AC 2009-803: ENTERPRISE RESOURCE PLANNING: A STUDY OF USER SATISFACTION WITH REFERENCE TO THE CONSTRUCTION INDUSTRY

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Enterprise Resource Planning: A Study of User Satisfaction with Reference to Construction Industry

Abstract

An Enterprise Resource Planning system (ERP) is a packaged business software system that integrates a series of modular software applications to serve all functions of an "Enterprise", including work flow and document management, scheduling, cost control, human resource management, procurement, quality control and reporting. It is used by many industries to support company business processes. This study identified and analyzed the factors that are associated with the implementation of enterprise resource planning (ERP) in the construction industry. It also attempted to conduct a comparative analysis of user satisfaction with ERP between construction and non-construction industries. A questionnaire was developed to collect the data through case studies from both construction and non-construction industries. Companies that used ERP systems in the United States were identified. Forty companies were randomly selected for case studies— 20 from the construction industry and 20 from the non-construction industries. The results of the study indicate a statistically significant difference between the groups in terms of user satisfaction with ERP as a product, vendor service for the systems, and knowledge of the users and their involvement with the systems.

Key words: Construction Industry, Enterprise Resource Planning, User Satisfaction.

Statement of the Problem

Enterprise Resource Planning System

An Enterprise Resource Planning system (ERP) is a packaged business software system that integrates a series of modular software applications to serve all functions of an "Enterprise", including work flow and document management, scheduling, cost control, human resource management, procurement, quality control and.

ERP systems include a set of software modules linked to a common database, and these modules can handle basic corporate functions such as manufacturing, finance, human resources, materials management, sales, and distribution[1]. ERP systems focus on integrating all internal enterprise transactions processing to balance demand and supply[2].

In short ERP helps to integrate the numerous data in an organization under one common platform. The purpose behind is not only to ensure transparency but also to facilitate tracking down information regarding the status of a particular order or its dispatch and so on. If a company succeed in this it will definitely achieve ERP benefit.

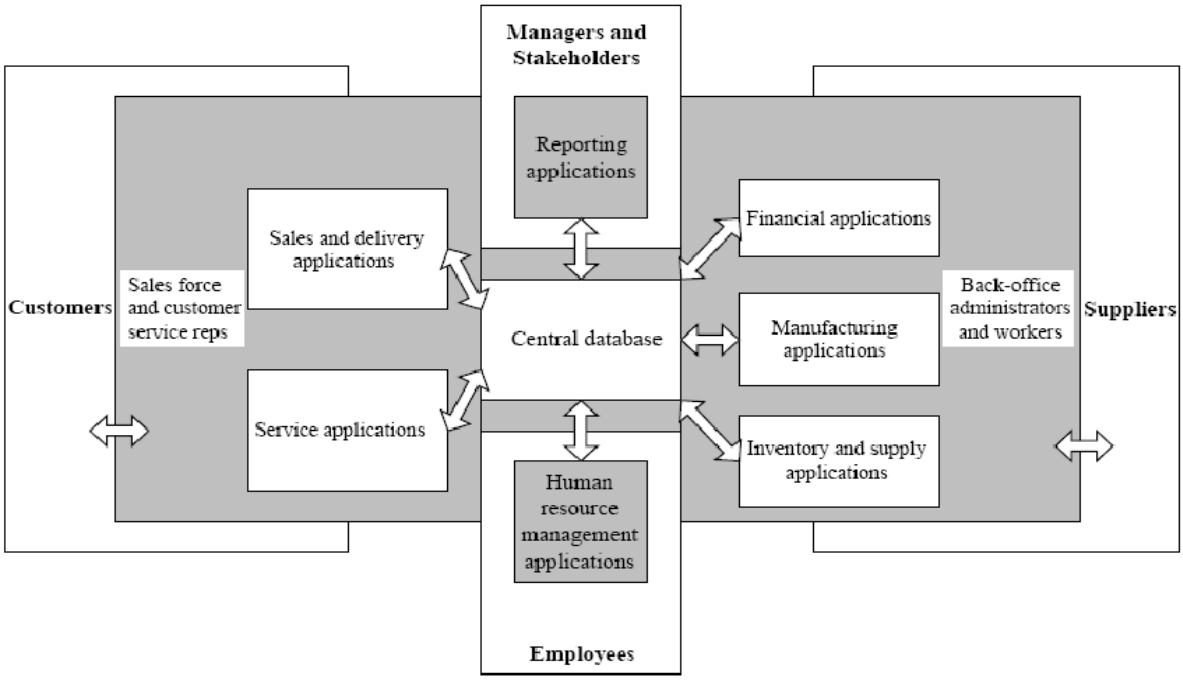

Figure 1: A schematic representation of an ERP system (adapted from Davenport, 1998)

Figure 1 shows a graphic representation of an ERP system. At the core of an enterprise system is a single comprehensive database. When new information is entered in one place, related information is automatically updated. Despite its capacity to integrate, an enterprise system is not flexible. It is a generic solution that does not always fit with each enterprise's individual characteristics[3].

