Designing A Framework For An Efficient ERP Implementation In Technical Educational Institutions

Thesis submitted in fulfillment of the requirement

for the award of the degree

of

Doctor of Philosophy

By

Shivani Goel

(Regn. No. 950903001)

Computer Science and Engineering Department

Thapar University

Patiala 147004 (India)

October 2012

CERTIFICATE

Certified that the thesis entitled '*Designing a Framework for an Efficient ERP Implementation in Technical Educational Institutions*' which is being submitted by Ms. Shivani Goel, in fulfillment of the requirements for award of the Degree of Doctor of Philosophy at Thapar University, Patiala, is a record of candidate's own work, carried out by her under our supervision and guidance. The matter embodied in this thesis has not been submitted in part or full to any other University or Institute for the award of any degree.

Ravi Kiran

Dr. Ravi Kiran

Professor and Head,

School of Behavioral Sciences & Business Studies

Thapar University

Patiala 147004

Place: Patiala

Date: Oct. 19, 2012

Deepak Garg

Dr. Deepak Garg

Associate Professor,

Computer Science & Engg Deptt.

Thapar University

Patiala 147004

Place: Patiala

Date: oct 19, 2012

ACKNOWLEDGEMENTS

It is a matter of great privilege to acknowledge the help and guidance which I received from several eminent sources.

First of all, I thank Almighty God and all my teachers and elders for their blessings for doing my research work.

I am profoundly indebted to my revered supervisors Dr (Ms.) Ravi Kiran, Professor, and Head, School of Behavioral Sciences and Business Studies, Thapar University, Patiala, and Dr. Deepak Garg for their sustained guidance in the accomplishment of my work. They have not only provided me valuable guidance but also inspired for a deep sense of understanding of the topic under study.

I would like to thank Dr Abhijit Mukherjee, Director, Thapar University, Patiala for providing all the facilities and support for doing my research work. I thank Head, Computer Science and Engineering Department and all the members of my URB for giving continuous support during the progress monitoring.

It's pleasure to express my regards to all the experts, faculty and students in Thapar University, Patiala, and in all other institutions who spared their valuable time and provided the important information required for the study. This work would not have been possible without their timely responses and feedback.

I find myself falling short of words in expressing my thanks to my father Sh. Ramesh Chand Goel, for providing me help and motivation in carrying out my research work. I would also like to thank all my family members for their endless support and patience, specially my daughters Gariyasi and Prakriti.

I would like to thank one and all whosoever has contributed in my research work directly or indirectly.

(Shivani Goel)

TABLE OF CONTENTS

ABSTRACT

Enterprise resource planning (ERP) started in mid 1970s for integrating all information in business at a single place for better control and management. The benefits from ERP implementation are: changed organization culture with common vision, better resource management, improved financial management, better report generation, improved alignment of strategies, improved data quality, improved coordination and communication among users and many more. With the use of interactive communication technologies, Educational institutions also felt the need to use ERP systems in the 1990s. Since then the TEIs all over the world have been investing in ERP implementations. The literature suggests cases of failure of ERP in spite of heavy investment costs and quite high maintenance costs. The benefits are left unrealized. Many researchers have identified various critical success factors for the successful ERP implementation in TEIs. These include top management support, change management, business process reengineering, user motivation, training, infrastructure cost, customization efforts, deployment strategies and vendor selection.

The present research aims to design a framework to help the TEIs in implementing ERP in an efficient way. Though operational efficiency is the main target for the research, it cannot be isolated from other important dimensions like user satisfaction, the costs and challenges for ERP implementation. The reasons for ERP failure or inefficient implementation could be due to the problems faced by the users in using the ERP solution. The present study aims to identify the problems faced by the users in TEIs, the challenges faced by management, various costs required for ERP implementation along with the factors that are important for user satisfaction. Also the perceived benefits from users of the TEIs are taken as targets for designing the framework for efficient ERP implementation in TEIs. The suggested framework, designed with inputs from 22 TEIs in India, will help improve the efficiency of ERP implementation and help the management to reduce the costs and realize the benefits.

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

Abbreviation	Full Form
AICTE	All India Council of Technical Education
API	Application Programming Interface
ASP	Application Service Provider
BPR	Business Process Reengineering
CMMI	Capability Maturity Model Integration
CRM	Customer Relationship Management
DQ	Data Quality
EAI	Enterprise Application Integration
ERP	Enterprise Resource Planning
FM	Financial Management
GUI	Graphical User Interface
HEI	Higher Education Institution
HRM	Human Resource Management
IaaS	Infrastructure As A Service
ICT	Information and Communication Technologies
IM	Inventory Management
IT	Information Technology

PaaS	Platform As A Service
SaaS	Software As A service
SAP	Systems, Applications, and Products in data processing
SOA	Service Oriented Architecture
TCO	Total Cost of Ownership
TEI	Technical Educational Institution
UI	User Interface

CHAPTER 1

INTRODUCTION

This chapter gives an introduction to various dimensions in the study.

1.1 ENTERPRISE RESOURCE PLANNING

Enterprise Resource Planning (ERP) consists of three words: Enterprise, Resource and Planning. 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 (Beheshti, 2006). In order to implement ERP, first IT systems must be available in the organization (Willcocks and Sykes, 2000). ERP system is also defined as the flow of information where the database is to save all enterprise data. The data in the enterprises increases with the passage of time (Swartz and Orgill, 2001). 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).

The academic institutions have been using ERP systems for more than a decade for managing the information and control, to achieve more efficiency and accessibility for all members. Also the aim of using ERP is to improve end user performance by providing better managerial tools in institutions (Kvavik et al., 2002). The educational institutions have many similarities and differences from business organizations as studied by Pollock and Cornford (2004). The institutions are termed as 'Unique' organizations. The difference lies in different structures, internal fragmentation, different purpose and limited measures for checking the benefits. These differences significantly affect the overall scope, design and approach to ERP implementation. ERP acts as an impetus for the replacement of a mix of aging legacy systems with a common platform for which Business Process Reengineering (BPR) was

used. BPR was considered to be a powerful tool in successful ERP implementation. BPR provides a unique way of customizing ERP (Koch, 2001). If done correctly, it would produce an increase in performance through the use of information technology. So there is a need to analyze all the processes required in technical educational institutions (TEIs) to be reengineered. The integration of all the processes is the final implementation stage. Also ERP systems may need to integrate with many other applications co-existing in the system.

The developers of ERP packages and the institutions willing to use ERP systems must identify what should an ERP package offer for TEIs. For this, it is necessary to find out the common services required by all TEIs. There are many ERP modules that are required in any TEI. These include human resource management, registration, finance, curriculum, examination, results, customer relationship management, inventory management etc. However, all these modules are not yet a part of all the ERP solutions used by various TEIs. There is a need to explore whether various TEIs in India are using the ERP solutions with these main modules. Also there is a need to verify the stage of ERP implementation in TEIs in India. There is an urgent need to identify the costs, benefits and challenges faced by management in TEIs in ERP implementation. Also there is a need to identify problems for ERP failure, perceived benefits and success factors for increasing user satisfaction from user's point of view in educational institutions so that a solution to handle these is decided. The present research has been initiated to design a framework for these. Here the framework has been proposed for TEIs but it may be applicable to other institutions also. The possible differences between TEIs and others is that of technical literacy, resource availability and applicability of the functionality of the whole framework.

1.2 ROLE OF ERP IN TEIs

> According to Eric Stine, director of higher education sales for SAP, "Currently ERP is viewed simply as a platform- technology as an end in and of itself – to power basic administrative processes… We are moving into an era where the University community witch build on that platform. The result

> will be technology as a means to an end- a way to more efficiently, effectively and profitably achieve long term goals" (EDUCAUSE 2002).

ERP systems are becoming an integral part of TEIs. The growth in the number of students, faculty, staff and research scenarios have increased the volume of transactions many-fold in educational institutions. So in order to maintain the effectiveness and efficiency of the administration systems, many higher educational institutions have implemented ERP systems. The ERP systems are described as standard platforms for better decision making information and institutional services. The core reasons for growth using ERP lies in the processes of reengineering, best practice and business process analysis and utilization of transaction systems (Kvavik et al., 2002; AlMashari, 2003).

Efficiency is a critical success factor in ERP implementation from the 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 enhanced benefits (Chou and Chang, 2008). In order to improve human efficiency, there must be some tool that can assist the humans in carrying out the 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. 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).

However existing ERP systems do not provide an efficient implementation as perceived by users in reality. There are many issues related to: people, business process reengineering (BPR), data migration, hardware and network configuration and cost overruns. The adverse effects of many of these have resulted in abandoning the ERP software. Therefore there is enormous risk associated with such bold initiatives. The failure to understand the relationship between investments and returns for institutions have led to failure in management of ERP systems. According to Swartz and Orgill (2001), TEIs have used ERP implementation as a building block for more advanced applications, such as e-commerce systems and portal technologies. This has led to spending of millions of dollars for ERP implementations. In a study by Kvavik et al. (2002), it is found that throughout the United States a number of universities have spent at least $5 billion dollars on ERP software.

If we consider the general scenario, ERP can be implemented by educational institutions in two ways

i) they can either custom design their own ERP software

ii) purchase software from one of the many ERP vendors in the marketplace

Both of these approaches have different investment scenarios. The development of custom-designed software is often too expensive to undertake and there are many problems and uncertainties with regard to development, updates and cost assessment. Many companies purchase ERP software from an ERP vendor. There are five main ERP system vendors which are successful in the ERP market. These are SAP, Oracle, JD Edwards, People Soft and BAAN (Kamhawi, 2008). Any TEI using ERP must be prepared to change the way in which it manages core administrative functions i.e. customization. In order to do this successfully it must also be prepared to tackle this as a major change in management project. The researchers found that default settings were accepted during ERP implementation and change often took place through a process of default rather than choice. The issue of default settings versus the maintenance of existing processes raises important questions of competitive advantage for TEIs in deciding whether to implement ERP and if yes, how they should go

about doing this. Both top management support and clear goals and objectives are important at all stages of ERP implementation.

1.3 BENEFITS OF ERP

There are a large number of benefits from ERP implementation which are identified by earlier researchers. The benefits include: replacing the older legacy systems with centralized ERP systems, modernizing the campus IT environment, for better services to students and staff, for better information for management and planning, to have the potential to decrease business risk and to enhance revenues by lowering costs through improved efficiency (Nah et al., 2001). ERP aims at increased efficiency of the system, business efficiency, improved communication and coordination (Spathis and Constantinides, 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, multifunctional and should manage the workflows in order to be efficient. ERP success refers to utilization of such systems to enhance operational efficiency and effectiveness (Ifinedo and Nahar,2006).

1.4 CHALLENGES OF ERP

There are many other challenges in ERP implementation. Flexibility in adoption of ERP is a challenge for ERP implementation success (Al-Mashari, 2003). Change management has been identified to be important for success in ERP Implementation (Hau and Kuzic, 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. To take advantage of the competitive capabilities of ERP systems, managers and employees must understand the basic principles of ERP for optimization.

Commitment by management is necessary to the success of an ERP system. This commitment needs to be incorporated into the business culture and employee population through the use of training programs. Security is an important challenge for ERP implementation which includes user authentication, authorization, time restriction and data security (She and Thuraisingham, 2007).

Most of the benefits and challenges identified have been true for business organizations where the process of ERP implementation started earlier. Educational institutions have entered only recently into this area and there is a need to identify and explore the relevance and use of ERP in these. It is with this perspective the present research has been undertaken to identify the important factors of ERP implementation in India to improve the efficiency and performance of TEIs. India is different in terms of its standing in the group of nations. It does not have sophisticated systems like developed countries and have better systems than under developed countries.

1.5 COSTS IN ERP

Modern Enterprise Resource Planning software is used not only in business for increasing the profits, speeding up the delivery and maintaining a healthy customer relationship but also for improving operational efficiency and effectiveness of information services. ERP software has been used by capital intensive industries, such as manufacturing, construction, aerospace, defense, finance, education, insurance, retail, and telecommunications sectors. ERP has been selected worldwide for its integration capability, reputation, standard software, three-tier client/server architecture, business engineering, and migration tool from the mainframe (Chung and Snyder, 2000).

The ERP solutions will likely continue to define the IT standards that could enable end users to integrate most of their information systems into one cohesive technology infrastructure. The business objectives of ERP solutions are customer services and lower cost for the

organization. All benefits though can be achieved at a higher cost. Thus cost constitute an important aspect that need not be ignored. The educational institutions investing in ERP are under pressure to lower their costs and achieve greater administrative efficiency (Abugabah and Sanzogni, 2010). The present research also tries to identify various costs involved in ERP implementation. Cost aspects covered in the research are ERP cost estimation and costs in ERP software. As cost involves increased expenditure, a trade off may be required between cost and benefits. Equally important is to assess whether it is feasible to reduce these costs. The present research also focuses upon identifying various methods of reducing the costs.

1.6 RATIONALE FOR THE STUDY

ERP in educational institutions and especially TEIs are more recent and the subject requires an in depth analysis. A successful implementation of ERP in TEIs can prove a backbone of business intelligence to TEIs by giving an integrated view (Parr and Shanks, 2000). So in the light of this, the present research has been undertaken to identify the success factors for efficient ERP implementation. It includes identification of the required features of ERP in TEIs, the importance of various modules in the institutions, costs, benefits, challenges and problems in ERP implementation.

1.7 ORGANIZATION OF THE THESIS

The thesis is organized in five chapters as explained below:

Chapter 1 - Introduction

This chapter is introductory in nature, providing a brief overview of the background of the research work. This chapter introduces the structure of the thesis. It covers the role of enterprise resource planning in technical educational institutions. It also covers the need and rationale for the study.

Chapter 2 – Review of the Literature and Identification of Research Gaps

In this chapter, different views of researchers on ERP implementation and success factors in TEIs are presented. In depth review of the ERP literature helps to know the emphasis and direction in which ERP has developed, the time periods of the studies, the success factors, the inhibitors, the costs and benefits and existing ERP frameworks for TEIs. It helps to identify the gaps in the earlier studies and provide the direction for research.

Chapter 3 – Research Design and Methodology

This chapter discusses the methodology of the research. The study uses both primary data and secondary data. It discusses the different methodologies adopted in the study, the population of the study, tools, methods of data collection and methods of data analysis. Secondary data has been used to identify the successful ERP practices used in educational institutions in the world.

Chapter 4 – Data Analysis and Discussion

This chapter covers the analysis and discussion of responses gathered through the questionnaires and presents the outcome of the various analyses. The chapter covers the ERP modules in TEIs, the perception gap in the implementation of these ERP modules in TEIs in India. The success factors and predictors of user satisfaction are highlighted through the factor analysis and regression analysis of three factors viz. functionality, security and quality respectively. The logistic regression analysis discriminates the factors in public and private TEIs. The overall benefits are categorized into technical and user factor using factor analysis. The relationship between costs and benefits is derived through regression analysis. Finally on the basis of the challenges, costs and learning paradigms studied and on the basis of the findings of the study, a framework is proposed along with its perceived benefits. All the aspects i.e., functionality, security, quality, costs, risk handling and user satisfaction are addressed in this framework. This chapter highlights all the factors considered in the proposed framework. It also summarizes the support from the literature supporting the

framework. The results of framework validation through case studies has also been summarized.

Chapter 5 – Conclusions and Future Scope

This chapter covers the learnings, recommendations and conclusions of the study and also highlights the recommendations regarding framework for efficient ERP implementation in TEIs. This chapter also involves a critical assessment of the work and contribution of research. The chapter also lists the further areas of research in TEIs. This sets the stage for designing an ERP framework covering all three aspects for improving efficiency and performance of TEIs.

CHAPTER 2

LITERATURE REVIEW

This chapter provides the literature review on need of ERP systems in educational institutions, existing ERP methodologies in TEIs, benefits, and costs in ERP. The chapter also covers various challenges, factors for user satisfaction and data quality along with risks in maintaining quality in ERP implementation in TEIs.

2.1 NEED FOR ERP IN TEIs

In recent years, governments have called for improvement in performance and efficiency in higher education. The educational institutions are pressurized to adopt new strategies to improve quality, performance requirements and competitive education environments. Consequently, the higher education sector has turned to e-governance and enterprise resource planning (ERP) systems in order to cope with the changing environment. As a result, existing management and administration computer systems have been replaced by ERP in educational institutions, to achieve more efficiency, accessibility of information for all users and improve end user's performance by providing better managerial tools (Pollock and Cornford, 2004).

ERP systems are comprehensive packaged software solutions which aim for total integration of all business processes and functions (Parr and Shanks, 2000). Many ERP implementations fail due to lack of quality in management of these systems. A number of researchers have identified critical success factors in successful ERP implementation. Successful factors of ERP implementation are: focused performance measures (Al-Mashari and Al-Mudimigh, 2003); commitment by top management (Wu and Wang, 2006); data accuracy; extensive education and training (Mohamed and McLaren, 2009; Zhang and Zhang, 2010).

ERP implementation is not always successful due to many reasons. Major causes of ERP failure in educational institutions identified are: lack of executive level commitment and leadership in management ; cultural issues like improper education and training to staff (Wu

and Wang, 2006); non-value added processes ; unrealistic expectations from the ERP; lack of data software quality and reliability which lead to ERP failure (Maheshwari et al., 2011).

2.2 EXISTING ERP METHODOLOGIES IN TEIs

Many researchers have studied ERP implementations in various universities and higher education institutions (HEIs). These are represented here in the chronological order from year 2001 to 2012.

In 2001, the benefits of ERP as reported by Swartz and Orgill (2001) include : improved access to accurate and timely information, user-friendly web-based interface, streamline processes and easy adoption of best business practices, reduced reliance on paper, automated e-alerts etc. They also provided the breakup of the costs for ERP which included the cost of consultants, cost of rent, employees salaries, capital expenses and operating expenses. The consultant cost was reported as the major contribution of cost. The framework is shown in figure 2.1 below:

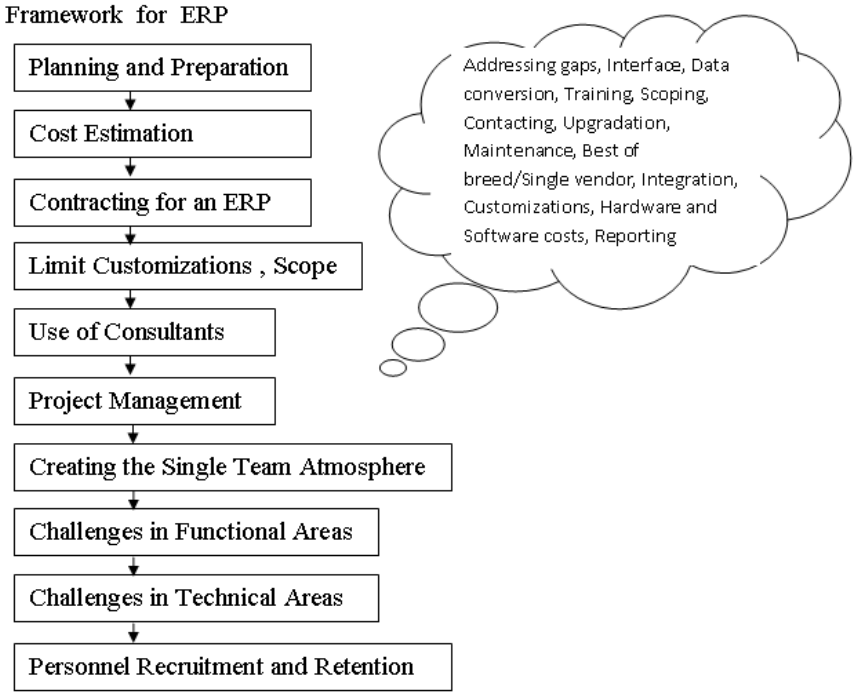


Figure 2.1 Framework for ERP in Universities (Swartz and Orgill, 2001)

Antonucci and Muehlen (2001) provided a description of the student's feedback of an international collaboration between two universities (one in U.S. and other in Germany) to address the issues of new e-centric business practices. The collaboration deployed the web to link the students dispersed geographically and a case scenario methodology which utilized SAP R/3 was used. The case scenarios that were developed allowed each University to remain autonomous by utilizing the concept of outsourcing portions of the business process. This provided an effective collaboration method between remote participants in universities which permitted the students to focus on the design and implementation of a business to business processes enabled by an ERP system. According to McConachie (2001), the benefits of ERP implementation should be considered from three levels namely the researcher, the University and the broader business community. In a case study of Central Queensland University (CQU), he concluded that culture influences the success or failure of ERP implementation.

