

Full Length Research Paper

A framework for efficient enterprise resource planning (ERP) implementation in technical educational institutions

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Technical educational institutions (TEIs) can use enterprise resource planning for an integrated, better and efficient system for management of all the information related to many users in these Institutions. Though ERP is used in many TEIs in India, but it has not been found to be completely successful. This paper aims at assessing the efficiency of implementing an ERP system from users' perspective. The study uses a survey of 900 users in four categories in technical educational institutes in India to gain feedback in their experience of applying ERP. The focus of paper is on three features for efficient ERP: functionality, security and quality. The present research identifies the success factors for efficient ERP implementation. The study also identifies the problems faced in ERP implementation and finally suggests a framework for efficient implementation of ERP in technical educational institutions. The framework designed will help the technical educational institutions in successful and efficient implementation of ERP. The ERP framework designed focuses on features to be enhanced, improved and controlled so as to make ERP system efficient to provide optimum user satisfaction.

Key words: Enterprise resource planning (ERP), functionality, security, quality, ease of use, framework, technical educational institutions.

INTRODUCTION

Enterprise resource planning (ERP) system assists enterprises in automating and integrating cross-functions such as accounting, procurement, distribution, inventory management, sales and marketing management and human resource management. An ERP system helps the different parts of the organization share data and knowledge, reduce costs, and improve management of business processes. For example an employee in purchase department has access to services of accounting module. This ability to share information gives businesses flexibility and efficiency in carrying out the

tasks (Tarn et al., 2002). There are other numerous benefits which any organization can get from ERP implementation. The need to increase efficiency is one of the most important reasons to implement an ERP system (Chang et al., 2000; Shang and Seddon, 2000; Ifinedo and Nahar, 2006). Efficiency is defined as the comparison of what is actually produced or performed with what can be achieved with the same consumption of resources like money, time, labor, etc.

Technical educational institutions can also be considered as the organizations which need the sharing of resources and data from a central place and coordination among all the modules, the ERP is becoming an essential part of management in TEIs. Many of the benefits stated above are also sought by TEIs. Universities have turned to ERP as a means of replacing existing management and administration computer systems since the last two decades. Pollock has identified how the universities and organizations are similar and different in the requirements for features provided by ERP systems

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Abbreviations: ERP, Enterprise resource planning; TEI, technical educational institution; ICTs, information and communication technologies; UI, User Interface.

which are generic in nature (Pollock and Cornford, 2004). The success factors and problems faced by TEIs in implementing ERP may differ from those faced by business enterprises. The aim of the present study is to identify the critical success factors for implementing ERP in TEIs. On the basis of the literature review, a survey has been designed to understand how diverse user groups within a Technical Educational Institution may value their experience of an ERP system and the way ERP system may be deployed to help improve its efficiency.

The present research has been taken with the following broad objectives:

1. To identify the factors that can facilitate an efficient implementation of ERP system in technical educational institutions.
2. To identify the problems faced by diverse group of users in technical educational institutions in using ERP system.
3. To propose a framework for efficient implementation of ERP in technical educational institutions.

The way chosen to answer these questions is to first identify the important features of ERP. The study then focuses on identifying the factors for these features. Then, the researchers identify the problems in accepting and using an ERP system by these diverse user groups' namely, faculty, research scholars, post-graduate and under-graduate students. Finally, a framework has been proposed based on the critical success factors and problems.

LITERATURE REVIEW

ERP packages provide generic off-the-shelf business and software solutions to customers. ERP systems include the integration of data and applications, replacement of old, fragmented legacy systems and quicker deployment of packaged systems as compared with in-house development and adoption of best practices in organizational processes (Luo and Strong, 2004).

An important characteristic of ERP systems is that, they are packaged software solutions rather than customized systems. As such, they come with built-in assumptions and procedures about organizations' business processes. These assumptions and procedures seldom match exactly with those of the implementing organization's existing processes. So ERP implementation is not always a success. Included functionality of the ERP is an indicator of the closeness to fit the company's business (Shyur, 2003).

Researchers have identified a large number of benefits derived from implementation of ERP. ERP benefits aim at increased efficiency of the system, business efficiency, improved communication and co-ordination (Spathis

2003), task efficiency, improved management decision making, improved financial, inventory or asset management, improved customer service and retention, ease of expansion or growth and increased flexibility, faster, more accurate transactions, reduction in headcount and cycle time, fewer physical resources and increased revenue (Shang and Seddon, 2000). The ERP system should be modular, integrated, parametric, flexible, secure, multi-functional and should manage the workflows in order to be efficient (Kakouris and Polychronopoulos, 2005). ERP success refers to utilization of such systems to enhance operational efficiency and effectiveness (Ifinedo and Nahar, 2006).

