instrument has strong content validity.

5.4 Construct Validity Analysis

Construct validity is established by showing that the instrument measures the construct it is intended to measure. Construct validity is evaluated by performing correlation and factor analysis. High correlations considered to indicate construct validity.

It is interesting to observe that the relative strength of the correlation between process stages and the implementation success. The phases such as implementation planning and installation strongly influence the implementation success individually and they are found to be statistically significant. The success of ERP implementation (dependent variable) is measured in this study whether the implementation was

completed within budget, within time, users were satisfied and users find it easy to use the system. This definition is consistent with the definitions for success associated with all types of information system projects, recognizing that there is no single set of accepted measurement criteria for evaluating information system success. Success is dependent not only on the factors that influence the system implementation during the course of the implementation timeframe, but also activities that occur during the ERP implementation.

6.0 DISCUSSION AND CONCLUSION

The Enter method of the regression analysis is used to study the implementation process phases that influence on the success of ERP implementation. The table 6 (available on request) shows the results of implementation process phases (independent variable) influence on implementation success (dependent variable). The relationship between the implementation process phases and implementation success is relatively strong ($R = .682$). It is also observed from the regression model that the influence of implementation process phases on ERP implementation success has been explained to the extent of 47%. It is found to be statistically significant ($P=.000$).

The primary contributions of this paper are the definition of constructs associated with the ERP implementation and the development of multi-item measurement scales for measuring these constructs. Unlike much prior ERP implementation research, this study takes a grounded theory approach using ERP experts' perceptions. Future ERP implementation empirical research linking these constructs in causal models in an ERP will benefit significantly from the existence of relevant construct definitions and good measurement scales. A secondary contribution of this work is the demonstration of a rigorous empirical scale and item development process.

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