In 2002, the characteristics identified by the Gartner group for ERP in higher education are modular structure and integrated system along with multiple scope. Out of 256 institutions surveyed by Educause Center for Academic Research, King et al. (2002) identified the factors affecting the vendors selection, the modules installed by implementers and the reasons for implementing ERP systems. They also studied the degree to which the implementation and how much they adhered to original implementation timeline. They reported that managing process and organizational change was very difficult along with customization. 87% respondents from staff and 78% from students reported that they benefitted from ERP implementation. The major challenge identified was the integration of ERP keeping in mind the people perspective instead of solely technical perspective. Nielsen(2002) investigated critical success factors in Australian University environment. He developed a theoretical framework for use and usefulness of ERP in universities. A number of critical success factors were identified for universities. Yakovlev (2002)has summarized various lessons learned from ERP implementation of PeopleSoft SA at the University of Wisconsin-Superior(WSU). The main focus is on data quality. Sharing of data across ERP system has the challenge of adding time dimension to data as well as to eliminate the

duplicate records. According to Yakovlev, the maintenance of legacy data not migrated to the ERP system along with upgrades is common challenge for ERP implementers.

Frantz et al. (2002) compiled a list of ERP implementation best practices for higher education institutions. They sampled 308 chief financial and information officers at 170 higher educational institutions throughout North America and found that the survey respondents ranked highest the statement regarding the endorsement of the implementation project by executive management. Top management support along with additional financial support for ERP implementation are the most important factors for ERP implementation success. Allen et al. (2002) identified critical success factors for ERP in public sector institutions. In a case study of four institutions, they suggested that to handle problems in business process reengineering impact of ERP systems, use of communication and change management procedures can help. They identified cost feasibility of system integration, training and user licenses as crucial factors which may impede ERP system utilization. Kvavik et al. (2002) have identified leadership, communication, central ownership of data, training, external assistance and the role of customizations and modifications as important critical success factors along with other factors such as learning and reporting for a promising ERP.

Thavapragasam (2003) in a case study of an Australian University, on examination of PeopleSoft Student Administration Module indicated that the users were not satisfied with the benefits of the system and the cost of the system. In order to get more benfits realized from ERP implementation, user-centered design of interface should be chosen. Seng and Churilov (2003) identified nine major processes for higher education enterprises. These are: business support, human resource management, grants management, material and services support, organization management, records management, student management, studies management, and University marketing. Weir and Mickool (2003) have identified the issue of buy versus assemble of ERP software solutions for universities. According to him, assembly approach can provide more independence and flexibility.

West and Daigle (2004) have identified the total cost of ownership (TCO) of ERP in universities. They have identified 5 major ERP life cycle costs and direct and indirect costs in ERP. The costs in ERP life cycle costs are costs of acquisition, implementation, operations, maintenance and replacement. In order to do a total cost of ownership analysis, direct and indirect costs need to be measured. Costs related to hardware, software, clients, servers, networks, peripherals, fees etc are direct or budgeted costs. Indirect costs include the cost of downtime and services to end users. Similarities and differences between other organizations and universities (in UK) in the use of ERP systems have been identified by Pollock and Cornford (2004). According to them, ERP systems are potentially a costly and high risk strategy for two reasons:

(i) ERP attempts to integrate and link together the whole range of functions across an organization and, therefore, if there are any problems with implementation, or if one part of the system does not work as expected, then the University may have to write off the whole investment in ERP.

(ii) Second, ERP systems are built with generic users in mind and systems rarely translate across the boundaries between organizations in the public and private organizations. Because of this generic type of system, universities must be confident that the ERP system implemented is the best match to their current and future business processes. If the ERP system fails to meet the University's unique needs, then the University must customize the system and this can cause a whole new set of problems (Pollock and Cornford, 2004). Thus the most costly affair for University authority in ERP implementation is customization because otherwise the cost is of adapting the organizational processes embedded in the software. The universities are to adopt the generic solutions provided by the ERP vendors. So the concern is to have a balance between the benefits provided by generic ERP solutions and specific requirements of the universities.

Zornada and Velkavrh (2005) presents research results in the field of ERP systems and their use in higher education institutions in Slovenia and abroad. The conclusion drawn is that higher education institutions should focus on informatics for quality assurance.

Fisher (2006), in a case study of three Australian universities identified the influences impacting the outcomes of ERP implementations. The research formed the basis for the development of guidelines for the effective and efficacious management of ERP implementations in these universities. Mehlinger (2006) focused on the characteristics of transformational leadership theory and its significance in predicting performance within a University. He used transformational culture as a predictor of the level of success of an ERP implementation. The case study included 10 campuses in a University system with an installed ERP system. The culture scores were correlated to the institutions degree of ERP implementation success. The results indicated that organizational culture had little or no impact on the successful implementation of an ERP system.

Davis and Huang (2007) examined the application of ERP software to the student information management in higher education at a Midwestern University. User satisfaction was found to be the most critical success factor for measuring the success of ERP implementation. The survey responses revealed that if the new system has improved user's work processes, only then it can add to effectiveness of ERP. For this, the users should have adequate support and training.

Alghathbar (2008) explored the implementation of an ERP system at King Saud University (KSU) in Saudi Arabia. It is one of the largest universities in Saudi Arabia with 22 colleges and 10 research centers. He highlighted various challenges and the positive factors required in implementing the ERP. He proposed that investment should be done with regard to change management and should change according to organizational preferences. A good project team should be selected and communication with the user should be continuous. Kwon (2008) has identified major activities in University ERP as shown in Figure 2.2 below:

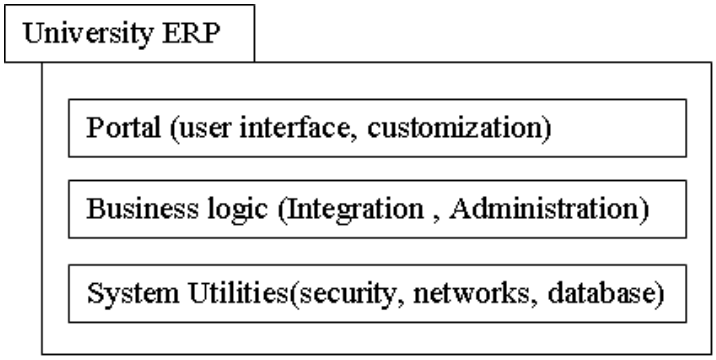


Figure 2.2 : Components of University ERP (Kwon, 2008)

Vathanophas and Lindsay (2009) have studied the impact of ERP in Thai universities. The universities selected for study were Chiang Mai University, Khon Kaen University, Mahasarakham University, Burapha University, Ramkhamhaeng University, Sukhothai Thammathirat Open University, Kasetsart University, Chulalongkorn University, Thammasat University, Mahidol University, Bangkok University, Prince of Songhkla University, Taksin University. The main factor found lacking was knowledge related to ERP system. Resources like computer and technology staff were also reported as scarce which limited the benefits which could be achieved from ERP implementation. Rashid et al. (2009) have studied an industry-academia qualitative analysis. The emphasis is placed on ERP Technovation - diffusion that is required to be executed for optimum ERP-diffusion of knowledge areas. The collaboration of leadership in industry and academia can provide better resource pooling to balance efficiency and effectiveness.

Iuliana et al. (2009) have identified how ERP can help in improving efficiency and effectiveness in a Romanian higher education institution. Use of ERP can help in improving the competition in the education sector. High cost and time is required to develop scalable and flexible ERP systems in higher education institutions. The major threat identified is the missing requirements for which prototyping is suggested. Reuse employing object oriented modeling and through the phases proposed in the framework can be one of the solutions to reduce the costs and reap the benefits of ERP.

Mohan (2009) analyzed the principles applied at Kent State University for ERP implementation. The important factors identified are higher costs of training and external assistance in ERP. The benefits could be achieved in terms of efficiency, effectiveness, reduced business risk and customer satisfaction. Sullivan (2009) investigated post ERP implementation experience in 6 higher education institutions to maximize the benefits. It was found that the ERP did not fit into exact needs of the universities. Also there is a need to improve the user understanding of ERP use to gain more benefits. So cost is mandatory for training. Technical support is needed at regular basis.

Wang (2010) studied an academy-oriented resource planning in Chinese Academy of Science. This study reinforces the need for resources in institutes should be for education and training in ERP. The author has proposed an architecture of academy oriented resource planning and a technical framework. Abugabah and Sanzogni (2010) have given the implications of ERP in higher education through literature review. They have suggested that most critical factors must be evaluated in order to explain the actual benefits that can be achieved through ERP systems by users and higher education institutes. Lack of user motivation is found to be the main factor that can lead to ERP failure. Further, under utilization of ERP resources is a critical concern for ERP success.

Maheshwari et al. (2011) have identified challenges and opportunities for ERP implementations in educational institutions. Benefits reported are classified as qualitative and quantitative. The measurable or quantitative benefits include big savings in person-hours, savings from phased-out legacy systems, increased productivity, efficiency and revenue, automation of various functions and hence streamlining the education processes. Qualitative benefits include improved process, data and operational security. Also transparency and accountability is enforced. Ahmad et al. (2011) proposed a framework for ERP in a Malaysian institute. They have identified four phases and critical success factors in ERP implementation for higher education institute. The four phases suggested are project initiation, project implementation, realization, operation and maintenance. Quality assurance

and coordination of resources are the critical success factors that are included in all phases. One needs to check for costs of these. Aldayel et al. (2011) have identified critical success factors of ERP implementation in 12 universities in Saudi Arabia namely King Saud University, King Fahd University of Petroleum & Minerals, Qassim University, Al-jouf University, Hail University, King Abdullah University, King Saud Bin Abdulaziz University, Taibah University, Islamic University in Almadinah, King AbdulAziz University in Jeddah, King Faisal University and Shaqra University. The critical success factors identified are choice of supplier and his support, resources support and training, project management, business process reengineering and customization.

Bhanti et al. (2011) identified architecture for data warehouse for e-governance in higher education institutions as shown in Figure 2.3 below:

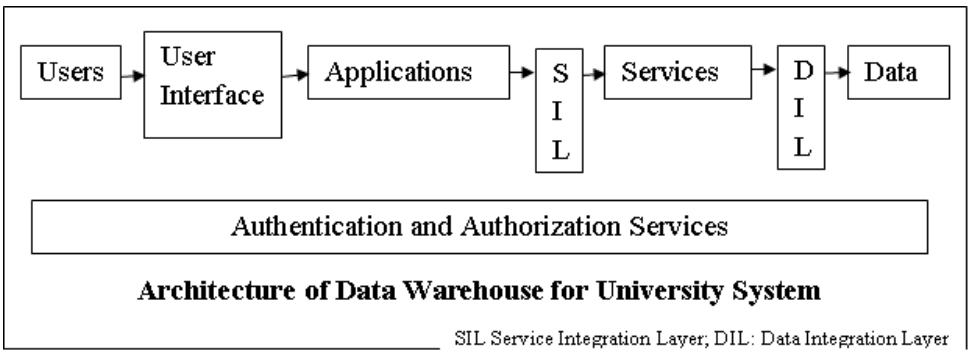


Figure 2.3 Architecture of Data Warehouse for University System (Bhanti et al. 2011)

Ghuman (2012) formulated a framework for effective ERP implementation in educational institutions based on various issues, problems and critical success factors affecting the successful implementation of ERP in educational institutions. Resistance from employees and training cost was affecting the effectiveness of ERP to a high level. The cost of acquisition of software and vendor support were not reported as major hindrance. Fig. 2.4 highlights the universities implementing ERP included in the literature review.

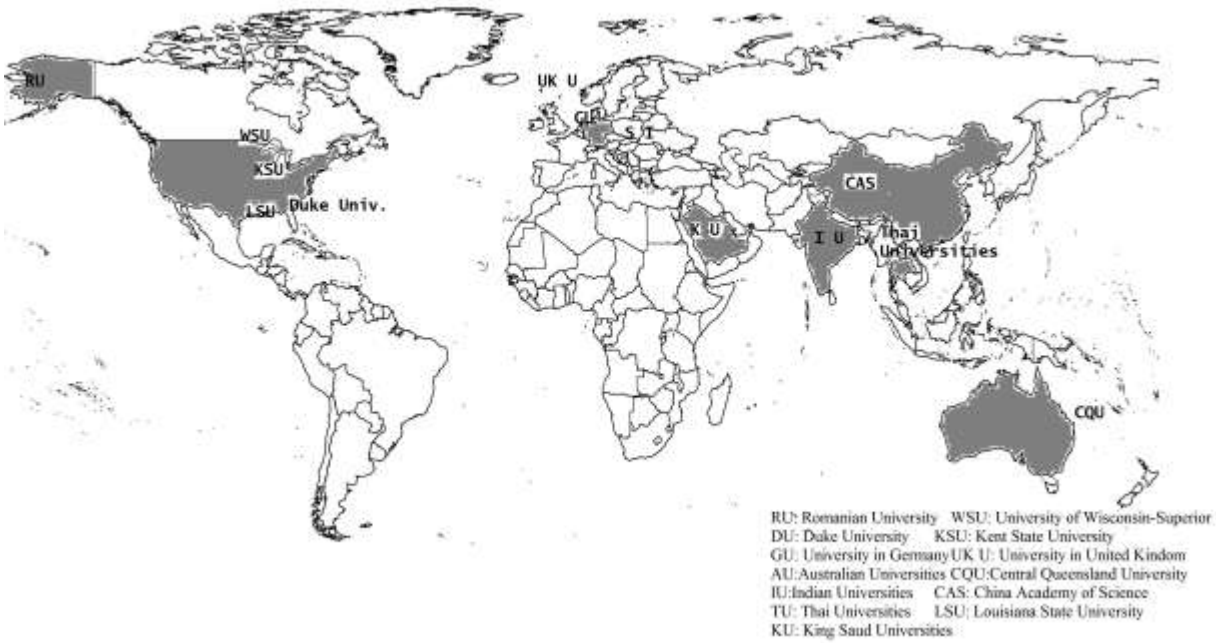


Figure 2.4: Universities with ERP implementations

Thus, the present study has done an extensive literature survey and tried to cover almost all the context to get a deeper insight into the critical success factors, the implementation hindrances and the associated costs and benefits of ERP. The next section covers the detailed review on benefits and costs of ERP.

2.3 BENEFITS OF ERP FOR TEIs IN EDUCATION

ERP provides planning for resources in an enterprise so that all the data and information can be stored at a central place (i.e., database) under the control of the administrator and can be accessed by all the units as per their access rights. ERP promises the seamless integration of all the information flowing through an organization – financial and accounting information, human resource information, supply chain information and customer information. ERP management helps the top executives to plan and organize the data and information to take effective strategic decisions. All other users get systematic procedures to store and access the data and information. Thus the main advantages of ERP software are: integration of

information and modules in the enterprise (Nah et al.,2001), reduced development risk, increased global competitiveness, business efficiency (Themistocleous et al., 2001), improved communication and coordination, task efficiency, data quality, better decision making, increased customer satisfaction, shared data and activities throughout the entire enterprise, easy generation of information, improved information accuracy, generation and accessing of information online (Willis and Willis-Brown,2002), improving organizational effectiveness and productivity and enhanced competitiveness of the organization in the market (Skibniewski and Zeng, 2010). Other organizational benefits include facilitating learning, empowering employees, building a culture with common visions, and improve employee morale and retention (Al-Mashari,2003; Shang and Seddon,2000), improved IT architecture, reduced maintenance burden through outsourcing and increased profitability (Hendricks et al., 2007).

The main category of benefits identified by Shang and Seddon are IT infrastructure, operational, managerial, organizational and strategic. Based on the literature review above and the framework developed by Shang and Seddon (2000), the main benefits in these categories which TEIs can achieve through ERP are summarized in table 2.1 below:

Table 2.1: Benefits of ERP for Technical Educational Institutions

Organizational	**IT Infrastructure**	**Managerial**	**Strategic**	**Operational**
-Changed culture with common vision -Broaden employee's skills -Supports organizational changes and corporate governance	-Reduced IT spending in future on ERP is in place -Easy implementation of new applications	-Better Resource Management (e.g. human and inventory) -Improved financial management and better report generation -Improved coordination and communication among all users	-Administrative Cost reduction -Improved planning and decision making for growth -Improve alignment of strategies and operations	-Improved response -Ease of user data access and inquiries -Quality improvement through reduction in errors -Better performance measurement and control

The benefits can be categorized from the point of view of two users. One is top management which aims at benefits in terms of IT infrastructure, managerial, organizational and strategic viewpoints. These benefits are for better management in TEIs while providing a good environment for education. ERP requires online management of all academic activities. This will require a culture change in TEIs which will also broaden the employee's skills. The management also aims to invest once in IT infrastructure and get benefits during implementation for a longer time. The management can also take good control for multiple campus sites for a common vision and strategy policy implementation. These all are required for maintaining a good environment for better education. The other beneficiaries are the faculty and students which gain benefits in terms of operational efficiency. In any TEI, the evaluation system is an important consideration for standards of good education. In education, the examinations and results are an important part and a lot of quality time can be wasted in these activities if all are done manually. The use of ERP modules help in reducing the time for performing the required tasks efficiently so that time can be utilized in productive work like research. Online course materials and online assessments can also improve the response time and hence save time and energy of both the students and the faculty. Online queries can help the students save their time. If academic activities are performed online, the chances of errors are reduced and hence efforts for corrections are also reduced. This can help in enhancing the quality of education imparted in any TEI.