The user participation in enterprise systems is essential (Kawalek and Wood-Harper, 2002). Efficiency is a critical success factor in ERP implementation from users' perspective. Improvement in efficiency can be achieved in terms of operational efficiency, task efficiency, human efficiency and overall system efficiency. The task efficiency of ERP is increased with greater customization, greater coordination improvements of ERP, better operational organizational mechanisms, greater improvements in coordination with other sub-units are associated with greater overall ERP benefits (Spathis, 2003; Chou and Chang, 2008).

In order to improve human efficiency, there must be some tool that can assist the humans in carrying out their tasks in less time. Information and communication technologies (ICTs) are considered a fundamental tool to improve business processes and efficiency. ICT helps organizations to move from functional to process-oriented approaches (Mohamed et al., 2010). The ICT used in ERP systems should be easy to use by users, that is, more usable. Usability is directly judged by the User Interface (UI) design of a system. This clearly indicates that user should be given a user-friendly interface covering convenient formats for input and output of information for making the efficient use of the system and easy implementation (Shyur, 2003; Singh and Wesson, 2009).

A system can be used efficiently in operation if the adopters are skilled in using the interface. The absence of e-skills has been identified as a big hurdle in successful ERP implementation (Mohamed and McLaren, 2009). Improving usage levels, training or guidance was identified as a crucial factor for improving usability (Maheshwari et al., 2010).

There are many challenges in ERP implementation. Flexibility in adoption of ERP is a challenge for ERP implementation success (Al-Mashari, 2003). Change management has been identified as important for success in ERP Implementation (Aladwani, 2001; Hau et al., 2010). The users should be able to use the system without being affected by changes at the back end. Training offers a good opportunity to help users adjust to the change that has been introduced by the ERP system (Aladwani, 2001, Gupta et al., 2004). To take advantage

of the competitive capabilities of ERP systems, managers and employees must understand the basic principles of ERP, so that, it can be used to its fullest potential. Commitment by users and management is necessary to the successful maintenance of an ERP system (Salmeron and Lopez, 2010). This commitment needs to be incorporated into the business culture and employee population through the use of training programs (Beheshti, 2006). Security is an important challenge for ERP implementation which includes user authentication, authorization, time restriction and data security (She and Thuraisingham, 2007). Maintaining quality during operation and maintenance of enterprise systems is also identified as a challenge (Hummel et al., 2010).

All these findings are related with ERP in business organizations. The aim of the present research is to see which of these factors are important for efficient implementation of ERP in TEIs.

MATERIALS AND METHODS

The present study used a self-structured questionnaire to find out the critical success factors and also to identify the problems for efficient implementation of ERP in various TEIs from diverse user groups' namely, faculty, research scholars, post-Graduate and undergraduate students. The content validation and face validation of the questionnaire was done by the domain experts. The pilot survey was done with 100 users. The reliability of the questionnaire was found to be 0.96 using Cronbach alpha.

The first section contains twenty-two questions addressing the three main features identified through literature survey namely i) functionality, (ii) security and (iii) quality. The study uses a Likert scale with 1 for Least priority to 5 for Highest priority. The final questionnaire was modified by incorporating the changes suggested by various domain experts. The study uses factor analysis to find the critical success factors in all these three key areas.

The next section of the survey aimed at identifying the problems in handling the implementation of the ERP system. Eight common problems identified by advice of domain experts and pilot survey were included, which are also judged on a Likert scale from 1 (Very low priority) to 5 (Very high priority). The content validation showed that the problems were relevant in the context of ERP implementation. The mean score of the problems was calculated to highlight the major problem.

A total of 900 responses to the questionnaires were received which included faculty (14%), research scholars (10%), post-graduate students (33%) and undergraduate students (43%). These diverse user groups' possessed varying levels of technical skills, expertise and experience for applying online system like ERP. The reliability of the questionnaire was found by measuring Cronbach Alpha using statistical software, SPSS v 17. The value for all sections varied from 0.836 to 0.937, indicating good Reliability score. The results of the same are summarized in Table 1.

RESULTS

Data analysis was done on all three features of ERP to identify the critical success factors. The results of these are summarized as follows:

Table 1. Reliability analysis.