Advantages of ERP

There are numerous functions of ERP which helps reducing the cost and hence increasing the profits of the company. Some of these functions are measurable and many of them are very difficult to measure. These can only be realized with thorough knowledge of the ERP system. Some of them are as follows:

Enhancement of Flexibility

There used to be fixed procedures and formalities to view or acquire the information from different departments within the company. Approvals of the senior executives had to be taken and it consumed a lot of time of the company. With the advent of ERP a person can easily and readily access the information from all over the company according to his position in the company. The level of information accessible varies according to the position and authority in the company and hence even confidentiality can be maintained.

Improvement in Quality

Areas of improvement have been very effectively identified within a company by the ERP systems. This has greatly helped to improve the overall quality. For example in the course of implementing ERP software the company would have found some obsolete practice. They can devise a novel and productive measure in consultation with the ERP vendor which will double the benefits given the ERP software implementation. Thus ERP project helps to identify the existing mistakes and improve upon them in a better manner. The ERP function will accrue only if ERP is carried properly in an organization.

Economy of Resources

ERP systems help to identify the areas within an organization where resources are not appropriately or efficiently used. Hence ERP systems help in significantly cutting down the resources such as time, money and labor. This improper allocation of resources would not be identified without the ERP implementation.

Enhancement of Decision Making

The purpose of the ERP system is reducing the communication time within an organization. ERP does this by automation of the business processes. Due to the automation, the various procedure of getting approvals from different level authorities is taken out of the picture. This helps in easing out the decision making process.

Every organization in the industry has different style of working. Hence the above mentioned functions are not standard and it varies at least by a small amount as it depends on the nature of the organization.

Need of ERP in Construction

The efficiency and productivity of the construction industry is crucial for the whole economy and for the organization itself to progress in this competitive era[4]. The construction industry needs to communicate on a large scale with other related businesses such as material and equipment suppliers, vendors, subcontractors and clients. ERP can be used by construction companies to improve responsiveness in relation to customers, strengthen supply chain partnerships, enhance organizational flexibility, improve decision making capabilities and reduce project completion time and lower costs.

Also the construction industry has the history of having huge amount business failures and low amount of profits. ERP can be useful in changing this as it has proved its potential in the other sectors[5]. There are very few studies conducted about the implementation of ERP systems in the construction industry. Recently, several practitioners have stated that ERP implementations have so far yielded more failures than successes in large construction firms[6]. When implemented to solve the right problems, these ERP systems can be a powerful tool for business improvement as seen in the manufacturing industry.

Measures of User Satisfaction in an ERP Environment

User satisfaction on information systems is defined as "the sum of one's feelings and attitudes toward a variety of factors related to the delivery of information products and services[7]. Literature indicates that valid measures for user satisfaction with ERP include the factors of (1) product quality, (2) service provided by the ERP vendor or contractor, and (3) user knowledge of and involvement in the use of ERP[7, 8, 9].

ERP systems are installed to integrate and synchronize all the activities of a company, provide accurate and timely data, facilitate efficient information flows, and reduce operational costs. Higher the usefulness of the product, more will be the user satisfaction.

Organizations seldom develop their own ERP systems; typically they employ contractors or vendors to provide the services. The contractors install the system according to standard operating procedures of the organization and provide training to key users. They are also responsible for ongoing support services to keep the program running efficiently. The quality of contractor service, therefore, is a key factor in measuring user satisfaction.

Last but not the least important measure of user satisfaction of ERP is knowledge and involvement of the users themselves. This satisfaction is affected by the degree to which the users perceive their usefulness in the involvement with the program and the extent of their comprehension of the system.

Hypothesis

This paper attempts to find the differences in user satisfaction, if any, among construction and non-construction industry users of ERP. It is hypothesized that there is a statistically significant difference in user satisfaction between these two sectors in terms of (1) ERP as a product, (2) contractor or vendor service provided for ERP, and (3) knowledge of and involvement in the use of ERP.

Methodology

Data collection procedure and sample size

Data was collected from 40 randomly selected companies, 20 construction and 20 non-construction, from different regions of the United States. The companies selected were either small or medium enterprises. A questionnaire was developed to collect user satisfaction data on (1) ERP as a product, (2) vendor service for the systems, and (3) user knowledge of and involvement with the systems. Data collection was done through telephonic interviews with the CEOs of the companies.

Variables and their operationalization

Category (CATEGORY): It is the category of the company. It was treated as a class variable consisting of two classes: (1) construction company (CONST) and (2) non-construction company (NONCONST).

ERP as a Product (PRODUCT): It is the user satisfaction with ERP. The variable was operationalized by measuring satisfaction with accuracy, completeness, and reliability of the product on a likert scale ranging from 1 (extremely dissatisfied) to 5 (extremely satisfied) for each of these constructs. The sum of the values of these constructs measured the user satisfaction with ERP as a Product. The range of satisfaction values for the variable could range from a minimum of 3 to maximum of 15.