2.4 COSTS IN ERP

ERP planning is the first phase in the overall ERP implementation life cycle. Cost estimation is an important activity of the planning phase. Cost overrun is one of the most critical risk in ERP implementation. Even properly planned, ERP projects end up incurring more costs than estimated. Though cost estimation is a difficult task, it is very important in order to meet the budget requirements. A framework developed using system dynamics simulation modeling of a case study organization can help the organizations to better predict the long-term cost of ERP systems in a better way, to identify key cost drivers, and to determine what dynamic relationships customizations have on total cost of ownership.

Main costs important for ERP are found to be consultation cost, architecture cost, implementation cost, integration cost and maintenance cost. The costs of the consultation before the procurement are a big portion of ERP system (Ziaee et al., 2006). The professional charges payable to the outsider also depends on the extent of the services availed by the company. The architecture of ERP systems have three distinct features. First is data dictionary which specifies thousands of domains that are associated with supporting fields and arranged in numerous tables which could be used across all functional areas within an organization for sharing of data. Second is the middleware which could make distributed systems possible by allowing users to set up application modules and databases at different locations. Data could be moved from a central system to a remote system, permitting applications to exchange information between them. The middleware not only routes data, but also knows what data are needed in a given situation. Third is the data warehouse which captures all semantics in the business processes, business objects, and organization model including all meta information about models, technical programming objects, and business objects. The ERP repository is able to exchange information via application programming interfaces (API). These three technology features are used to coordinate marketing, manufacturing, distribution, and human resources tasks in the organization. When an integrated ERP is in place, an organization can build whole enterprise applications on top of it. The architecture for IT alignment is given in Figure 2.5 below:

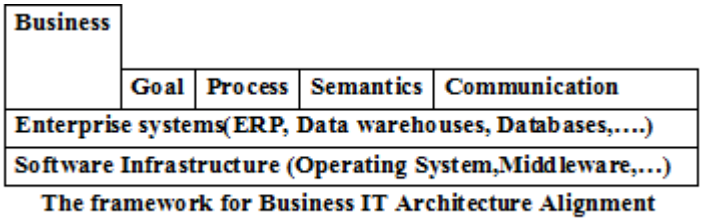


Figure 2.5: Framework for Business IT Architecture Alignment

Any given ERP system cannot fit as per the complete requirement of any organization in spite of the fact that they have business practice processes in their repository. So the organization needs to select those applications available from software vendors for its specific requirements, and integrate both the applications and ERP system into the

organization's IT backbones. Integration of other applications or software with ERP is not easy. So the organization needs to modify or adapt the current ERP which is a costly affair. The major cost factor is in integrating ERP with other applications or software (Chung and Snyder, 2000).

Along with integration, customization cost consists of cost of adapting the organizational processes embedded in the software. Customizations include all the exercises from business process engineering to gap analysis to actual restructuring. Modifying and transferring data and systems from the old form to new form is a costly affair (Pollock and Cornford, 2004).

Maintenance is the longest phase of the ERP lifecycle. There is an opportunity to improve the system in a variety of ways including business process reengineering (BPR) and extending the use of delivered functionality (Willis and Willis-Brown, 2002). The companies should have better insights in and control over the processes like maintenance and evolvability to improve business and software development processes in order to increase productivity, reduce costs, improve quality, and thus strengthen their position relative to their competitors . In order to reduce long-term maintenance costs, Business Process Reengineering (BPR) is encouraged in order to take full advantage of the ERP software but it is difficult because it requires significant enterprise-wide change management which results in high upfront costs. To address evolvability during the whole lifecycle of the system and to maintain the enterprise system at reasonable costs, companies have a strong need at the level of software architecture (Breivold et al., 2008). In order to take complete advantage of ERP systems, and to control TCO, ERP implementations require drastic structural and cultural changes within the organization including BPR.

Besides this, the other costs found important for ERP implementation are: cost of developing interfaces and training (Davis and Huang, 2007), cost of standardization and cost of change management (Alghathbar,2008), cost of technology (Vathanophasa and Lindsay, 2009), cost of updates (West and Daigle, 2004), cost of standardization (Swartz and Orgill, 2001) and cost of risk management. Attention should be given for handling these costs.

2.5 CHALLENGES IN ERP IMPLEMENTATION IN TEIs

There are many challenges in ERP implementation. Enterprise systems impose their own logic on a company's strategy, organization and culture. The ERP package contains many modules which need to be integrated. According to Davenport, the larger the number of modules selected, the greater the integration benefits, but also, the greater the costs, risks and changes involved. ERP implementations are challenging due to cross-module integration, data standardization, adoption of the underlying business model, compressed implementation schedule and the involvement of a large number of stakeholders (Soh et al., 2000). Due to competition among institutions, there is pressure on management for improved administrative operations (Allen et al., 2002). Along with internal integration, an added complexity is the integration of ERP environments with non-ERP environments, which has complex management implications (Ash and Burn, 2003). The complexity increases with increase in the number of implementation modules (Aloini et al., 2007). The ever expanding amount of information also leads to an increase in system integration complexity (Youngberg et al., 2009). It will be beneficial to fit business processes to the ERP package rather than customizing the package because excessive customization leads to many problems (Momoh et al., 2010). The level of customization is an implementation approach issue that must be considered when applied to an ERP solution. Helo (2008) argues that from a technical point of view, the key choice in ERP implementation is to find an optimal strategy to balance between customization of the ERP system versus changing the organizational procedure within the company.

ERP implemented is not successful in all enterprises. So it is very important to implement ERP in a phased manner and in the proper way to get the maximum advantage of the implementation. Here lessons from ERP implementation in organizations can be helpful for TEIs, in order to avoid the blunders committed in enterprises on ERP implementation. This has been identified by many researchers. They have also identified the reason for failure of ERP implementation. Users resistance to change and poor training are critical challenges in ERP implementation which are responsible for ERP failure (Koh et al., 2006). Momoh et al.(2010) have identified an expanded list of challenges faced during ERP implementation in

enterprises over 13 years from 1997 to 2009. Excessive customization, dilemma of internal integration, poor understanding of business applications and requirements, lack of change management, poor data quality, misalignment of IT with business, hidden costs, and lack of top management support are the identified challenges as shown in Figure 2.6.

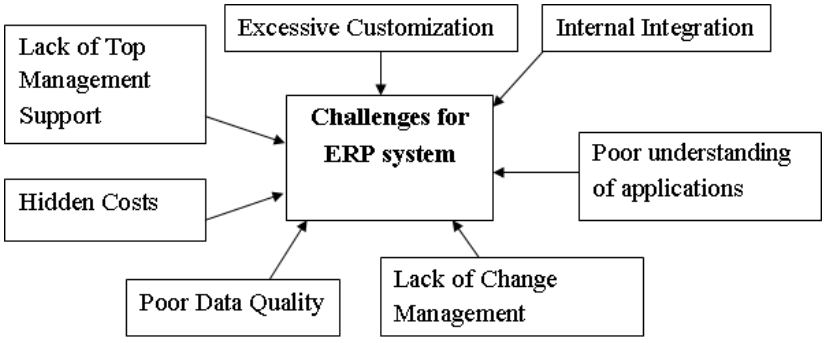


Figure 2.6: Challenges for ERP Success (Momoh et al., 2010)

2.6 DISRUPTIONS FOR ERP IN TEIs

The main reasons for failures are disruptions caused in a system. In order to assess the security of an ERP system, the common disruptions leading to vulnerabilities need to be identified. A total of 25 technical users from TEIs were consulted using unstructured interviews as an information gathering tool for identifying the major disruptions in ERP in TEIs. The major technical disruptions identified in ERP system in a TEI are network failure, failure of surveillance system and interface issues. These can cause vulnerabilities like attack on the web-based interface for getting the database configuration management, attack on network devices, wireless access points etc. Poor security system, inadequate training and poor error tracking system have been identified as organizational factors. Due to gap in security of the network, attackers can get access to network's critical assets. Poor error attacking system can cause serious attacks unnoticed which can consume system resources. The error by the person operating the ERP system can also cause the failure of the system. The wrong intensions of the users in ERP may cause malicious attacks in the system like man –in-the-middle attack, phishing and spoofing attacks etc. Various sources of disruptions which may cause vulnerabilities in ERP in TEIs are shown in Figure 2.7 below:

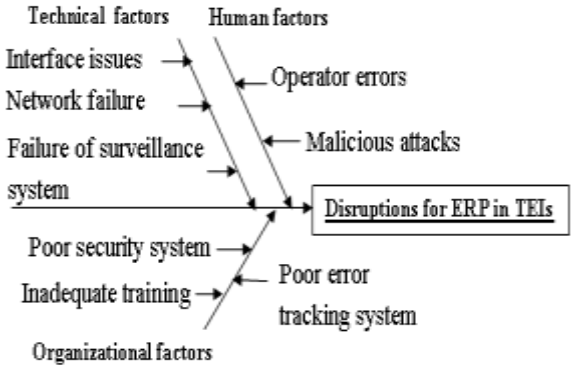


Figure 2.7 : Disruptions for ERP in TEIs (Goel et al., 2012)

2.7 RISKS IN MAINTAINING QUALITY IN ERP IMPLEMENTATION

Project management including risk management has been mentioned as one of the critical factors in ERP implementation (Themistocleous et al., 2001; Scott and Vessey, 2002; Kumar et al., 2003; Kim et al., 2005; Chen et al., 2009). Thus, undertaking good project management is the need of the hour. Though ERP implementation seeks to streamline and integrate all the activities of an educational institution, still there are many risks in the ERP implementation. These are:

a) Authenticity: Users may illegally access accounts. The people who are not a part of the system may hack the confidential data and this can be dangerous.

b) Authorization Security: Authorization control of the central database is a critical issue. One unauthorized access may lead to failure of the whole system by exposing sensitive and confidential information.

c) Non availability of resources: Requirements for internet or local network may increase drastically with the use of ERP in the TEI. Failure of network even for a small amount of time may result in chaos or delay in processing of important information.

d) Complexity of Capacity: As the number of users in the educational institutions increase every year, data of users also increase. This could lead to the problem of storage capacity of the system.

e) Poor response time: Due to simultaneous access of network, the efficiency of the system may reduce which may cause more processing time than usual. This may frustrate the users.

f) Interoperability: If different modules need data in different formats, then there is a problem of data conversion. This may lead to wrong interpretation of data. Data conversion may be time consuming or difficult too which further increases the overhead in use of ERP solutions.

g) Difficulty in integration: ERP implementation in parts may lead to issues like wrong integration of modules, wrong information flow between modules, missing information between modules.

h) Poor recoverability: The integration of information is done at a common place called repository or a database. This single point in case of failure or getting corrupted, can result in a disaster. All the information may be difficult to be recovered. This could contain critical information also.

i) Poor understandability: Documentation provided with ERP solution for technical people as well as users may be inadequate resulting in poor usability and understandability of the system.

j) Vendor dependency : Poor support from vendor can cause a system failure or delay in installations, changes or upgradations and hence maintenance. The institutions may even be

solely dependent on vendors to impart training for modifications or alterations incorporated in ERP.

2.8 USER SATISFACTION AND DATA QUALITY IN ERP

The success of any system is measured through the satisfaction of its users. Quality of information, data and system along with user satisfaction is an area of research since the beginning of ERP. The first framework for ERP success considering user satisfaction was given by Delone and Mclean (1992). It is shown in Figure 2.8.

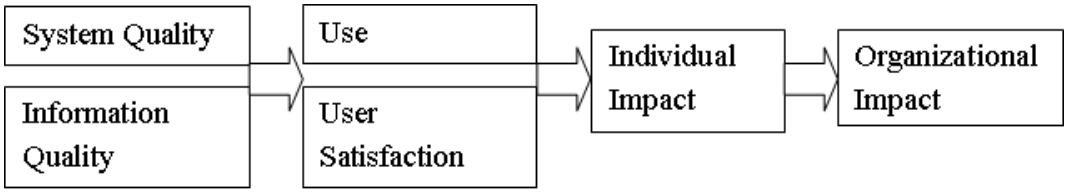


Figure 2.8 : Mclean Success Framework (Delone and Mclean, 1992)

According to Gable et al. (2003), the success of ERP system is dependent on quality of system and quality along with individual and organizational impact. The model is shown in Figure 2.9 below:

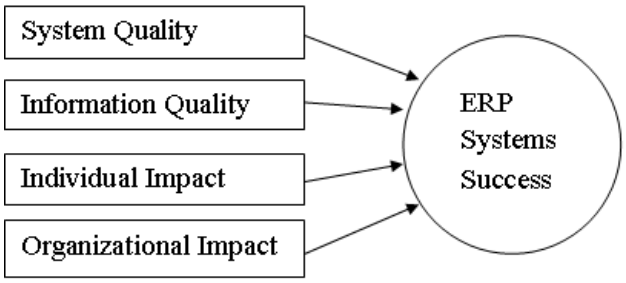


Figure 2.9 : ERP Success Framework (Gable et al., 2003)

This model was further extended by Ifinedo (2006). He added two new dimensions for success measurement. These were the quality of vendor communication and the impact of the workgroup also along with individual and organizational impact. The ERP success measurement model is shown in Figure 2.10 below:

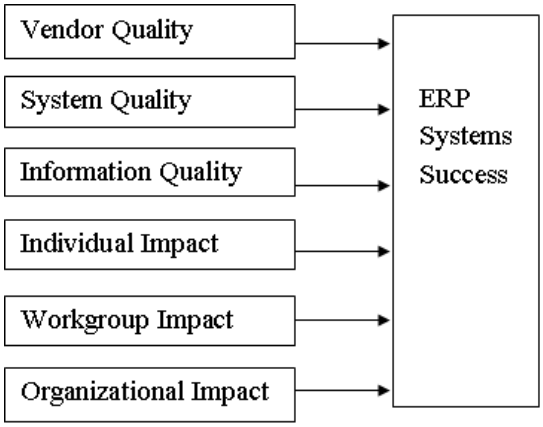


Figure 2.10 : ERP Success Measurement Model (Ifinedo, 2006)

The ERP often supports industry specific functions like business functions, high volume warehousing transactions for retailers, patient management in hospitals and student administration at universities etc. (Al-Mashari, 2003). Prior to ERP implementation, all the operations in TEIs were performed in traditional ways. Transforming all the operations to online mode is a tedious job and requires many organizational changes. So the TEIs must be able to manage organizational change for successfully implementing ERP systems (Frantz et al., 2002). Implementing organizational change involves many challenges. All the operations include data and information processing. Information is collected from data and data is very crucial in ERP as the data needs to be stored from all the enterprise modules at a central place and made accessible to all. Quality of data is defined as data that is fit for use by data consumers in a framework for understanding data quality issues given by (Xu et al., 2002).

The data consumers in TEIs are top management, technical staff, faculty and users. The data stored in one ERP module is accessed by other ERP module for producing the desired information and results. Thus, the quality of data entered in any ERP module in important. If

the quality of data input in one ERP module is not good, then it can have negative effect on the functionality of other ERP modules (Haug et al., 2009).

As data is central for any ERP system, there are many challenges related to data quality which can cause dissatisfaction among users and hence failure of ERP implementation. Case studies on ERP implementation in industries show that the ERP projects did not produce the expected benefits because they were lacking data quality (Umble et al., 2003). Data quality focuses on the quality of information which any information system produces as output. With increase in the number of users, the user's data is increasing day by day. The growing volume of data may result in inefficiency in storing, managing and processing of information (Vayghan et al., 2007). This growing volume of data may also cause the problem of scalability (Roberts, 2010).

Prior to the starting the use of ERP in any organization, many factors need to be considered like top management commitment, training facilities, infrastructure and human resource planning etc.(Wei et al, 2008). The success of ERP implementation can be judged by many evaluation measures such as evaluation of attained benefits, evaluation of misfit resolution strategies and evaluation of user and organizational learning (Nicolaou, 2004). There is a need to develop a standard user satisfaction criteria to assess users' satisfaction with ERP system implementation success (Thavapragasam, 2003; Davis and Huang, 2007). There are ERP software like SAP University Alliance program, which provides good functions for technical institutions but the constraint of cost is a hindrance in its use. The solution to cut the cost is open source ERP. But there are many problems and risks in using open source ERP software (Huynh et al., 2011).

All ERP solutions focus on different aspects of quality. There are various dimensions in which data quality can be measured. The literature supported the data quality attributes are shown in Table 2.2.

Table 2.2: Data Quality factors for ERP	
Data Quality factor	**Support in literature**
Accuracy	Wang et al., 1996; Naumann et al., 2000; Klein 2001; Eppler et al., 2002; Zornada et al.,2005; Carlo et al., 2011
Accessibility	Wang et al., 1996; Dedeke 2000; Eppler et al., 2002; Haug, 2009; Tsinidou et al., 2010
Availability	Dedeke 2000; Naumann et al., 2000; Klein 2001; Tsinidou et al., 2010
Amount of data	Wang et al., 1996; Naumann et al., 2000; Klein, 2001;
Consistency	Dedeke 2000; Eppler et al., 2002; Zornada et al., 2005
Completeness	Wang et al., 1996; Dedeke 2000; Naumann et al., 2000; Zornada et al., 2005; Wei et al, 2008
Concise representation	Wang et al., 1996; Dedeke 2000; Naumann et al., 2000; Eppler et al., 2002
Efficiency	Dedeke 2000; Calisir et al., 2004; Wei et al, 2008; Tsinidou et al., 2010
Interoperability	Wang et al., 1996; Dedeke 2000; Naumann et al., 2000; Calisir et al., 2004
Maintainability	Eppler et al., 2002; Zornada et al., 2005
User readiness	Zhu et al., 2000
Reliability	Naumann et al., 2000; Wei et al, 2008
Reputation	Wang et al., 1996; Naumann et al., 2000; Wei et al, 2008

Security	Wang et al., 1996; Dedeke 2000; Naumann et al., 2000; Klein 2001; Eppler et al., 2002; Zornada et al., 2005; Wei et al, 2008
Timeliness	Wang et al., 1996; Dedeke 2000; Naumann et al., 2000; Eppler et al., 2002; Tsinidou et al., 2010
Usability	Calisir et al., 2004; Wei et al, 2008; Tsinidou et al., 2010
Usefulness	Calisir et al., 2004; Haug, 2009
Understandability	Wang et al., 1996; Naumann et al., 2000; Klein 2001; Calisir et al., 2004; Tsinidou et al., 2010
Value addition	Wang et al., 1996; Dedeke 2000; Naumann et al., 2000

TEIs involve planning, administration and evaluation of efforts in order to incorporate data quality. Thus, data quality is an important consideration for ERP implementation success (Zhang et al., 2005).

2.9 GAPS IN LITERATURE

The exhaustive review done on all aspects of ERP highlight that there are many aspects of ERP which are researched. The attention is given to ERP system success through user satisfaction, data and information quality, security. The benefits as perceived by users are also discussed by various researchers. The costs and challenges from management perspective are also studied in detail. Though there is wealth of literature available on ERP implementation, there are many issues like relation of all these aspects with respect to efficiency of the ERP system. Thus there is a need to identify the critical parameters which can affect the efficiency of ERP and ways to improve these.