Section	Number of Items	Cronbach's alpha
Functionality	20	0.937
Security	12	0.859
Quality	12	0.848
Problems	08	0.836

Functionality

Functionality is the estimated percent of the company's functional requirements that are met by the ERP system (Sun et al., 2005). Ten questions covered under functionality in the questionnaire have been reduced to two factors using factor analysis namely, (i) Operational efficiency and (ii) User accessibility. Operational efficiency deals with difficulties on issues of efficient features regarding system's point of view, and User accessibility factor basically deals with the issues related with interface usage from user's point of view. The results are shown in Table 2.

The two factors for Functionality viz. operational efficiency and user accessibility explained 74.249% of the overall variation. The three important variables identified with high factor loading in Operational efficiency are i) Adequate documentation (ii) Good features and iii) User readiness.

Similarly, in User accessibility, the important variables identified are i) Data storage, ii) Ease of use and iii) Facilitation in problem handling. This factor explained 35.386% of variation.

Security

As identified through literature review, security constitutes an important issue regarding ERP implementation. Six questions covered under security have been reduced to two factors, namely (i) User security and (ii) System security. User security deals with difficulties on issues of securities regarding user's point of view, and the System security factor basically deals with the security perspective considering the system issues. The results are summarized in Table 3.

The above two factors for Security that is, User security and System security explained 74.034% of the total variation. The variables in User security in order of high factor loading are i) Authorization security ii) Data Confidentiality and iii) Authentication safety.

The variables in System security in order of higher loadings are i) Server downtime ii) System failure chances and (iii) Biometric measures.

Quality

Success of ERP system relies a lot, on the quality of

Table 2. Factor analysis of functionality.

Functionality	Eigen value	% of variance	Cumulative %	Item	Factor loading	Rank
Operational efficiency	3.886	38.864	38.864	Adequate documentation	0.916	1
				Good features	0.794	2
				User readiness	0.725	3
				Reduced efforts	0.641	4
				Customization	0.566	5
User accessibility	3.539	35.386	74.249	Data storage	0.882	1
				Ease of use	0.699	2
				Facilitation in problem handling	0.69	3
				Online help	0.636	4
				Training	0.616	5

Table 3. Factor analysis of security.

Security	Eigen value	% of variance	Cumulative %	Item	Factor loading	Rank
User security	2.681	43.626	43.626	Authorization security	0.908	1
				Data confidentiality	0.901	2
				Authentication safety	0.842	3
System security	1.824	30.408	74.034	Server downtime	0.903	1
				Systemfailure chances	0.629	2
				Biometric measures	0.607	3

Table 4. Factor analysis of quality.

Quality	Eigen value	% of variance	Cumulative %	Item	Factor loading	Rank
Usability	2.875	47.919	47.919	Availability	0.897	1
				Average error rate	0.872	2
				Increased efficiency	0.807	3
				Correction time	0.701	4
Scalability	1.398	23.298	71.217	Easy additions	0.945	1
				Interoperability	0.84	2

services provided by ERP system. Six aspects covered under Quality were reduced to two factors viz. (i) Usability and (ii) Scalability. The results are summarized in Table 4. These factors for Quality explained 71.217% of the total variation. The variables in Usability in order of higher item loadings are: i) Availability ii) Average error rate and iii) Increased efficiency.

The variables in Scalability in order of higher item loadings are i) Easy additions and ii) Interoperability with a factor loading of 0.84. The details of all these three features along with their factors are summarized in the Figure 1.

ERP implementation inhibitors

The next objective of the study has been to identify the common problems in efficient deployment of an ERP system. Regarding ERP inhibitors, eight areas have been identified as discussed below:

1. Internet dependency: All diverse user groups' reported network problems as a major inhibitor. These include the dependency on the internet for accessing the ERP software and the delays that occur due to non availability of the internet to carry out the transactions. It also