Vendor Service for the Systems (VENDOR): It the user satisfaction related to vendor or contractor service for the systems. The variable was operationalized by measuring satisfaction with the competency, domain knowledge, reliability of the vendor or contractor on a likert scale ranging from 1 (extremely dissatisfied) to 5 (extremely satisfied) for each of these constructs. The sum of the values of these constructs measured the user satisfaction with Vendor Service for the Systems. The range of satisfaction values for the variable could range from a minimum of 3 to maximum of 15.

Knowledge of and Involvement with the Systems (KI): It is the satisfaction related to user knowledge and involvement. The variable was operationalized by measuring satisfaction with the knowledge of the program, comprehension of the program, involvement with the program, and perceived benefits of the system on a likert scale ranging from 1 (extremely dissatisfied) to 5 (extremely satisfied) for each of these constructs. The sum of the values of these constructs measured the user satisfaction on knowledge of and involvement with the systems. The range of satisfaction values for the variable could range from a minimum of 4 to maximum of 20.

Analysis and Results

The hypotheses were tested using a General Linear Model. It is an extension of linear regression model that allows analyzing the effects of class variables on the criterion variables. The following models were used for the analysis, using CATEGORY as the response variable:

$$\text{PRODUCT} = \beta_0 + \beta_1 \text{ CATEGORY} + \xi \qquad \text{Eqn. (1)}$$

$$\text{VENDOR} = \beta_0 + \beta_1 \text{ CATEGORY} + \xi \qquad \text{Eqn. (2)}$$

$$\text{KI} = \beta_0 + \beta_1 \text{ CATEGORY} + \xi \qquad \text{Eqn. (3)}$$

where β_0 = intercept,

β_1= regression coefficient, and
ξ = error term in the equation.

The results of the analyses are shown in Tables 1, 2, and 3.

Table 1: Summary of General Linear Model analysis for CATEGORY using PRODUCT as a dependent variable

Parameter	Reg. coefficient	t-value	p-value	R^2	F-value	p>F
Intercept	11.80	34.68	<0.0001	0.40	24.87	<0.001
CON	-2.40	-4.99	<0.0001			
NONCON						

Table 2: Summary of General Linear Model analysis for CATEGORY using VENDOR as a dependent variable

Parameter	Reg. coefficient	t-value	p-value	R^2	Model F-value	p>F
Intercept	11.20	39.21	<0.0001	0.68	79.43	<0.001
CON	-3.60	-8.91	<0.0001			
NONCON						

Table 3: Summary of General Linear Model analysis for CATEGORY using KI as a dependent variable

Parameter	Reg. coefficient	t-value	p-value	R^2	F-value	p>F
Intercept	15.40	32.76	<0.0001	0.62	61.16	<0.001
CON	-5.20	-7.82	<0.0001			
NONCON						

The results indicated that all the three user satisfaction factors were correlated with CATEGORY at the level of significance of less than 0.0001 level. The predictive efficacy of the models for VENDOR and KI variables, indicated by the R^2 values, were moderately high; that of the model for PRODUCT variable was not that high, but such values are usually considered to be satisfactory related to empirical studies in social sciences[10].

Least Squares Means option of General Linear Model was used to find out the directions of the differences in user satisfaction between construction and non-construction companies. The analysis shows how significant is the pair-wise difference in means of the variables. The results are shown in Tables 4.

Table 6: Pairwise differences in user satisfaction

Variable	Mean user satisfaction		p-value
	CONS	NONCON	
PRODUCT	9.40	11.80	<0.0001
VENDOR	7.60	11.20	<0.0001
KI	10.20	15.40	<0.0001

The results clearly indicate that the user satisfaction levels on three dimensions related to ERP measured in the study was significantly higher in non-construction industry than construction industry, at least for the sample population. However, the difference was found to be the least for ERP as a product.

Conclusions

The study shows that domain knowledge, related experience and the technical competence of the ERP vendors is much better in the non construction industry as compared to that in the construction industry. There have not been many implementations in the construction industry and more over not even many studies have been conducted over the implementations in the construction industry.

The ERP system is fairly accurate and reliable in both construction and non-construction industries. But the biggest problem in the construction industry is the completeness of the system in terms of functionality. The system is not able to give the required flexibility needed to serve the construction industry. It is still not successful in completely meeting the needs of the industry, while this is not such a big problem in the non construction industry. This is probably because of the reason that the ERP systems have not developed keeping the construction industry in mind.

The non-construction industry is using ERP for a longer time the construction industry. This is probably the reason why the systems have not yet been properly customized to meet all the requirements of the construction industry. When it comes to the training and the education of the end user it is a very crucial factor in both the type of industry. Construction industry being a new comer is lagging behind in this respect. It is reflected by low user satisfaction scores in issues related to user knowledge and involvement.

The relatively low difference in user satisfaction scores on ERP as a product is worth mentioning. It suggests that the construction industry underscores the importance of using ERP as a product. They probably realize the advantages of using the systems, despite some reported failures of such implementations. When implemented to solve the right problems, the ERP systems can be a powerful tool for business improvement as witnessed by the manufacturing industry.

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