CHAPTER SUMMARY

This chapter summarizes the findings of many researchers related to ERP implementation. It covers the critical success factors covered by many researchers. Since the concept of ERP was initially started in business organizations, the chapter includes the ERP implementation costs, benefits, challenges, risks and critical success factors in business organizations as well as educational institutions. This chapter identifies the broad areas of research. The next chapter is going to focus on detailed methodology to set the framework for research.

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

This chapter provides the research design, sampling, methods of data collection, sample selection and survey areas and methods of data analysis.

3.1 RESEARCH DESIGN

The present study aims at developing a framework which can be useful for efficient implementation of Enterprise Resource Planning solutions in any technical educational institution (TEI). The study uses a descriptive research design.

3.1.1 Objectives of the Study

The objectives of the present study are:

1. To study and analyze the prevalent methodologies in the ERP solution implementation.
2. To understand cost benefit analysis of ERP solutions.
3. To design a framework for an efficient ERP solution implementation.
4. To verify and validate the proposed framework.

3.1.2 Investigation Approach

- Examine the existing methodologies for ERP implementation in various technical educational institutions and universities all over the world and list the findings. This has been done through literature review of ERP in various universities of the world.
- Study various problems and challenges reported by various researchers in successful ERP implementation in TEIs. Through literature review, an effort has been made to identify the problems and challenges reported by various researchers in ERP implementation.

- Study various benefits and costs in ERP implementation in TEIs through a questionnaire on costs and benefits.
- Design questionnaires and interview questions for seeking opinion of all stakeholders.
- Analyze and interpret the data using the appropriate data mining and statistical techniques like reliability analysis, Chi square tests, factor analysis, linear regression and logistic regression.
- Design a framework for the efficient ERP implementation in TEIs
- Verify and validate the framework through case study and literature.

3.2 RESEARCH METHODOLOGY

3.2.1 Sampling Details

The survey was conducted in three parts. In the initial phase, a questionnaire was designed to get inputs for the framework implementation status, problems and critical success factors of ERP. The study used a self-structured questionnaire to find out the current status of ERP implementation, critical success factors and problems for efficient ERP implementation in various Technical Educational Institutes (TEIs) in India. For this, an effort was made to cover the selected top 50 institutions in India chosen from the best ranked institutions as given by survey conducted by India Today (2010). The questionnaire was sent to 50 TEIs but the response was received from 22 TEIs only. A total of 900 responses to the questionnaire were received which included faculty (14%), PhD students (10%), post graduate students (33%) and undergraduate students(43%). All the four groups of users possessed varying levels of technical skills, expertise and experience for using an online system like ERP. The frequency of use and level of satisfaction was different among all these groups.

$$\alpha = \frac{K}{K-1}\left(1 - \frac{\sum_{i=1}^{K}\sigma_{Y_i}^2}{\sigma_X^2}\right)$$

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 α where K is the number of components. Answers to

all questions were on a Likert scale ranging from 1(Least Priority) to 5 (Highest Priority). The final questionnaires were updated by incorporating the changes suggested by various domain experts. The dependent variables taken were frequency of use and level of user satisfaction.

In the second part, the cost benefit analysis of ERP implementation was done by considering two TEIs in North India as a case study. The questionnaire consisted of nine benefits and eleven costs all of which were rated on a Likert scale from 1(Least Value) to 5 (Highest Value). A response from a total of 100 users was obtained which included technical experts and faculty.

In the third part, the validation of framework was done by considering five TEIs in North India as a case study. The questionnaire consisted of nine factors proposed in the framework all of which were rated on a Likert scale from 1(Least Priority) to 5 (Highest Priority). The response was collected from a total of 25 users which included technical experts and faculty involved in ERP implementation from five TEIs which had implemented ERP at least for 3 years.

3.3 DETAILS OF THE QUESTIONNAIRES

3.3.1 Research Features for first questionnaire (Success factors, problems, current implementation status)

The first section contained twenty-two questions addressing the three features identified through literature survey namely i) functionality, (ii) security and (iii) quality. Functionality scale had ten items. Through factor analysis these were reduced to two factors using factor analysis viz. (i) Operational Efficiency and (ii) User Accessibility. Operational Efficiency deals with difficulties faced by users in operational aspects of ERP. The variables in Operational efficiency are (i) Adequate Documentation, (ii) Good Features, (iii) User Readiness, (iv) Reduced efforts and (v) Customization. User Accessibility factor basically deals with the issues related with interface usage from user's perspective. The variables in

User Accessibility are: (i) Data storage, (ii) Ease of Use, iii) Facilitation in Problem Handling, iv) Online Help and v) Training.

Security scale had six items. The six items under security were reduced to two factors as a result of the factor analysis. These are (i) User Security and (ii) System Security. User Security deals with difficulties on issues of securities regarding user point of view and System Security factor basically deals with the Security perspective considering the system issues. The variables in User Security are (i) Authorization security, (ii) Data Confidentiality and (iii) Authentication Safety. The variables in System Security are (i) Server Downtime, (ii) System failure Chances and (iii) Biometric Measures.

Quality scale has six items. Variables on Quality were reduced to two factors viz. (i) Usability and (ii) Scalability. The variables in Usability are: (i) Availability, (ii) Average Error Rate, (iii) Increased efficiency and (iv) Correction Time. The variables in Scalability are (i) Easy additions and (ii) Interoperability.

The next section of the survey aimed at identifying the problems in handling the implementation of the ERP system. Eight common problems identified with advice of domain experts and pilot survey were included. The content validation showed that the problems were relevant in the context of ERP implementation. The mean of these were calculated to highlight the major problems. The eight problems included in the study are: internet dependency, updation difficulty, time constraint, time consuming, less personal contact, reliance on technical assistance, difficulty in use and less training.

The last section of the questionnaire contained five questions on five modules for survey namely Academic module, Customer Relationship Management module, Inventory Management module, Finance module and Human Resource Management module.

The internal reliability of the instrument was assessed using Cronbach's Alpha using data mining statistical software SPSS 20.0 and content was validated by a panel of experts. High reliability has been observed and this implies that the items do measure the same construct satisfactorily. The results are summarized in table 3.1:

TABLE 3.1 Reliability analysis for Success factors

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

3.3.2 Research Features for Cost Benefit Analysis

This questionnaire had two sections. One related to various costs in ERP system and the other covers the benefits associated with ERP. A total of 11 major costs identified from the literature survey have been included in the questionnaire. These are: cost of developing interfaces, cost of training, cost of technology, cost of customization, cost of updates, cost of integration, cost of standardization, cost of change management, cost of risk management, cost of regular monitoring and cost of ERP consultant.

The tangible and intangible benefits which are supposed to be observed with the use of ERP system identified and a total of nine benefits were included in the questionnaire. These are: enhanced flexibility of the system, competitiveness, organizational culture, user satisfaction, improved IT skills of the employees, system stability, improved data quality, better coordination and communication and system security. Due to confidentiality issues, exact values for costs and benefits in Lacs (or dollars) was not provided by respondents. So the amount of efforts / time was taken as the unit for giving the inputs for costs and benefits. The benefits for ERP system have been categorized as: technical benefits and user benefits. The

internal reliability of the instrument was assessed using Cronbach's Alpha using statistical software SPSS 20.0. and content was validated by a panel of experts. The results are summarized in table 3.2:

Table 3.2: Reliability Analysis for Cost Benefit		
Section	**Number of items**	**Cronbach Alpha**
Costs	11	0.799
Benefits	9	0.762

Factor analysis of benefits was done to find the technical benefits and user benefits. Regression analysis was applied to find the relation between the cost and benefits.

3.3.3 Research Features for Framework Validation

For case study analysis, five TEIs were considered. Data was collected from 25 users for getting their opinion about the proposed framework. The designed framework covered all the aspects of ERP in TEIs with inputs from common users covering the aspects of functionality, security and quality and domain experts in cost benefit analysis. A questionnaire was used as the research instrument which contained thirteen questions on thirteen factors in the proposed framework.

The factors included are: communication, data confidentiality, data quality, dependency on vendor, implementation cost, network availability, operational efficiency, scalability, security, top management support, usability.

The study uses a five point Likert scale for getting the inputs, with 1-least priority and 5 as the highest priority. The results are summarized in table 3.3:

Table 3.3: Reliability Analysis for framework		
Section	**Number of items**	**Cronbach Alpha**
Factors	13	0.764

3.4 TOOLS AND TECHNIQUES

The study used descriptive statistics for studying the overall trends. Mean score of the responses was taken for finding the critical problems in ERP implementation. The mean score of the five TEIs was compared for getting the opinion about the factors proposed in the framework.

Chi-Square test has been used to find the variation in the perception gap in the implementation of ERP modules in public and private TEIs along with universities . Chi-square is a test that measures the fit of the observed values to the expected values. The bigger the difference, or deviance, of the observed from the expected values, the poorer the fit of the model. Therefore we want a small deviance. As we add more variables to the equation, the deviance should get smaller, indicating an improvement of fit.

Factor analysis attempts to identify a set of dimensions that is not directly observable in a large set of variables. This analysis is used to summarize a majority of the information in a data set in terms of relatively lesser new categories called factors. Factor analysis has been used in this study to reduce the features of: functionality, security, quality and benefits into smaller number of factors which can be used for further analysis. Frequency of use and user satisfaction has been taken as independent variables.

Data mining technique regression analysis has been used to determine the relationship between functionality, security and quality. Regression is a data mining technique used to fit an equation to a dataset (Basha et al. 2010). The simplest form of regression, linear regression, uses the formula of a straight line ($y = mx + b$) and determines the appropriate values for m and b to predict the value of y based upon a given value of x. Linear regression analysis is used to find the relationship between sub factors of functionality, security and quality with user satisfaction. It is also used to find relation between costs and benefits.

Logistic regression is a regression analysis and a data mining technique which is used for predicting the outcome of a variable that can take on a limited number of categories, known as categorical variable. It provides a method for modeling a binary response variable, which takes values 0 and 1. In logistic regression, the dependent variable is binary. In logistic regression, we are predicting the likelihood that Y is equal to 1 (rather than 0) given certain values of X. That is, if X and Y have a positive linear relationship, the probability that a person will have a score of Y=1 will increase as values of X increase.

In the present study, logistic step-wise regression was used to find the factors which differentiate between public and private TEIs. The results indicate that from all of the 22 attributes considered for user satisfaction, public and private TEIs differ in understandability, convenience, value addition, User readiness, adaptability, authority, reliability and interoperability. The analysis took 11 steps. All the parameters were reported to be useful to model because Wald statistic was small(<0.05). The Wald statistics is analogous to the *t*-test in linear regression. It is used to assess the significance of coefficients. It is used to assess the contribution of individual predictors.

CHAPTER SUMMARY

Choosing the right research design and methodology is one of the most important aspects of the research process for targeted outcomes. Today very potent and scientific tools are available which make the process faster, more reliable and accurate. Questionnaires based primary data and in-person interviews and observations have been chosen for the present study. This chapter presented an insight into the methodology that has been used for data analysis and interpretation in the subsequent chapters.

CHAPTER 4

DATA ANALYSIS and DISCUSSION

4.1 Existing methodologies in ERP in TEIs

4.1.1 ERP Modules in TEIs

The study covers five main modules for the ERP in Technical Educational Institutions. These are Academic module, Human Resource module, Finance module, Customer Relationship Module and Inventory Module. The functionalities to be provided by these modules are:

***a) Academic module*:** It should include all the activities for smooth conduct of students and faculty in various departments like accounts and academics. It mainly includes central control of student registration, time table, rooms management, result management activities etc.

***b) Human Resource module*:** This module is needed to handle the information about all the recruitments, promotions and other professional records of faculty and other staff.

***c) Customer Relationship Management (CRM)*:** This module is required to maintain the relationship with students, their parents and with consultants and vendors for ERP.

***d) Inventory Management* :** In order to collect the status of all inventory items from all the departments at a central place , inventory module is required.

***e) Finance Module*:** In order to handle all financial transactions like online fee, salaries, fines etc., a finance module is extremely important especially in today's e-environment.

There is a difference in requirement of specific modules in TEIs from business organizations. There is a specific requirement of Academic module in TEIs for carrying out all the academic transactions. Finance module is required for carrying out financial transactions like fee and salary management while Inventory module can be related with inventory management in research projects etc. Human resource management is required for handling recruitment while customer relationship management module is required for handling student's database.

4.1.2 Perception Gap (Public versus Private TEIs)

The present study covers the public and private TEIs and it is important to identify the perception gap between ERP requirement and ERP implementation for all five modules. The above five modules in ERP in TEIs are still not implemented in various TEIs in India. The required level indicates the priority with which the module is required . The actual priority is indicating the status of a particular module implementation. The differences between the two can indicate where the ERP vendors should add functionality.

The survey aimed at seeing the relation between ERP implementation in Public and Private technical educational institutions. The results are summarized in Table 4.1 below:

Table 4.1: Required level of ERP Modules in Public and Private TEIs

Academic Module	1	2	3	4	5	Total	ChiSq.:
Public	12.1%	8.9%	1.6%	28.2%	**49.2%**	100.0%	150.256
Private	.7%	.7%	4.2%	9.6%	**84.8%**	100.0%	df: 4 p<=0.001
HR Module	1	2	3	4	5	Total	ChiSq.:
Public	3.2%	7.3%	15.3%	34.7%	**39.5%**	100.0%	109.557
Private	.5%	1.9%	3.1%	11.9%	**82.6%**	100.0%	df: 4 p<=0.001
Finance Module	1	2	3	4	5	Total	ChiSq.:
Public	4.8%	3.2%	10.4%	**52.0%**	29.6%	100.0%	219.148
Private	.5%	1.1%	2.7%	8.0%	**87.8%**	100.0%	df: 4 p<=0.001
CRM Module	1	2	3	4	5	Total	ChiSq.:
Public	3.2%	8.8%	15.2%	24.0%	**48.8%**	100.0%	131.247
Private	.6%	2.1%	2.4%	4.7%	**90.1%**	100.0%	df: 4 p<=0.001
Inventory Module	1	2	3	4	5	Total	Chi Sq.: 59.116
Public	7.2%	9.6%	11.2%	17.6%	**54.4%**	100.0%	df: 4
Private	1.5%	1.8%	4.1%	10.4%	**82.1%**	100.0%	p<=0.001

Chi-Square is significant for all the modules suggesting that there is a significant difference between Public and Private TEIs. The above results show that there are significant variations reported in all the modules between Public and Private institutions. All the five modules are required at a higher priority in Private institutions as compared to Public institutions. The maximum variation is shown in the requirement for the Finance module while the minimum variation is found in Inventory Module.

The results of the actual level of implementations of the above five modules is shown in Table 4.2.

Table 4.2: Actual level of ERP Modules in Public and Private TEIs

Academic Module	1	2	3	4	5	Total	ChiSq.:
Public	33.3%	18.3%	**40.0%**	4.2%	4.2%	100.0%	229.494
Private	2.8%	2.6%	**48.8%**	18.5%	27.2%	100.0%	df: 4 p<=0.001
HR Module	1	2	3	4	5	Total	ChiSq.:
Public	**31.1%**	21.0%	30.3%	15.1%	2.5%	100.0%	166.133
Private	1.1%	**45.8%**	31.1%	19.0%	2.9%	100.0%	df: 4 p<=0.001
Finance Module	1	2	3	4	5	Total	ChiSq.:
Public	29.7%	**35.6%**	14.4%	16.9%	3.4%	100.0%	101.546
Private	4.3%	**44.9%**	38.4%	6.6%	5.8%	100.0%	df: 4 p<=0.001
CRM Module	1	2	3	4	5	Total	ChiSq.:
Public	**33.6%**	21.8%	32.8%	8.4%	3.4%	100.0%	128.356
Private	3.7%	**53.4%**	25.4%	13.8%	3.6%	100.0%	df: 4 p<=0.001
Inventory Module	1	2	3	4	5	Total	Chi Sq.: 75.946
Public	**41.0%**	16.2%	10.3%	24.8%	7.7%	100.0%	df: 4
Private	21.5%	**44.4%**	23.6%	6.9%	3.6%	100.0%	p<=0.001

The majority of the users say that Academic module is implemented only upto 60% in both Public and Private institutions. The implementation level of HR module is less than 20% in

Public institutions while less than 40% in Private institutions. The Finance module is implemented less than 40% in both Public and Private institutions. The status of the CR module is negligible in Public institutions while it is implemented upto 40% in private institutions. Inventory module is again in the unimplemented stage in Public institutions as indicated by majority of the users while it is implemented only upto 40% in private institutions. Chi-Square is significant for actual implementation of ERP in Public and Private sector.

4.1.3 Perception Gap (Universities versus Autonomous Institutions)

The study also covers the perception gap in Universities versus Autonomous Institutions (AI). The mean values of the required level of module and the actual level of module is judged. 80% of total users rated the priority as highest value 5 as Required level for Academic module. The results are summarized in table 4.3.

Table 4.3: Required level of ERP Modules in Universities and Autonomous TEIs

Academic Module	1	2	3	4	5	Total	Chi Sq.: 76.376
University	2.1%	1.9%	2.1%	11.2%	**82.6%**	100.0%	df: 4
AI	3.4%	1.1%	19.3%	21.6%	**54.5%**	100.0%	p<=0.001
HR Module	1	2	3	4	5	Total	Chi Sq.: 80.603
University	.6%	2.6%	5.0%	11.9%	**79.9%**	100.0%	df: 4
AI	3.7%	3.7%	6.2%	**46.9%**	39.5%	100.0%	p<=0.001
Finance Module	1	2	3	4	5	Total	ChiSq.:173.181
University	1.0%	1.0%	3.8%	9.3%	**84.9%**	100.0%	df: 4
AI	2.2%	4.5%	4.5%	**59.6%**	29.2%	100.0%	p<=0.001
CRM Module	1	2	3	4	5	Total	Chi Sq.: 21.928
University	.9%	2.3%	4.6%	7.5%	**84.8%**	100.0%	df: 4
AI	2.5%	11.3%	3.8%	10.0%	**72.5%**	100.0%	p<=0.001
Inventory Module	1	2	3	4	5	Total	Chi Sq.: 67.438
University	1.0%	3.0%	5.0%	11.0%	**80.0%**	100.0%	df: 4
AI	15.4%	3.8%	7.7%	16.7%	**56.4%**	100.0%	p<=0.001

The above results show that there are significant variations reported in all the modules between University and autonomous institutes. All the five modules are required at a higher priority in Universities as compared to autonomous institutes. The maximum variation is shown in the requirement for the Finance module while the minimum variation is found in Customer Relationship Module. Chi-Square is significant indicating a difference in ERP requirement by Universities and Autonomous Institutions. Table 4.4 summarizes the actual level of implementation in various modules in Universities and Autonomous institutes.