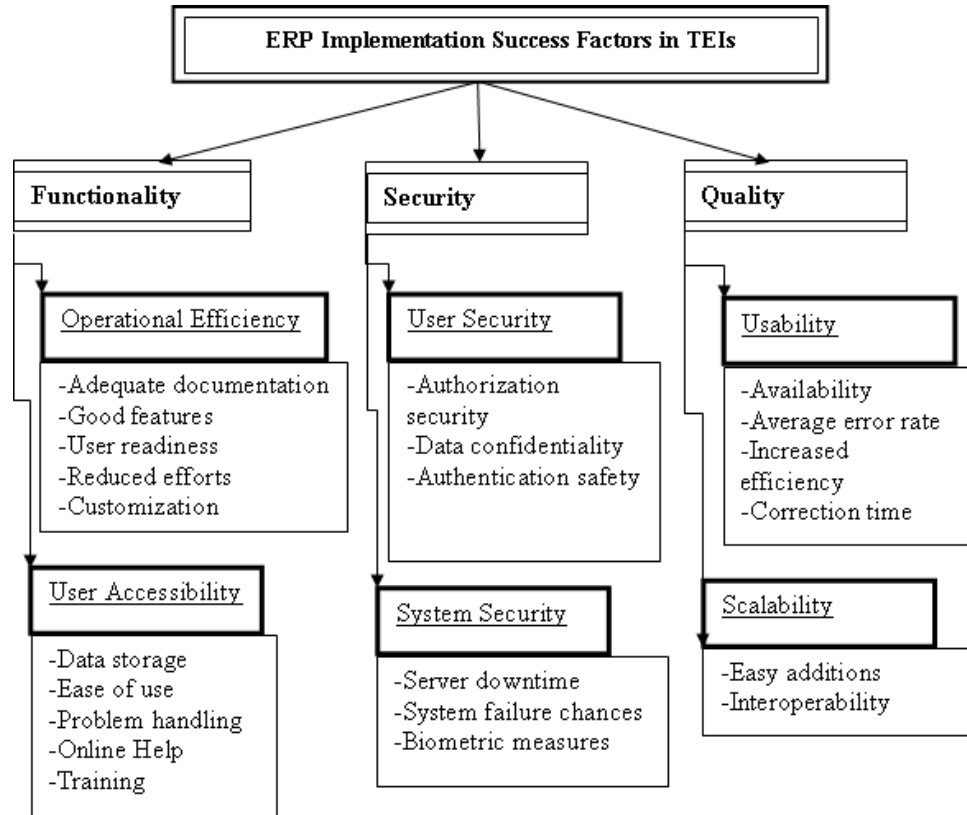


Figure 1. Major success factors for efficient ERP implementation in TEIs.

included repetition of the transactions if the internet connection is broken before a transaction is complete. This was reported with the highest priority.

2. Updation difficulty: All user groups found difficulty in updation of the information once it is entered. This problem also had a high mean score.

3. Time constraint: Entering the information online under a particular time constraint was next on priority. This could also be due to the restricted time access of internet. Although, time was given for data entry but many a times as the access to Internet was unavailable, submitting the complete information under a time constraint was a problem. This was mainly due to the limited Internet availability.

4. Time consuming: The ERP system in TEIs sometimes required the same information to be filled a number of times. As expected the faculty and students expressed uneasiness regarding supplying the same information time and again. Also the format for inputs for entering data was found to be time consuming and formats kept changing demanding the same information in different format again and again.

5. Less personal contact: Since with the use of the system, most of the information was required to be filled in and then accessed online. This resulted in less personal interactions and formal communications. This

may prove to be a hurdle in organizational culture.

6. Reliance on technical assistance: Diverse user groups' reported requirement of technical assistance while using ERP modules to provide immediate solutions to problems encountered during using ERP modules.

7. Difficulty in use: The interface was found to be difficult to use. The interface included the use of screens, menus, forms and other graphical user interface (GUI) elements. The GUI was not user friendly and, the users in academic institutions found it difficult to use.

8. Inadequate training: The system was found difficult to use because of lack of adequate training on e- skills in using the ERP system. Either the users were trained once and less manual or online help was available for users for applications of ERP.

The results of the responses for problems encountered in ERP applications are summarized in Table 5. The inhibitors identified in ERP implementation are depicted in Figure 2. Inadequate training in e-skills for ERP applications is the most critical problem. Dependency on internet for carrying out the transactions in ERP system is the second major problem. Many users found the ERP system interface difficult to use. As all the activities are needed online, the time constraint was a big hurdle. Due to inadequate training, reliance on technical assistance

Table 5. Inhibitors in ERP implementation.

User type		Difficulty in use	Inadequate training	Time consuming	Time constraint	Internet dependency	Updation difficulty	Less personal contact	Reliance on technical assistance
Ug	Mean	3.38	3.75	2.88	3.03	3.56	2.94	3.21	3.26
	N	434	433	434	433	436	437	435	435
Pg	Mean	3.51	4.17	3.26	4.03	3.82	3.57	3.28	3.43
	N	314	312	309	314	315	315	314	315
Res. Sch.	Mean	3.54	3.37	2.5	4.41	4.07	4.15	2.98	2.54
	N	46	46	46	46	46	46	46	46
Faculty	Mean	4.07	4.02	3.31	3.34	3.27	2.87	3.34	3.3
	N	84	82	86	86	86	86	86	86
Total	Mean	3.5	3.9	3.03	3.49	3.65	3.22	3.23	3.29
	N	878	873	875	879	883	884	881	882

Ug, Undergraduate; Pg, postgraduate; Res. Sch, research school.