Table 4.4 Actual level of ERP Modules in Universities and Autonomous Institutions

Academic Module	1	2	3	4	5	Total	ChiSq.:266.261
University	2.4%	4.8%	**51.3%**	15.6%	25.8%	100.0%	df: 4
AI	**47.2%**	4.5%	14.6%	24.7%	9.0%	100.0%	p<=0.001
HR Module	1	2	3	4	5	Total	ChiSq.:159.173
University	2.7%	**44.6%**	31.1%	20.1%	1.5%	100.0%	df: 4
AI	**31.7%**	19.5%	30.5%	4.9%	13.4%	100.0%	p<=0.001
Finance Module	1	2	3	4	5	Total	ChiSq.:214.700
University	3.3%	**48.3%**	35.8%	8.2%	4.3%	100.0%	df: 4
AI	**50.6%**	5.2%	20.8%	10.4%	13.0%	100.0%	p<=0.001
CRM Module	1	2	3	4	5	Total	ChiSq.:216.549
University	3.7%	**54.1%**	26.5%	12.9%	2.9%	100.0%	df: 4
AI	**48.8%**	1.3%	27.5%	13.8%	8.8%	100.0%	p<=0.001
Inventory Module	1	2	3	4	5	Total	Chi Sq.: 76.172
University	22.7%	**44.2%**	22.0%	7.7%	3.5%	100.0%	df: 4
AI	**42.3%**	3.8%	15.4%	28.2%	10.3%	100.0%	p<=0.001

The majority of the users say that in case Academic module implementation level is 60% in Universities and less than 20% in Autonomous institutes. The implementation level of HR, Finance, CRM and Inventory module is less than 40% in Universities while that is again in the unimplemented stage in Autonomous institutes as indicated by majority of the users. Chi-Square results suggest a significant difference in actual implementation status of ERP in Universities and Autonomous Institutions.

4.1.4 Overall Perception Gap

Overall, the mean of the current implementation status versus the required level irrespective of the type of institute is summarized below in Table 4.5:

Table 4.5 Overall Perception Gap in Implementation status

Module	Academic Module	HR Module	Finance Module	CR Module	Inventory Module
Required	4.6	4.0	4.2	4.1	4.0
Actual	3.4	2.2	1.9	2.1	1.7
Implementation status %	73.9%	55.0%	45.2%	51.2%	42.5%

All the above results depict the priorities in requirement of modules priority and actual implementation status. More deviation from the required priority indicates more work is to be done for implementing that module. The survey indicated the results shown in Figure 4.1 for perception gap in implementation of ERP modules in TEIs:

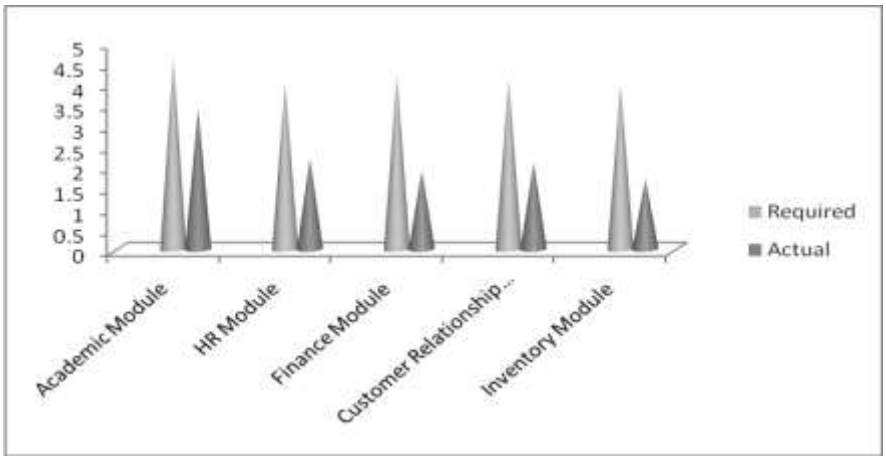


Fig.4.1 : Actual versus Perceived Implementation status of ERP modules

From the mean of all the inputs, it is indicated that Academic module is required at the highest priority followed by the requirement of the HR module; Customer relationship

module; Finance module and Inventory module. The results shows that Academic management is implemented 73.9%. HR management module is implemented only upto 55%. Finance management module is implemented only by 45%. CRM module is implemented upto 51.2%. Inventory management module is implemented only 42.5%. The results of this phase suggest that ERP implementation in TEIs is still in initial stage and there are wide gaps in requirement and actual implementation status.

4.2 COST BENEFIT ANALYSIS

4.2.1 Cost Benefit Factors

The benefits achieved from ERP implementation in TEIs is a good indicator of success of ERP system. Nine variables are considered for benefits namely organizational culture, competitiveness, system stability, system security, user satisfaction, better communication and coordination, improved data quality, enhanced flexibility of the system and improved IT skills of the employees. These were reduced to two factors viz. (i) technical benefits and (ii)user benefits.

Factor analysis results are shown in table 4.6.

Table 4.6 Factor Analysis for Benefits

	Factor Loading	**Technical Benefits**	**User Benefits**
(i)	Organizational Culture	0.656	
(ii)	Competitiveness	0.820	
(iii)	System stability	0.900	
(iv)	Improved IT skills of employees	0.906	
(v)	Enhanced flexibility of system		0.373
(vi)	User satisfaction		0.455
(vii)	Better Coordination and communication		0.519
(viii)	Improved data quality		0.649
(ix)	System security		0.821

The technical benefits highlights the benefits which the management of any TEI can achieve with ERP implementation. These include organizational culture, competitiveness, system stability and improved IT skills of the employees.

The user benefits factor highlights the benefits to ERP users in TEIs. The benefits in this category are: system security, user satisfaction, better coordination and communication, improved data quality, and enhanced flexibility of the system.

The next phase of research focused on conducting a cost-benefit analysis for ERP in TEIs.

4.2.2 Regression Analysis

Based upon factor analysis, the overall benefits have been classified as technical benefits and user benefits. Further multivariate regression analysis has been used taking factors viz. technical and user benefits as dependent variable and various types of costs as independent variables.

4.2.2.1 Regression Analysis for technical Benefits

The regression results depict R value as 0.924 and adjusted R^2 value as 0.835. This model is able to predict 83.5 % of variation. The regression results show that p-level is highly significant for seven out of eleven cost factors. Predictors of the models are: cost of developing interfaces, cost of training, cost of customization, cost of integration, cost of standardization and cost of change management. Cost of developing interfaces is reported to be most significant factor in technical benefits factor. Cost of customization, cost of updates and cost of regular monitoring are reported to be negatively correlated with technical benefits factor. The F test of model is highly significant with $p<0.001$ and R^2 value is 0.853.

The linear regression model equation (1) for Technical Benefits (TB) would be written as

$$TB = -10.342 + 1.337 * C1 + 1.064 * C2 + 0.118 * C3 – 1.228 * C4 – 0.469 * C5 + 0.846 * C6 + 0.626 * C7 + 0.387 * C8 + 0.157 * C9 – 0.152 * C10 – 0.085 * C11 \quad \text{……..(1)}$$

The results are shown in table 4.7.

Table 4.7 Linear Regression Analysis for Technical Benefits

	Var	B	Std Error B	β	t	Sig.
	(Constant)	-10.342	1.542		-6.705	0.001***
C1	Cost of developing interfaces	1.337	0.394	0.685	3.396	0.001***
C2	Cost of training	1.064	0.149	0.944	7.124	0.001***
C3	Cost of technology	0.118	0.214	0.089	0.551	0.583
C4	Cost of customization	-1.228	0.190	-0.886	-6.448	0.001***
C5	Cost of updates	-0.469	0.220	-0.445	-2.131	0.036*
C6	Cost of integration	0.846	0.185	0.611	4.574	0.001***
C7	Cost of standardization	0.626	0.176	0.391	3.558	0.001***
C8	Cost of change management	0.387	0.095	0.290	4.068	0.001***
C9	Cost of risk management	0.157	0.141	0.062	1.114	0.268
C10	Cost of regular monitoring	-0.152	0.076	-0.100	-1.982	0.051*
C11	Cost of ERP consultant	-0.085	0.060	-0.082	-1.417	0.160

R=0.924 Adj. R^2 =0.835 F=46.431 p <.001

4.2.2.2 Regression Analysis for User Benefits

The regression results for user benefits depict R value as 0.894 and adjusted R^2 value as 0.774. This model is able to predict 77.4 % of variation. Predictors of the model are: cost of developing interfaces, cost of technology, cost of customization, cost of updates, cost of integration, cost of standardization and cost of change management. The regression results show that p-level is highly significant for eight out of eleven cost factors. Cost of technology is reported to be most significant factor in user benefits factor. Cost of customization, cost of integration and cost of risk management are reported to be negatively correlated with user benefits factor. The F test of model is highly significant and R^2 value is 0.799.

The results are shown in table 4.8:

Table 4.8 Linear Regression Analysis for User Benefits

	Var	B	Std Error B	β	t	Sig.
	(Constant)	-0.269	1.804		-0.149	0.882
C1	Cost of developing interfaces	-1.466	0.460	-0.751	-3.183	0.002***
C2	Cost of training	-0.193	0.175	-0.172	-1.107	0.271
C3	Cost of technology	2.449	0.251	1.855	9.775	0.001***
C4	Cost of customization	-1.300	0.223	-0.938	-5.835	0.001***
C5	Cost of updates	1.610	0.258	1.527	6.248	0.001***
C6	Cost of integration	-2.195	0.216	-1.587	10.150	0.001***
C7	Cost of standardization	0.928	0.206	0.580	4.512	0.001***
C8	Cost of change management	-0.315	0.111	-0.236	-2.834	0.006***
C9	Cost of risk management	0.479	0.165	0.189	2.910	0.005***
C10	Cost of regular monitoring	-0.170	0.089	-0.112	-1.901	0.061**
C11	Cost of ERP consultant	0.037	0.070	0.036	0.524	0.602

R=0.894 Adj. R^2 =0.774 F= 31.794 p <.001

The linear regression model equation (2) for user benefits (UB) would be written as:

UB = -0.269 -1.466*C1 – 0.193*C2 + 2.449*C3 - 1.300*C4 + 1.610*C5 -2.195*C6 + 0.928*C7 - 0.315*C* + 0.479*C9 – 0.170*C10 + 0.037*C11 ……(2)

4.2.3 Relation between Costs and Benefits

The relation between technical and user benefits and all the costs considered here is shown in Figure 4.2. The costs which are positively correlated with benefits are shown with solid arrow and boxes while the costs which are correlated negatively with benefits are shown with dotted arrows and boxes.

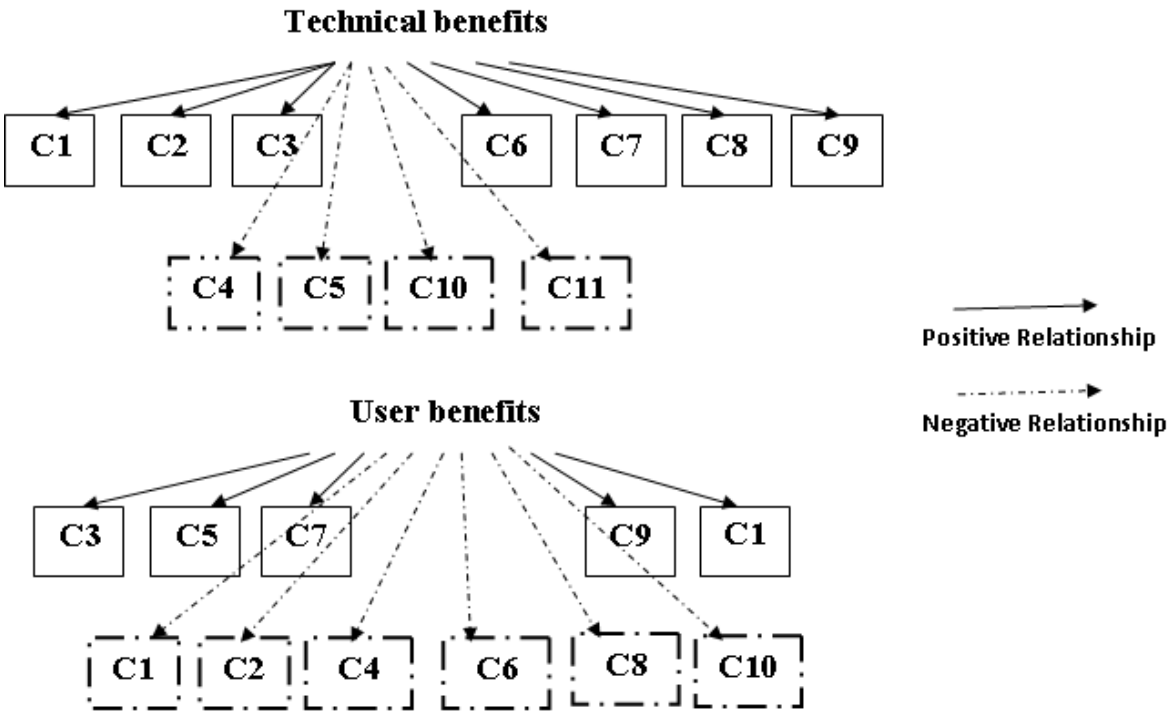


Figure 4.2: Relation between Costs and Benefits in ERP in TEIs

The results of the regression analysis point to several significant findings. First, it shows that in TEIs, the signs of all the regression coefficients in both the models are not positive, that is, all variables are not positively related with overall benefits. These results confirm other empirical findings indicating that many different cost factors are important in shaping the overall benefits. Secondly, it is apparent that the cost of technology and cost of risk management are positively related to overall benefits. Also the cost of technology has the greatest impact on user and technical benefits as seen by the magnitude of the regression coefficient of this cost factor. Thirdly, the cost of customization and cost of regular monitoring are related negatively with overall benefits. Also the cost of customization has a large negative impact on user and technical benefits as seen by the magnitude of the negative regression coefficient of this cost factor. The reason for this could be the extensive costs for customization and regular monitoring required. The predictors of technical benefits are cost of developing interfaces, cost of training (Davis and Huang, 2007), cost of integration (Pollock and Cornford, 2004), cost of standardization and cost of change management (Alghathbar,2008). Important predictors of user benefits are cost of technology (Vathanophas

and Lindsay, 2009), cost of updates (West and Daigle, 2004), cost of standardization (Swartz and Orgill, 2001) and cost of risk management. Cost of customization and regular monitoring are negatively related with all benefits. Cost of standardization is found to be significant in all benefits. Attention should be given for handling these costs.

4.3 DESIGN OF FRAMEWORK

4.3.1 Success Factors for ERP Implementation

A total of 900 responses to the questionnaire were received which included faculty (14%), PhD students(10%), post graduate students (33%) and undergraduate students(43%). All the four groups of users possessed varying levels of technical skills, expertise and experience for using an online system like ERP. The results of factor analysis for the three factors viz. functionality, quality and security are summarized in subsections.

4.3.1.1 Factor analysis for Functionality

The scale for functionality consisted of 10 items. These ten items were reduced to two factors of functionality. There are:

(i) Operational Efficiency

(ii) User Accessibility.

The factors for Functionality explained 74.249 % of the overall variation as shown in table 4.9. The variables in Operational efficiency are: i) Adequate documentation with a factor loading of 0.916 (ii) Good features with a factor loading of 0.794, iii) User readiness with a factor loading of 0.725, (iv) Reduced efforts with a factor loading of 0.641 and (v) Customization with a factor loading of 0.566.

The variables in User Accessibility are: i) Data storage with a factor loading of 0.882, ii) Ease of Use with a factor loading of 0.699, iii) Facilitation in problem handling with a factor loading of 0.690, iv) Online help with a factor loading of 0.636 and v) Training with a factor loading of 0.616.

Table 4.9 : Factor Analysis for Functionality

Functionality	Eigen value	% of Variance	Cumulative %	Items	Factor Loading	Rank
1.Operational Efficiency	3.886	38.864	38.864	i)Adequate Documentation	0.916	1
				ii) Good Features	0.794	2
				iii) User Readiness	0.725	3
				iv) Reduced efforts	0.641	4
				v)Customization	0.566	5
2.User Accessibility	3.539	35.386	74.250	i) Data Storage	0.882	1
				ii) Ease of Use	0.699	2
				iii)Facilitation in Problem Handling	0.69	3
				iv)Online Help	0.636	4
				v)Training	0.616	5

4.3.1.2 Factor analysis for Security

As identified through literature review, security constitutes an important issue regarding ERP implementation. Six items covered under security were reduced to two factors as a result of the factor analysis viz. (i) User Security and (ii) System Security. The above two factors for Security explained 74.034 % of the total variation.

The variables in User Security are i) Authorization security with a factor loading of 0.908, ii) Data Confidentiality with a factor loading of 0.901 and iii) Authentication Safety with a factor loading of 0.842.

The variables in System Security are i) Server Downtime with a factor loading of 0.903 followed by ii) System failure Chances with a factor loading of 0.629 and (iii) Biometric Measures with a factor loading of 0.607. The results are summarized in table 4.10.

Table 4.10 : Factor Analysis for Security

Security	**Eigen value**	**% of Variance**	**Cumulative %**	**Items**	**Factor Loading**	**Rank**
1.User Security	2.681	43.626	43.626	i) Authorization Security	0.908	1
				ii) Data Confidentiality	0.901	2
				iii)Authentication Safety	0.842	3
2. System Security	1.824	30.408	74.034	i)Server Downtime	0.903	1
				ii) System Failure Chances	0.629	2
				iii) Biometric Measures	0.607	3

4.3.1.3 Factor analysis for Quality

Success of ERP system relies a lot on the quality of services provided by ERP system. Six aspects covered under Quality were reduced to two factors viz. (i) Usability and (ii) Scalability. Usability deals with the ease with which the user is able to use the ERP system. The scalability refers to the ease with which the system can be scaled to fit with new modules and interoperate with heterogeneous modules.

These factors for Quality explained 71.217 % of the total variation. The variables in Usability are i)Availability with a factor loading of 0.897 followed by ii) Average error rate with a factor loading of 0.872, iii) Increased efficiency with a factor loading of 0.807 and iv) Correction time with a factor loading of 0.701. The variables in Scalability are i) Easy additions with a factor loading of 0.945 and ii) Interoperability with a factor loading of 0.34.

The results are summarized in Table 4.11.