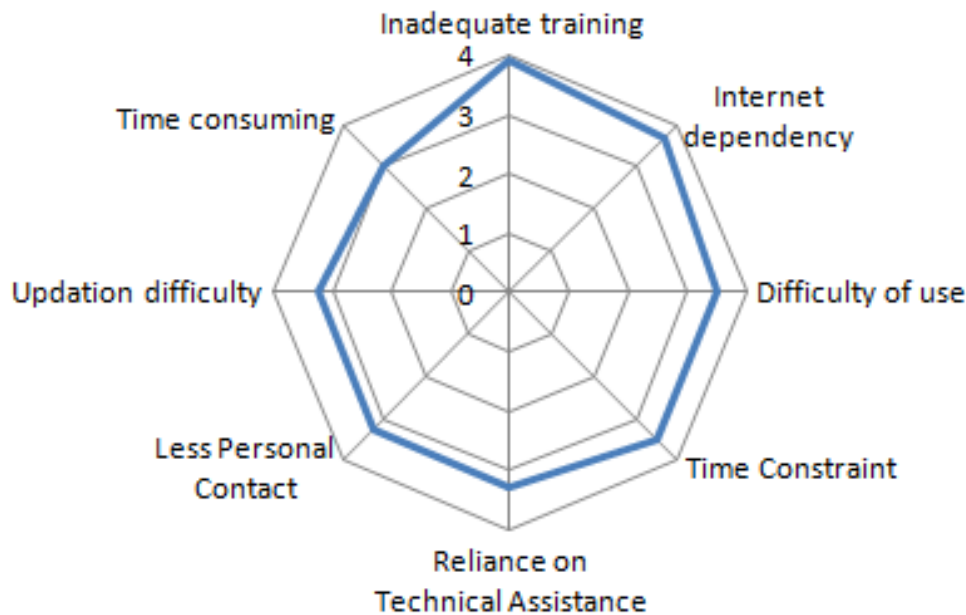


Figure 2. Inhibitors in ERP Implementation in TEIs.

was also a problem reported by users.

Proposed policy framework

On the basis of factors derived from literature review and responses from the diverse groups of users’ on critical success factors as well as problems encountered in ERP applications, a framework has been proposed to help the technical educational institutions in an efficient ERP

implementation. The framework is depicted in Figure 3.

DISCUSSION

The first step of the research was to identify important success factors and the next was to identify the problems faced in efficient Implementation of ERP System. The two when related revealed that certain features need to be improved, some to be enhanced, while there are certain

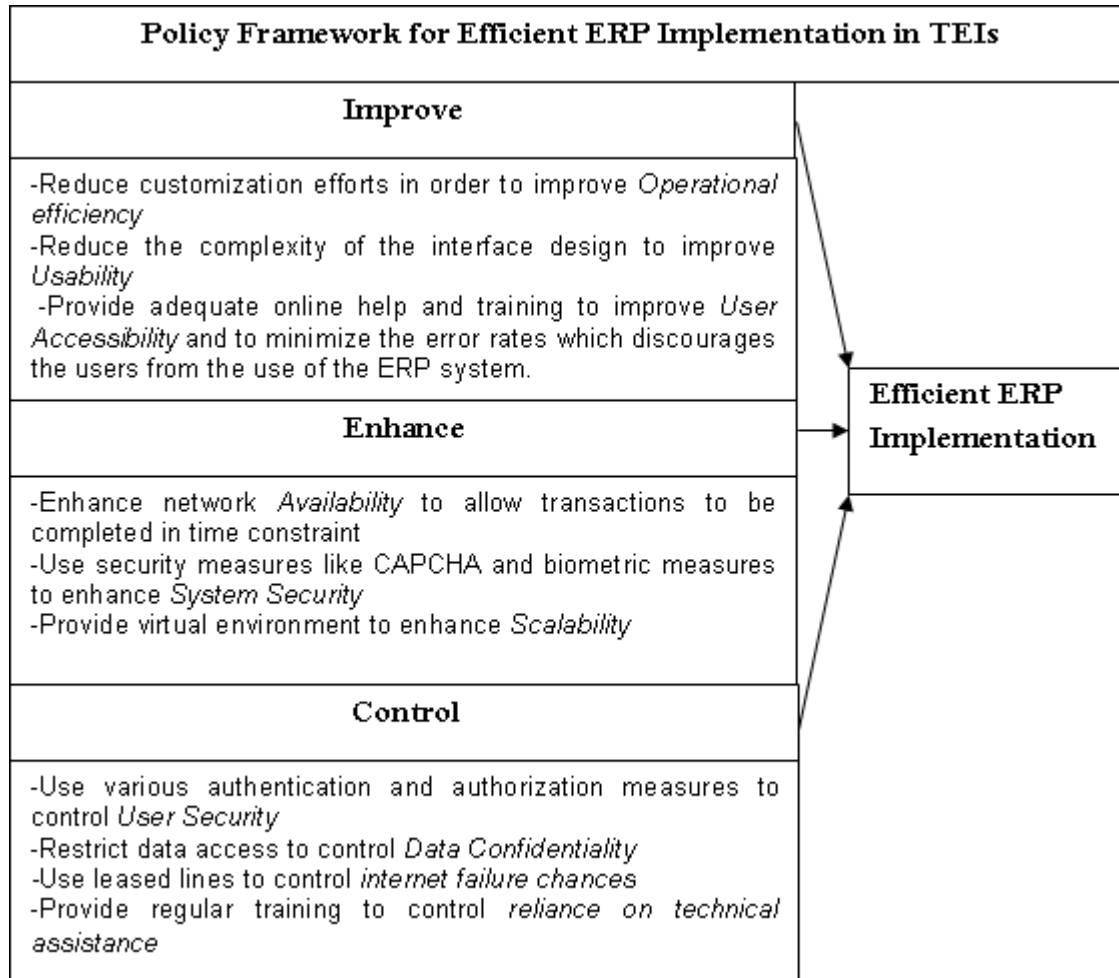


Figure 3. Policy framework for efficient ERP in TEIs.

other activities which need to be controlled to provide an efficient ERP implementation. All these are highlighted as follows:

1. Improvement: Operational efficiency and Usability should be improved. The processing overhead of the transactions in ERP system should be reduced to improve the speed of transactions. The interface for various users should be made easy to use. So the complexity of the interface design should be reduced keeping into consideration the different skill sets of users in TEIs.

2. Enhancement: User accessibility, system security and scalability should be enhanced. Network availability should be increased so that the transactions with particular deadline can be completed in time. The accuracy of the transactions should be enhanced to minimize the error rates which discourage the users from the applying ERP modules. Online help and training on e-skills for ERP applications should also be made extensive so that diverse user groups' can access the system more

frequently. Scalability can be enhanced by providing a virtual environments like cloud technology Software as a Service (SaaS).

3. Controlling: User security should be controlled by all possible means by incorporating valid authentication and authorization measures. Confidentiality of data should be controlled by encryption or by restricting the data access. The ERP system should be made customizable so that it can be used by a wide variety of TEIs.

Conclusions

The ERP solution is the software used for better management of the activities, data and information across the institutions. A successfully implemented ERP system provides not only valuable information processing capability to better control costs and identify ways to be more efficient in dealing with the users. This improvement in communication through ERP interface and information storage at central place can improve the quality of the

knowledge assets in TEIs. The study results, based upon the data collected from various TEIs in India using the ERP, demonstrate the potential effectiveness of an ERP from users' perspective discussed below:

1. The survey results indicated that inadequate training (Gupta et al., 2004; Mohamed and McLaren, 2009; Maheshwari et al. 2010), dependency on internet along with the difficulty in using the interface (Lee et al., 2003) are crucial inhibitors in functionality of and efficiency of ERP. Though personal contacts have reduced but the dependency on technical people for carrying out the transactions correctly has increased. The information once entered cannot be updated easily which is reported as a hindrance in ERP success for motivating users for ERP applications and hence reduce its efficiency.
2. There are many important issues identified regarding the security of ERP system. This includes authentication which aims to restrict entry into the system and access control, that is, authorization which aims to restrict the data and functions allowed to be accessed by diverse user groups' (She and Thuraisingham, 2007). Implementation of biometric measures can enhance security of ERP system.
3. The system quality and service quality are important factors in ERP implementation success (Ifinedo et al., 2010). Availability of the ERP system is a crucial factor as there are deadline constraints. Easy additions and interoperability were identified as required characteristics of the efficient ERP system.

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