Table 4.11: Factor Analysis for Quality

Quality	Eigen value	% of Variance	Cumulative %	Items	Factor Loading	Rank
1.Usability	2.875	47.919	47.919	i) Availability	0.897	1
				ii) Average Error Rate	0.872	2
				iii)Increased Efficiency	0.807	3
				iv) Correction Time	0.701	4
2.Scalability	1.398	23.298	71.217	i) Easy Additions	0.945	1
				ii)Interoperability	0.34	2

4.3.1.4 Major Success factors for ERP

The important three factors which can affect user satisfaction in ERP system in TEIs found by the above survey are functionality, security and quality of ERP system are shown in Figure 4.3 below:

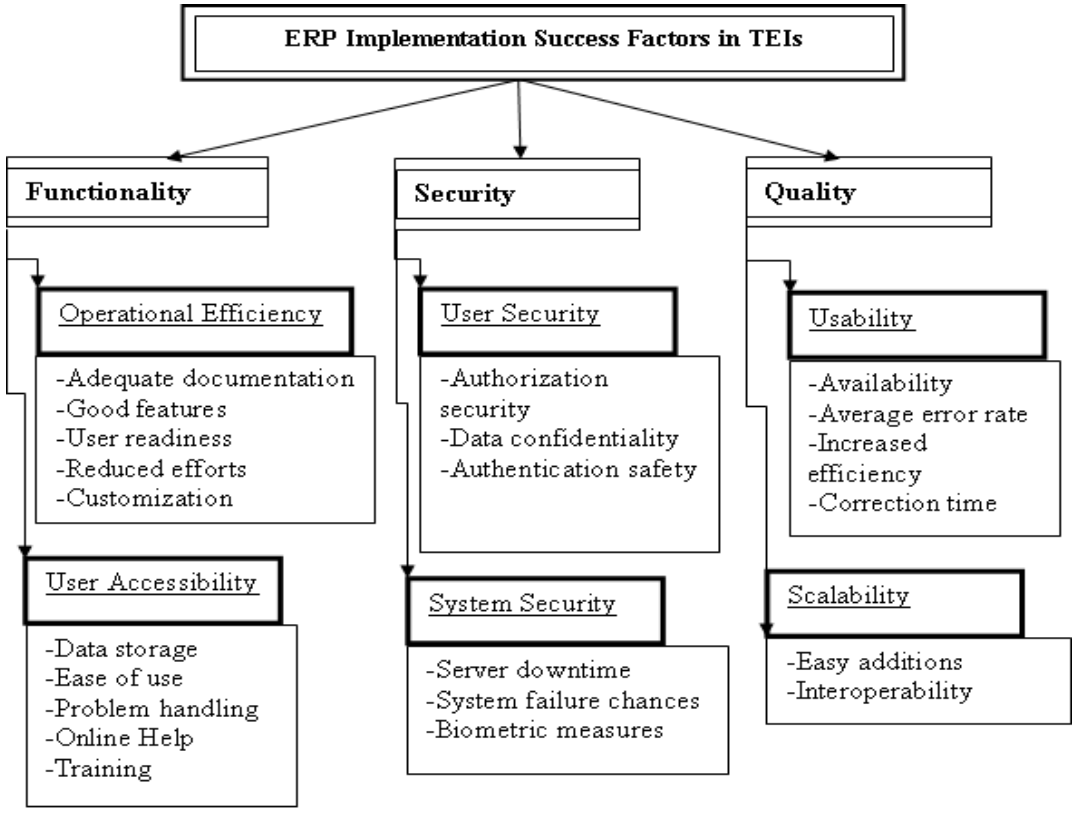


Figure 4.3 Major Success factors for Efficient ERP Implementation in TEIs

User satisfaction is closely related to data quality of any information system. In order to find the predictors of user satisfaction among all the factors identified above, these were mapped to their equivalent data quality attributes. The overall functionality was judged by two sub factors namely a) Operational Efficiency including understandability, completeness, convenience, value addition and interactivity, and b) User Accessibility including relevancy, user readiness, concise representation, amount of data and adaptability. The sub factors in overall security are: a) System Security including consistency, reliability and safety and b) User Security including authority, authenticity and accessibility. The overall quality is represented as two sub factors namely a) Usability including availability, accuracy, efficiency and timeliness and b) Scalability which included scalability and interoperability. The regression analysis was done to check the relative importance of each one of these success factors for user satisfaction.

4.3.2 Regression Analysis

In order to find the predictors of user satisfaction, logistic regression analysis was done to find the factors which can be used for differentiating between two types of TEIs i.e. Public or Private. Linear regression analysis was done to find the important predictors of user satisfaction for all TEIs.

4.3.2.1 Logistic step-wise regression analysis

In the study, both Public and Private TEIs are considered and there is significant difference reported in ERP implementation in both. In order to find the attributes which can be used to differentiate between the two types of TEIs, binary logistic regression analysis was conducted. Here ten attributes are found useful to differentiate Public and Private TEIs [Wald statistic are significant($p<0.05$)]. These are understandability, convenience, interactivity, value addition, user readiness, adaptability, authority, reliability, efficiency and interoperability.

The Logistic regression model for predicting Private TEI can be written as:

$$Y = -9.069 + 0.878*X_1 + 0.709*X_2 - 0.830*X_3 + 0.496*X_4 + 0.384*X_5 + 0.511*X_6 + 0.569*X_7 + 0.693*X_8 - 0.554*X_9 + 0.555*X_{10}. \quad \text{…….(3)}$$

where Y = logarithm of probability of being Private to the probability of being Public , X_1 = understandability, X_2 = Convenience, X_3 = Interactivity, X_4 = Value addition, X_5 = User readiness, X_6 = Adaptability, X_7 = Authority, X_8 = Reliability, X_9 = Efficiency, X_{10} = Interoperability.

It is able to predict whether the TEI is Public or Private based on the above logistic regression equation. If the probability for a given set of 10 attributes of an individual works out to be less than 0.5, it suggests that the individual is Public TEI otherwise a Private TEI.

The results are shown in table 4.12.

Table 4.12 Logistic Regression Analysis for Public and Private TEIs

	B	S.E.	Wald	df	Sig.	Exp(B)
Understandability	.878	.198	19.760	1	.001	2.406
Convenience	.709	.194	13.400	1	.001	2.031
Interactivity	-.830	.192	18.690	1	.001	.436
Value addition	.496	.211	5.543	1	.019	1.642
User readiness	.384	.189	4.157	1	.041	1.469
Adaptability	.511	.203	6.299	1	.012	1.666
Authority	.569	.190	8.954	1	.003	1.766
Reliability	.693	.175	15.618	1	.001	2.000
Efficiency	-.554	.236	5.493	1	.019	.574
Interoperability	.555	.180	9.496	1	.002	1.743
Constant	-9.069	1.106	67.288	1	.001	.000

The Hosmer-Lemeshow statistic at the last step indicates a good fit [Chi-square 13.764, df=8, p=0.088] as the significance value is greater than 0.05. The other statistics are '-2 Log

likelihood value' is 246.475, Cox and Snell R square is 0.423 and Nagelkerke R square is 0.753. Hence, the model adequately fits the data. The sensitivity of predicting Public TEIs is 75.2% while that of Private TEIs is 97.7%.

It may be observed from table 4.12 that there are two attributes namely Interactivity and Efficiency (whose 'B' coefficient are negative) which are associated with Public TEI. Higher the score for these attributes, the lower is the probability of being Private TEI.

4.3.2.2 Linear step-wise regression analysis

A linear regression analysis was employed to identify which variables made significant contributions to predicting end-user satisfaction with ERP systems in both types of TEIs i.e. Public and Private. The principal components revealed by principal component analysis were used in the regression analysis. After revealing these components, the component scores were calculated for each end-user. The results of the analysis, including β coefficient, t-statistic, and significance level for each independent variable, are reported in Table 4.13.

The regression results depict R value as 0.718 and adjusted R^2 value as 0.514. This model is able to predict 51.4% of variation. The independent variables found significant are Operational Efficiency, System Security and Usability.

Table 4.13 Linear Regression Analysis for User Satisfaction

Var	B	Std Error B	β	t	Sig.
(Constant)	.607	.055		10.935	.001
Operational Efficiency	.289	.025	.461	11.583	.001
System Security	.104	.019	.185	5.584	.001
Usability	.089	.025	.138	3.496	.001

Dependent variable: User Satisfaction

R=0.718 Adj. R^2 =0.514 S.E. of Reg.=0.415 F(Stats)=317.029

Sig(FStats) <.001

The regression results shows that p–level is highly significant. Operational efficiency is reported to be most significant factor in user satisfaction. The system security is found to be more significant than user security by users. The next important factor reported is usability.

F test of model is highly significant and R^2 value is 0.516. The linear regression model equation (4) would be written as follows:

$$Y_1 = 0.607 + 0.289 * X_1 + 0.104 * X_2 + 0.089 * X_3 \quad (4)$$

where Y_1= Satisfaction level, X_1 = Operational efficiency, X_2 = System Security, X_3 = Usability

Further, five sub factors are considered for measuring the Operational Efficiency; three sub factors are considered for measuring System Security and four sub factors are considered for measuring the Usability. The linear step wise linear regression analysis for these three important factors indicate the important sub factors in predicting the success of these three factors.

4.3.2.3 Linear Regression Analysis for Operational Efficiency

The results of individual linear step wise regression analysis for operational efficiency are summarized in Table 4.14.

Table 4.14 Linear Regression Analysis for Operational Efficiency

Var	B	Std Error B	β	t	Sig.
(Constant)	.697	.052		13.310	.001
Adaptability	.188	.017	.370	10.795	.001
Concise Representation	.186	.020	.294	9.241	.001
Relevancy	.134	.018	.272	7.446	.001
User readiness	-.108	.023	-.203	-4.712	.001
Amount of data	.065	.017	.130	3.797	.001

Dependent variable: User Satisfaction

R=0.713 Adj. R^2 =0.532 S.E. of Reg.=0.407 F(Stats)=204.107

Sig(FStats) <=.001

The results of the regression analysis shows that in TEIs, the variables that are positively related with overall operational efficiency are adaptability, concise representation, relevancy and amount of data. The results implies that adaptability and concise representation have the greatest impact on operational efficiency as seen by the magnitude of the regression coefficient of these sub factors. The attribute which is related negatively with operational efficiency is user readiness as shown by the regression coefficient.

4.3.2.4 Linear Regression Analysis for System Security

The results of individual linear step wise regression analysis for operational efficiency are summarized in Table 4.15:

Table 4.15 Linear Regression Analysis for System Security

Var	B	Std Error B	β	t	Sig.
(Constant)	1.149	.053		21.628	.001
Consistency	.197	.015	.429	13.230	.001
Safety	.060	.011	.166	5.525	.001
Reliability	.077	.015	.153	5.163	.001

Dependent variable: User Satisfaction

R=0.612 Adj. R^2 =0.373 S.E. of Reg.=0.471 F(Stats)=178.480

Sig(FStats) <=.001

The regression results show that in TEIs, the variables that are positively related with overall system security are consistency, safety and reliability. The results indicate that all the three sub factors considered for system security are positively related with system security as indicated by the regression coefficient results. Consistency has the greatest impact on system security as seen by the magnitude of the regression coefficient of this sub factor.

4.3.2.5 Linear Regression Analysis for Usability

The results of individual linear step wise regression analysis for usability are summarized in Table 4.16:

Table 4.16 Linear Regression Analysis for Usability

Var	B	Std Error B	β	t	Sig.
(Constant)	.961	.051		18.700	.001
Efficiency	.296	.018	.551	16.056	.001
Availability	.069	.016	.148	4.305	.001

Dependent variable: User Satisfaction

R=0.661 Adj. R^2 =0.435 S.E. of Reg.=0.447 F(Stats)=345.897

Sig(FStats) <=.001

The regression results show that in TEIs, the variables that are positively related with overall usability are efficiency and availability. The results imply that efficiency has the greatest impact on usability as seen by the magnitude of the regression coefficient of this sub factor. The attributes which are not related with usability are timeliness and accuracy as indicated by the regression results.

4.3.2.6 Predictors for user satisfaction in ERP in TEIs

The results of the regression analysis point to several significant findings. First, it shows that in TEIs, the signs of all the regression coefficients in first model are positive, that is, all variables are positively related with overall user satisfaction. These result confirm other empirical findings indicating that many different factors are important in shaping the overall user satisfaction. Secondly, it is apparent that the user satisfaction is directly proportional to operational efficiency. This implies that operational efficiency has the greatest impact on user satisfaction as seen by the magnitude of the regression coefficient of this factor. The attributes which contribute in improved operational efficiency are adaptability, concise

representation, relevancy and amount of data as seen from their regression coefficients. User readiness is found to be negatively correlated with operational efficiency as shown from the regression coefficient. This indicates that users may not be ready to use the system.

The next two factors in terms of magnitude of impact are system security and usability. Consistency, reliability and safety are the attributes which can help in improving the system security while efficiency and availability can help in improving the usability of TEIs. However, the user satisfaction seem not to relate to user security, user accessibility and interoperability as these have been eliminated from the model. The predictors of user satisfaction are shown in Figure 4.4:

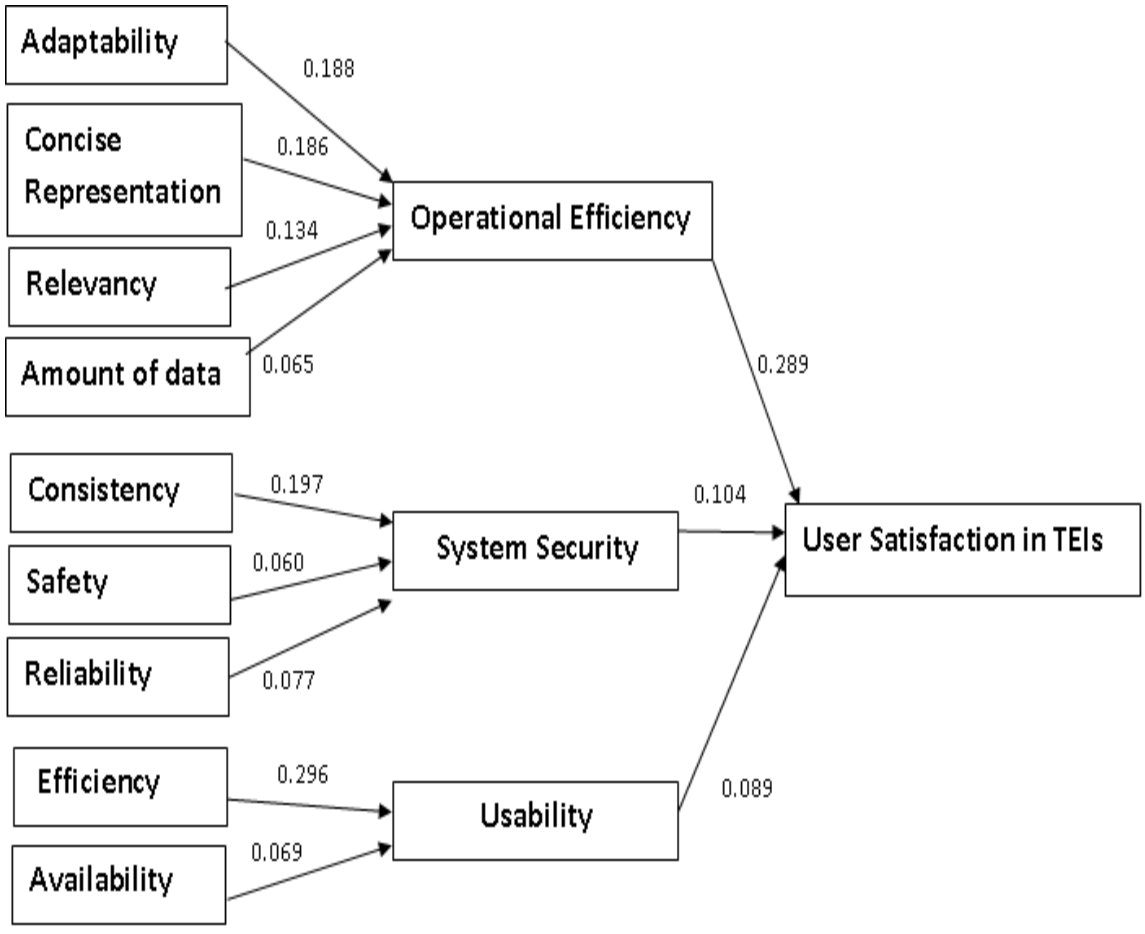


Figure 4.4 Predictors of user satisfaction in ERP in TEIs

The proposed model emphasizes on other attributes like adaptability, concise representation and accuracy as important predictors for user satisfaction (Haug et al.,2011). The success of the model lies in finding all the determinants which when improved can increase the level of user satisfaction in TEIs. It provides valuable information for institutions and identifies the relationships between specific factors and overall user satisfaction. This model can help all the TEIs in implementing enterprise resource planning in a way that can increase the user satisfaction of the ERP system.

4.3.3 ERP implementation inhibitors and challenges

The next phase of research was to identify the common problems in efficient deployment of an ERP system to provide useful information (Goel et al., 2011). Regarding ERP inhibitors, eight areas were identified as discussed below:

a) *Network Dependency:* The use of ERP systems require all transactions to be done online. This causes the dependency on the network for accessing the ERP software. Delays can also occur due to non availability of the network (internet connectivity) to carry out the transactions. This was reported as a major problem with the highest priority.

b) *Updation difficulty:* Updation difficulty was reported by many users specially difficulty in updation of the information once it is entered. This problem had a high mean score.

c) *Time Constraint:* All the information needs to be entered online and there are some strict deadlines for critical tasks. The users may not be able to submit all required information on time due to the restricted time access of internet connection. This problem was given a higher priority due to the limited network availability.

d) *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 in different formats.

e) *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 may result in less personal

interactions and formal communications. This also proved to be a hurdle in organizational culture.

f) *Reliance on Technical Assistance:* All the users may not be able to solve the problems while using ERP modules and they required technical assistance to be available. The reason reported was less training.

g) *Difficulty in Use:* The interface of the ERP system includes the use of screens, menus, forms and other graphical user interface (GUI) elements. If the GUI was not user friendly, the users in academia found it difficult to use.

h) *Inadequate Training:* The system was found difficult to use because of lack of training in using the ERP system. The reason for this could be that either the users were trained once and less manual or online help was available for users to use the system. The results of responses for questionnaires filled from all respondents are summarized in Table 4.17.

Table 4.17 : Inhibitors in ERP implementation in TEIs

User Type		Difficulty in Use	Adequate Training	Time Consuming	Time Constraint	Network Dependency	Updation Difficulty	Less Personal Contact	Reliance 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
PhD	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

The inhibitors in ERP implementation are listed in Figure 4.5

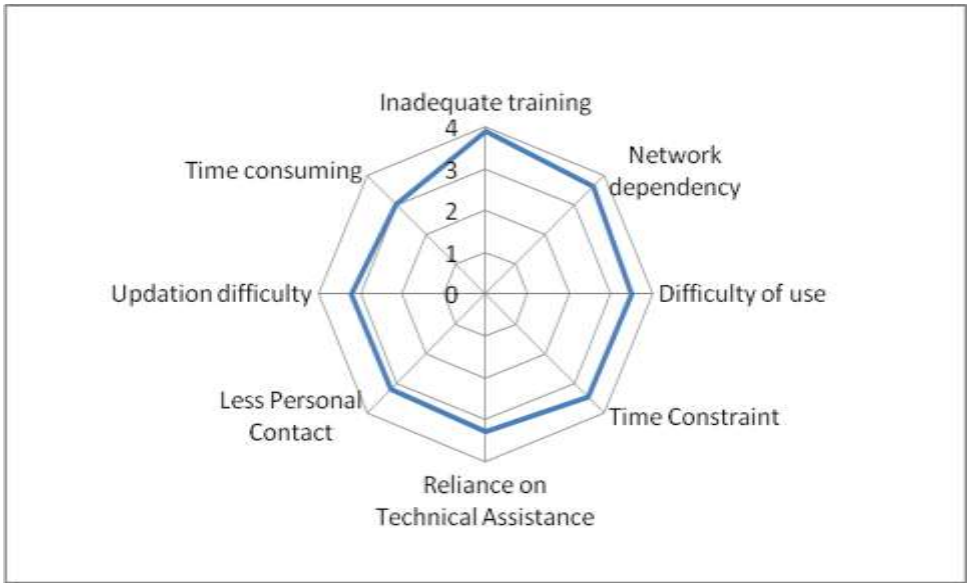


Figure 4.5: Inhibitors in ERP Implementation in TEIs

Earlier literature also supports that inadequate training is a severe problem in ERP implementation. Inadequate training is the most common problem (Aladwani, 2001; Maheshwari et al., 2011). Dependency on network for carrying out the transactions in ERP system is the second major problem. Though this problem is not reported in foreign universities, it is one of the problems in Indian scenario and this is improving day by day. Many users found the ERP system interface difficult to use. As all the activities are online, the deadline constraint is a big hurdle. User resistance to change is the reason for this (Koh et al., 2006).

4.3.4 Framework

During the survey, the important success factors and problems in efficient implementation of ERP System in TEIs are identified. Various costs incurred in ERP implementation have also been identified and their relationship with benefits is analyzed. All of these revealed that certain features need to be improved and/or enhanced, while there are certain other activities which need to be controlled to provide an efficient ERP implementation. All these are highlighted in Figure 4.6 below:

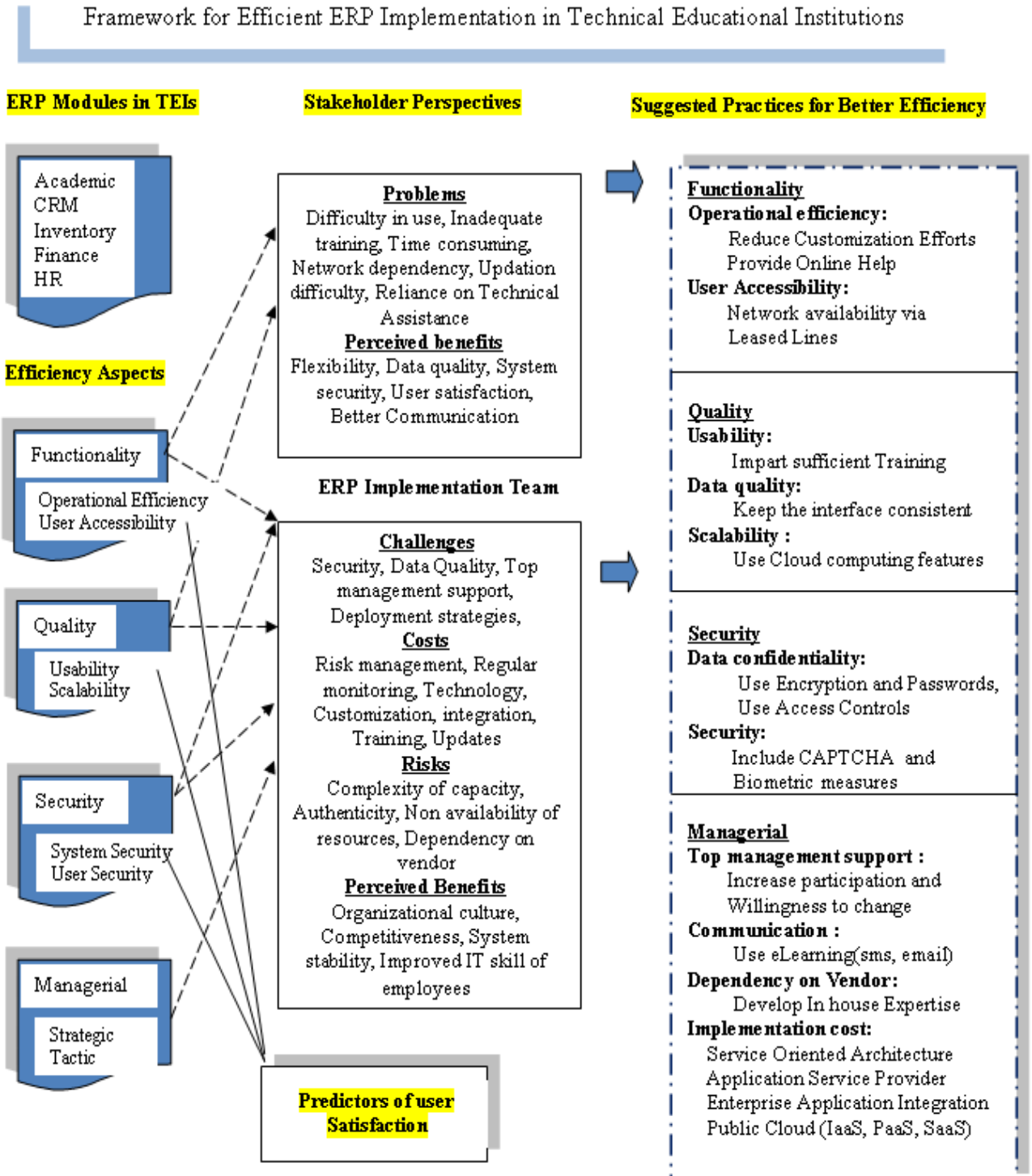


Figure 4.6 Framework for efficient ERP in TEIs

The phases of development of framework are as follows: First of all, modules of ERP used in TEIs are identified. Only Academic module is found to be implemented. There is a need to implement customer relationship management module, finance module, inventory module and human resource management module.

Next the stakeholders in ERP in TEIs are identified. These are students, faculty, management and vendor. As the goals of all these users are different in the sense that management is investing in ERP implementation and has different strategic, tactical and managerial benefits perception for measuring efficiency. The students and faculty have operational and organizational benefits perception as measures of efficiency. So the next step is to identify the different perceptions of efficiency from both type of users. So, four aspects for efficiency are considered. These are functionality, security and quality from user point of view and managerial efficiency from ERP implementation team (i.e. management) point of view.

The factors identified as important in functional efficiency are operational efficiency and user accessibility. The factors identified as important for quality efficient ERP are scalability and usability. System security and user security are identified as factors important for security. The predictors of user satisfaction are operational efficiency, security and usability. To understand the reasons of inefficiency of ERP system, problems faced by users were recorded. To achieve a set of goals, perceived benefits are considered from user's point of view.

In order to find the areas of inefficiency in ERP implementation, the challenges, risks and costs are recorded from management point of view through informal interviews. To define the measurement of managerial efficiency, perceived benefits from ERP implementation team are also collected.

The suggested practices are provided in four sections namely efficiency in functionality, efficiency through quality, efficiency through security and managerial efficiency.

a) Efficiency in functionality: Operational efficiency should be improved (Calisir et al., 2004; Wei et al, 2008; Tsinidou et al., 2010). The processing overhead of the transactions in ERP system should be reduced to improve the speed of transactions. The ERP system should be made customizable so that it can be used by a wide variety of TEIs. The customization efforts should also be reduced in order to facilitate easy use and better operational efficiency (Aldayel et al., 2011).

In order to improve user accessibility, network availability should be increased so that the transactions with particular deadline can be completed in time (Kahn et al., 2002). Strong network signal strength and its availability is the need of the hour. Top management should ensure timely connectivity for a longer duration. The accuracy of the transactions should be enhanced to minimize the error rates which discourages the users from the use of the ERP system (Willis and Willis-Brown, 2002; Zornada et al.,2005; Carlo et al., 2011).

b) Efficiency through quality: The interface for various users should be made easy to use (Davis and Huang, 2007). The design of the interface affects the utility of the interface from user or organization point of view (Piramuthu and Shaw, 2009). So the complexity of the interface design should be reduced keeping into consideration the different skill sets of users in TEIs. Training or guidance has been identified as a crucial factor for improving usability (Maheshwari et al. 2010).

Scalability is also one dimension for improving quality. Virtual environments like cloud computing can help in achieving better scalability (Creeger, 2009). The data can be stored on a public cloud and accessed as and when required. This eliminates the risk of complexity of storage capacity in any ERP system. Using infrastructure as a service can help in scaling ERP systems to multiple resources available on a public cloud (Goscinski & Brock, 2010).

c) Efficiency through security: System security and user security should be enhanced(Wang et al., 1996; Zornada et al., 2005; Wei et al, 2008). User security should be controlled by all possible means, i.e., by incorporating valid authentication and authorization measures (Zhu et al., 2000; Meldal and Luckman, 1997). Confidentiality of data should be controlled by encryption or by restricting the data access. For making an ERP system efficient in terms of security, various security measures proposed are use of CAPTCHA, biometric measures and access controls for improving security of system from unauthenticated access. The software system can be prevented from unauthorized access using watermarking (Mahalaxmi and Raju, 2011). The confidentiality of data can be controlled using encryption and passwords. All the University people should be made to learn about security (Manson et al., 2006).

d) Managerial efficiency: The top management support can be increased by more participation in decision making, establishing and changing requirements and during auditing. Training can also help in reducing the support costs in ERP (King et al., 2002). Use of e-learning can improve interactivity (Anderson, 2005). This includes the use of email, SMS, video conferencing etc. to improve communication among various users of ERP.

Data quality should be improved through consistent structure of databases and interfaces (Singh and Singh, 2010). Providing adequate documentation can also help in better knowledge management and support training (Sharma et al., 2012).

In order to reduce the cost of ERP implementation, various techniques like service oriented architecture, enterprise application integration and application service provider are suggested (Singla, 2008). The database in ERP system cannot make decisions automatically. It needs to integrate transactions systems with some decision support system through data warehouse (Shafiei et al., 2009). Also, dependency of vendor should be reduced.

4.4 VERIFICATION AND VALIDATION OF FRAMEWORK

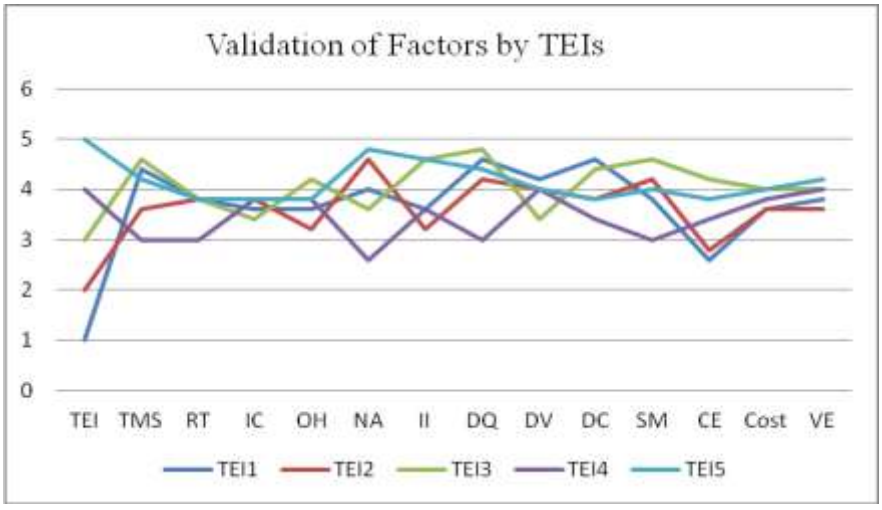
In order to validate the proposed framework, a case study of five North Indian TEIs was taken up. All these TEIs are using ERP for more than 3 years. Questionnaire and informal interviews were taken as the tool for gathering the information. The faculty and technical

experts were asked about their opinion about the factors proposed in the framework. The results of the case study for individual TEI and overall mean are summarized in table 4.18.

Table 4.18 Survey Results for Validation of Framework

	TEI 1	TEI 2	TEI 3	TEI 4	TEI 5	Mean
Increasing Top Management Support	4.4	3.6	4.6	3	4.2	3.96
Providing Regular Training	3.8	3.8	3.8	3	3.8	3.64
Reducing the Interface Complexity (using same data formats and adequate documentation)	3.6	3.8	3.4	3.8	3.8	3.68
Providing Online Help	3.6	3.2	4.2	3.8	3.8	3.72
Enhancing Network availability	4	4.6	3.6	2.6	4.8	3.92
Improving Interactivity for Better Communication (email, sms to parents etc.)	3.6	3.2	4.6	3.6	4.6	3.92
Improving Data Quality (correctness, completeness and consistency of data)	4.6	4.2	4.8	3	4.4	4.2
Reducing Dependency on Vendor	4.2	4	3.4	4	4	3.92
Controlling Data confidentiality (encryption, passwords)	4.6	3.8	4.4	3.4	3.8	4
Enhancing Security Measures (using CAPTCHA, Biometric measures)	3.8	4.2	4.6	3	4	3.92
Reducing the Customization Efforts (when purchase from vendor)	2.6	2.8	4.2	3.4	3.8	3.36
Reducing the Implementation Cost (using SOA,ASP , EAI)	3.6	3.6	4	3.8	4	3.8
Implementing Virtual Environment for better scalability(Cloud)	3.8	3.6	4	4	4.2	4

The above table 4.18 shows the mean value of responses for all the ten factors proposed in the framework. Values more than 3.5 as response in favor of all the items proposed in the framework verifies and validates that the framework is suitable for improving efficiency in ERP implementation in TEIs. If we compare the overall mean score of all these factors, the highest priority is given to improving data quality (4.2). The second highest priority is given to controlling data confidentiality (4) and implementation of virtual environment for better scalability(4). Top management support is also among the top priority factors supported by all TEIs with a mean score of 3.96. The next higher priority (mean score 3.92) is given to enhancing network availability and security measures, improving interactivity and reducing dependency on vendors. Rest all the factors are also considered important by all TEIs in the study. Reducing customization efforts is given the least priority though it is very important factor. This could be due to the fact that ERP implementation is still not complete in TEIs. The difference of opinion in responses from all the TEIs is shown in Figure 4.7:



TMS-Top Management Support RT-Regular Training IC-Interface Complexity OH-Online Help NA- Network Availability II-Improving Interactivity DQ- Data Quality DV-Dependency on vendor DC -Data Confidentiality SM-Security Measures CE Customization efforts VE- Virtual Environment

Figure 4.7 Responses for framework validation in TEIs

The most important factor required is the functionality provided by the ERP solution. The need at present is to identify all the requirements first before starting with the ERP so that

proper vendor, ERP package, deployment strategies and latest technology can be selected. Selecting the vendor with good reputation is good for handling vendor related risks. Proper support documents should be asked by vendor while buying the ERP solution or while developing it in-house. All ERP modules should be tested first using integration testing so as to avoid all the problems arising due to later integration of some modules. If complete ERP solution is not available as a whole, then thorough testing of newly added modules should first be done with a sample run of already implemented modules. Only successfully executing module should be integrated with legacy systems (Lee and Hong, 2003). Capability Maturity Model Integration level 3 is suggested by Day and Lutteroth (2011) for better integration.

Good functionality may still be not used properly by the users of the ERP system due to improper training. Inadequate training is found to be an hindrance in efficient implementation of ERP. The users should be provided with adequate training to use the system efficiently (Kumar et al., 2010). The top management should provide support all through the implementation to make ERP a success. Online help and regular training can enhance understandability. Training cost can be reduced is the technical people in the institutions are trained first so that they can train the people in the organization. Poor data quality leads to customer dissatisfaction and increased operational cost. The increases in error rate also reduces the efficiency of the enterprise system (Redman, 1998). So training can help in eliminating errors and better response. This can help management in achieving operational and organizational benefits as suggested by Shang and Seddon(2000).

User and system security are reported as important factors for efficient ERP. There are many important issues identified regarding the security of ERP system. These include authentication which aims to restrict entry into the system and access control i.e. authorization which aims to restrict the data and functions which are allowed to be accessed by various users(She and Thuraisingham, 2007). In order to protect databases from unauthorized access, use biometric authentication measures along with access control rights like view, update or delete etc. at various levels in the organization. Implementation of

biometric measures are required for making the ERP efficient. Passwords should be strong (a mix of alphabets, digits, lowercase and upper case letters and of a minimum and maximum length). After one year or so, there must be a requirement for changing the passwords.

The system quality and service quality are important factors in ERP implementation success (Ifinedo et al., 2010). Easy additions and interoperability were identified as required characteristics of the efficient ERP system. Open standards may be used for designing interfaces to handle the problem of interoperability. The proposed framework has been validated through a case study of two TEIs. The work done by many other researchers in various parts of country and abroad have also supported many of the factors proposed in this research work.

Cost of implementation can be reduced by various new technologies like cloud computing, service oriented architecture, application service provider and enterprise application integration (Goel et al., 2012). This can also help in achieving benefits like reduced spending in infrastructure in future, easy implementation of new applications and better resource management (Shang and Seddon, 2000).

CHAPTER SUMMARY

Efficiency of any system can be related to many aspects of the system. This is in increased use of the system along with maintaining the quality and security of the system. The system can be cost efficient if the cost can be minimized and benefits can be maximized. After analyzing the current status of ERP implementation in TEIs in India, problems faced by users in ERP implementation and factors for user satisfaction, an effort was made to finalize the success factors in the form of a framework. The ways to reduce cost and maximize benefits have also been incorporated in the framework. The users at various levels in TEIs were included, i.e. technical experts, faculty and students. Common shared views of all these help us in formulating the framework presented in this chapter which can help in efficient implementation of ERP in TEIs.

Chapter 5

CONCLUSIONS AND FUTURE SCOPE

The aim of the study is to design the framework for an efficient ERP implementation. An ERP system can be made efficient by considering various attributes of the system like increasing user satisfaction, reduction in problems faced by the users and making the system flexible and easy to use from user's perspectives. From management's perspective, efficiency can be defined in terms of cost efficiency, administrative ease and better resource utilization. The aim of the present research is to realize all the benefits perceived by users as well as management. The work done in this research addresses all of the above.

5.1 Revisiting the objectives

The first objective of the research has been: *To Study and Analyze the prevalent methodologies the ERP implementation*

This has been done with the help of literature survey. The study tried to find the implementation and required status of ERP Modules in TEIs. The study tried to identify the Challenges and Risks for ERP. The inhibitors have also been identified through the survey from twenty two institutes. These are discussed below:

5.1.1 ERP Modules

The success of the ERP system for the TEI can be measured if all the users are able to get everything required in the ERP system. Many TEIs are using custom developed ERP solutions by many vendors. The common modules identified as required are academic module, customer relationship management module, human resource management module, inventory management module and finance module. The academic module is implemented by many of the TEIs which were included in the survey. The need is to implement the remaining modules.

5.1.2 Challenges and Risks for ERP

The challenges faced in ERP implementation in Technical Educational Institutions include: maintaining data quality (Bernroider et al., 2009), top management support (Al-Mashari,2003), change management(Aladwani, 2001, Maheshwari et al., 2010; Marnwick and Labuschagne,2005), requirements handling (Momoh et al., 2010), technology, security, user training (Sun et al., 2005) , deployment strategies, standardization and flexibility, vendor selection and support and functionality (Bernroider et al., 2009), domain knowledge of ERP team (Mohamad and McLaren, 2009) and Business Process Reengineering i.e. the institutions must redesign some processes before applying automated information technology like ERP(Koch, 2001). The risks identified are: availability, authentication and authorization access, recoverability and complexity of capacity.

5.1.3 Inhibitors

The survey results indicated that inadequate training, dependency on network along with the difficulty in using the interface (Lee and Hong, 2003) are crucial inhibitors in functionality of and efficient 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 using it efficiently. The commitment of users is an important factor for making the system efficient (Salmeron and Lopez, 2010).

5.2 COST BENEFIT ANALYSIS

The second objective of the study has been *To understand cost benefit analysis of ERP solutions* .

For this it is essential to identify the costs and benefits and analyze the relation between the two. The present research used literature review to identify costs and benefits. The benefits were categorized into two factors, viz. technical benefits and user benefits through factor analysis. The study used regression analysis to find the relation between costs and user benefits and Technical benefits.

5.2.1 Costs

The important costs covered in the survey are: cost of developing interfaces, cost of training(Davis and Huang, 2007), cost of integration (Pollock and Cornford, 2004), cost of change management (Alghathbar,2008), cost of technology (Vathanophas and Stuart, 2009), cost of updates (West and Daigle, 2004), cost of standardization(Swartz and Orgill, 2001), cost of ERP consultant, cost of risk management, cost of regular monitoring and cost of customization(Pollock and Cornford, 2004).

5.2.2 Benefits

The tangible and intangible benefits which are supposed to be observed with the use of ERP system were identified and included in the questionnaire. There are: improved IT skills of employees, system stability, competitiveness, improved data quality(Swartz and Orgill, 2001, Redman 1998), better coordination and communication (Antonucci and Muehlen, 2001), organizational culture (Mehlinger,2006) and user satisfaction (Thavapragasam, 2003, Davis and Huang, 2007). All of these are found to be significant for the study and are supported by other researchers.

5.2.3 Relation between Costs and Benefits

There are 11 costs reported as important predictors of benefits as discussed in section 4.2. The research and case studies by many researchers have also supported these which validates that the results are consistent with the findings of other researchers. The predictors of technical benefits are cost of developing interfaces, cost of training (Davis and Huang, 2007), cost of integration(Pollock and Cornford, 2004), cost of standardization and cost of change management(Alghathbar,2008). Important predictors of user benefits are cost of technology(Vathanophas and Lindsay, 2009), cost of updates (West and Daigle, 2004), cost of standardization(Swartz and Orgill, 2001) and cost of risk management.

It can be concluded that universities must decide whether to conduct expensive customization work on standard ERP systems to better match these to their own unique processes or adopt

their own processes to the best practices embedded in the ERP software. Issues of customization lie at the heart of determining the costs of ERP systems for universities and it was found that customizations caused the biggest problems for institutions when implementing ERP (Pollock and Cornford, 2004; Aldayel et al., 2011). The suggestion is that existing business practices and processes should be re-evaluated and the standardized processes embedded in the ERP system should be considered for use. Indeed, this is what most ERP implementers do as they adapt their organization to the system, rather than the system to their organization.

5.3 DESIGN OF FRAMEWORK

The next objective of research has been *To design a framework for an efficient implementation of ERP solutions.*

The earlier analysis conducted helped in identifying the importance of ERP modules judged through the perception gap. The framework revolves around the three key factors, viz. functionality, quality and security. The designed framework for efficient ERP has to focus on enhancing all three. The study has also suggested the steps to enhance these. Efficient ERP implementation requires benefits to be enhanced. Thus the study also used the regression model to identify the important predictors of user and technical benefits. Also included in the study are inhibitors, which need to be controlled for improving efficiency in TEIs.

5.3.1 Success factors for ERP implementation and User Satisfaction

Student's satisfaction is an important factor for the success in higher education institutions (Deshields Jr et al., 2005). Satisfaction with availability of computing resources is also critical for students (Letcher et al., 2010). System quality and information quality is also identified as of high importance in ERP systems (Al-Fawaz et al.,2011). But the proposed model has identified that operational efficiency and security are also important along with system quality for increased user satisfaction as discussed in section 4.3. Also the difference in opinion about attributes in achieving user satisfaction in public and private TEIs is highlighted. Data quality is important for success of any enterprise in implementing ERP

successfully (Xu et al., 2002; Vosburg et al.,2001; Zhang et al., 2005). Here, 22 data quality attributes are considered for providing overall functionality, security and quality which contribute to user satisfaction. Each of these three factors are further subdivided into two factors each using factor analysis. The common predictor of user satisfaction in ERP implementation in technical educational institutions is operational efficiency which is defined by understandability, completeness, convenience of use, value addition by system and enhanced interactivity. The findings are summarized in Figure below:

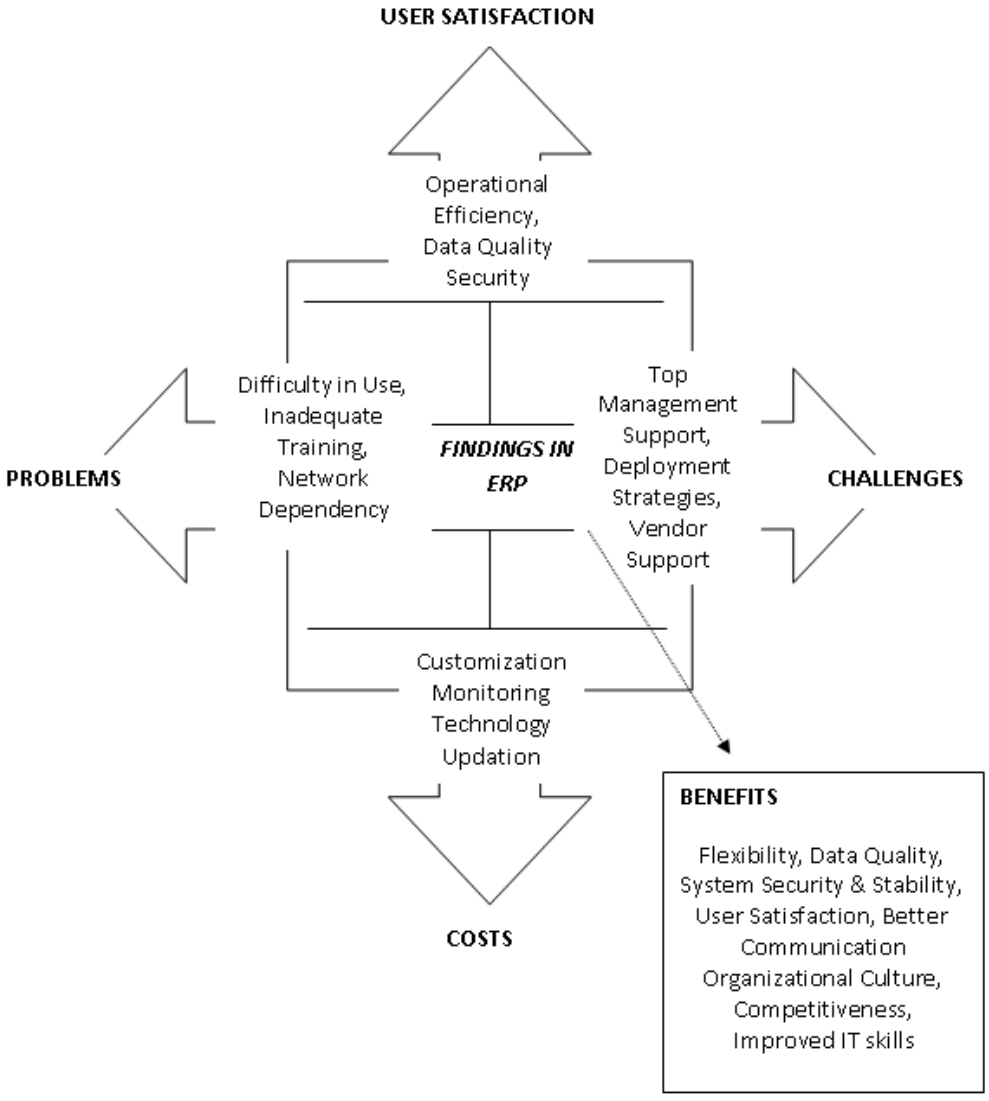


Figure 5.1 Findings in ERP

The proposed framework included the success factors as top management support, data quality, scalability, operational efficiency, network availability, usability, security, data

confidentiality and implementation cost as discussed in section 4.3. To help achieve these success factors, number of practices are suggested which can surely help the TEIs management in improving the efficiency of the ERP system.

5.4 Verification and validation of proposed framework

The last objective of research has been *To verify and validate the proposed framework.*

The validation is done through five TEIs having ERP for at least three years. This has also been supported by extensive literature available on ERP implementation in Universities in many developed countries of the world as discussed in section 4.4. ERP implementation level in TEIs in India is still low, with only high implementation status in academic modules. Thus this study has laid the foundation by designing the framework. The verification of the suggested practices is also done by support from literature and validated though extensive interviews with ERP teams in Five TEIs. Majority of factors recommended in the framework have been accepted by ERP teams involved in the implementation of five TEIs.

FUTURE SCOPE

This case study of an ERP implementation at various technical educational institutions has been designed to gather an overall view from the perspective of management, technical experts, faculty and students. Recent literature has been reviewed to see the key theories, critical success factors and best practices currently recognized in the TEIs and industry to insure a successful ERP implementation. While the goal of the initial research proposal was effectively designed, response was obtained only from a limited number of technical educational institutions (22 only). Increased survey participation will improve the validity of a future case study. But still, the results shown by this study will add valuable information for use by technical educational institutions in upgrading their ERP software in the future. The present research has identified many important factors which can help in achieving efficient ERP implementation in TEIs. The further step is to implement these in practice.

REFERENCES

Abugabah, A. & Sanzogni, L. (2010). Enterprise Resource Planning (ERP) System in Higher Education: A literature Review and Implications. *International Journal of Human and Social Sciences*, 5(6), 395- 399.

Ahmad, R.M.T.R.L., Othman, Z., & Mukhtar, M. (2011). Campus ERP Framework for Private Institutions of Higher Learning Environment in Malaysia. *Wseas Transactions On Advances In Engineering Education,* 1(8), 1-12.

Aladwani, A. M. (2001). Change management strategies for successful ERP implementation. *Business Process Management Journal*, 7 (3), 266-275.

Aldayel, A. I., Aldayel M. S. & Al-Mudimigh A. S. (2011). The Critical Success Factors of ERP implementation in Higher Education in Saudi Arabia: A Case Study. *Journal of Information Technology and Economic Development,* 2(2), 1-16.

Alghathbar, K. (2008). Practical ERP implementation in Government Organization. *International Conference on E-Learning, E-Business, Enterprise Information Systems, and E-Government,* 343-349.

Al-Fawaz, K., Eldabi, T. & Kamal M. (2011). Investigating Factors Influencing The Decision Making Process For ERP Adoption And Implementation: An Exploratory Case Study. *European, Mediterranean and Middle Eastern Conference on Information Systems,* May 30-31, Athens, Greece, 141-153.

Al-Mashari, M. (2003). Enterprise Resource Planning: A Research Agenda. *Industrial Management and Data Systems*, 103(1), 22-27.

Al-Mashari, M. & Al-Mudimigh, A. (2003).ERP implementation: Lessons from a case study. *Information Technology & People,* 16(1), 21-33.

Allen, D., Kern, T. & Havenhand M. (2002). ERP critical Success factors: An Exploration of the Contextual Factors in Public Sector Institutions. *Proceedings of the 35th Hawaii International Conference on System Sciences – 2002,* 1-10.

Aloini, D., Dulmin, R. and Mininno, V. (2007). Risk management in ERP project introduction: review of the literature. *Information & Management*, 44(6), 547-67

Anderson, J. (2005). IT, e-learning and Teacher Development. *International Education Journal: ERC004 Special Issue*, 5(5), 1-14.

Antonucci, Y. L. & Muehlen, M. Z. (2001). Deployment of Business to Business Scenarios in ERP Education: Evaluation and Experiences from an International Collaboration. *Seventh Americas Conference on Information Systems*, 998-1004.

Ash, C. & Burn, J. (2003). A strategic framework for the management of ERP enabled e-business change. *European Journal of Operational Research*, 146(2), 374-94.

Bhanti, P., Kaushal, U. & Pandey, A. (2011). E-Governance in Higher Education: Concept and Role of Data Warehousing Techniques. *International Journal of Computer Applications*, 18(1), 15-19.

Basha, S.A. H., Govardhan A., Raju S. V., & Sultana N. (2010). A Comparative Analysis of Prediction Techniques for Predicting Graduate Rate of University. *European Journal of Scientific Research*, 46 (2), 186-193.

Beheshti, Hooshang M. (2006). What managers should know about ERP/ERP II. *Management Research News*, 29(4), 184-193.

Bernroider, E. W.N., Sudzina, F. & Pucihar, A. (2009). European criteria for assessing enterprise resource planning (ERP) systems: Preliminary results from multiple empirical studies. *22nd Bled eConference eEnablement: Facilitating an Open, Effective and Representative eSociety June 14 - 17, 2009, Bled, Slovenia*, 369-381.

Calisir, F. & Calisir, F. (2004). The relation of interface usability characteristics, perceived usefulness, and perceived ease of use to end-user satisfaction with enterprise resource planning (ERP) systems. *Computers in Human Behavior*, 20, 505–515.

Carlo, B., Daniele, B., Federico, C. & Somone, G.(2011). A data quality methodology for heterogeneous data. *International Journal of Database Management System* , 3(1), 60-79.

Chen, C., Law, C., Chuck, C. H. & Yang, S. C. (2009). Managing ERP Implementation Failure: A Project Management Perspective. *IEEE Transactions on Engineering Management*, 56(1), 157-170.

Chou, S. W. & Chang, Y. C. (2008). The implementation factors that influence the ERP (enterprise resource planning) benefits. *Decision Support Systems*. 46(1), 149-157.

Chung, S. H. & Snyder, C. (2000). A ERP adoption: a technological evolution approach. *International Journal of Agile Management Sys*tem, 2(1), 24-32.

Creeger, M. (2009). CTO Roundtable: Cloud Computing: An Overview. *ACMQueue* 7(5), 1-5.

Davis, M. J. & Huang, Z. (2007). ERP in Higher Education: A Case Study of SAP and Campus Management. *Issues in Information Systems,* 8(1), 120-126.

Day, B. & Lutteroth, C. (2011). Climbing the ladder: Capability Maturity Model Integration Level 3. *Enterprise Information System,* 5(1), 125 – 144.

Dedeke, A. (2000). A conceptual framework for developing quality measures for information systems. *In Proceedings of 5th International Conference on Information Quality*, 126–128.

DeLone, W. H. & McLean, E. R. (1992). Information systems success: the quest for the dependable variable. *Information Systems Research*, 3(1), 60-95.

Deshields, Jr O. W., Kara, A. & Kaynak, E. (2005). Determinants of Business student satisfaction and retention in higher education: Applying Herzberg's two-factor theory. *International Journal of Educational Management*, 19(2), 128-139.

Eppler, M. et al. (2002). Measuring information quality in the web context: A survey of state-of-the-art instruments and an application methodology. In *Proceedings of 7th International Conference on Information Quality*, 187–196.

Fisher, M. D. (2006). Staff Perceptions of an Enterprise Resource Planning System Implementation: A Case Study of three Australian Universities. Queensland Central Queensland University. PhD Thesis.

Frantz, P.S., Southerland, A.R. &Johnson, J.T. (2002). ERP software implementation best practices, *EDUCAUSE Quarterly* 4, 38–45.

Gable, G. G., Sedera, D. & Chan, T. (2003). Enterprise Systems Success: A Measurement Model. *Twenty Fourth International Conference on Information Systems 2003*, 576-591.

Ghuman, K. (2012). Incorporation of ERP in Educational Institutions: An Empirical Study. *International Conference on Technology and Business Management*, March 26-28 2012, 318-324.

Goel S., Kiran. R. & Garg, D. (2011). A Framework For Efficient Enterprise Resource Planning (ERP) Implementation In Technical Educational Institutions. African *Journal of Business Management*, 5(34), 13197-13204.

Goel, S., Kiran. R. & Garg, D. (2012). Technologies for Cost Efficient ERP: A theoretical Perspective. *International Conference on Advances in Computing*, Bangalore, 3-4 July, 2012, Proceedings of ICAdC, SPRINGER, AISC 174, pp. 113–120.

Goscinski, A. & Brock, M. (2010). Towards Dynamic and attribute based publication, discovery and selection for Cloud computing. *Journal of Future Generation Computer Systems*, 26, 947-970.

Hau, T. T. V. & Kuzic J. (2010). Change Management Strategies for the Successful Implementation of Enterprise Resource Planning Systems. *In proceedings of the IEEE Second International Conference on Knowledge and Systems Engineering, Hanoi, Vietnam*, October 07-09 2010, 178-182.

Haug, A., Arlbjorn, J. S. & Pedersen A. (2009). A Classification Model of ERP System Data Quality. *Industrial Management and Data Systems*, 109(8), 1053-1068.

Helo, P. (2008). Expectation and reality in ERP implementation: consultant and solution provider perspective. *Industrial Management & Data Systems*, 108 (8), 1045-59.

Hendricks, K. B., Singhal, V. R., & Stratman, J. K. (2007). The Impact of Enterprise Systems on Corporate Performance: A study of ERP, SCM, and CRM System Implementations. *Journal of Operations Management*, *25*(1), 65-82.

Huynh, Minh Q. and Chu, Hung W. (2011). Open-Source ERP: Is It Ripe for Use in Teaching Supply Chain Management?. *Journal of Information Technology Education: Innovations in Practice* , 10,181-194

Ifinedo P.E. (2006). Enterprise Resource Planning Systems Success Assessment: An Integrative Framework. Jyväskylä Studies in Computing, PhD Thesis.

Ifinedo, P. E.& Nahar N. (2006). Prioritization of Enterprise Resource Planning (ERP) Systems Success Measures: Viewpoints of Two Organizational Stakeholder Groups. *In proceedings of SAC'06, April 2006, Dijon, ACM*, 1554-1560.

Ifinedo, P. E. , Rapp, B., Ifinedo, A., Sundberg, K. (2010). Relationship among ERP Post – implementation success constructs: An Analysis at the Organizational Level. *Journal of Computers in Human Behavior*, 26(5), 1136-1148.

Iuliana, S., Adela, B., Radu, C., RĂZVAN, Z. & Floarea, N. (2009). Improving organizational efficiency and effectiveness in a Romanian Higher Education Institution. *WSEAS TRANSACTIONS on COMPUTERS* , 8(10), 1641-1650.

Kahn, B. K. et al. (2002). Information quality benchmarks: Product and service performance. *Communications of the ACM,* 45(4), 84–192**.**

Kamhawi, E.M. (2008). Enterprise Resource Planning Systems Adoption In Bahrain: Motives, Benefits, And Barriers. *Journal of Enterprise Information Management* 21(3), 310–334.

Kim, Y., Lee, Z. & Gosain, S. (2005). Impediments to successful ERP implementations process. *Business Process Management Journal*, 11(2), 158–170.

King, P., Kvavik, R. B. & Voloudakis, J. (2002). Enterprise resource planning systems in higher education. *EDUCAUSE Research Bulletin,* 22(22), 1-11.

Klein, B. D. (2001). User perceptions of data quality: Internet and traditional text sources. *The Journal of Computer Information Systems*, 41(4), 9–18.

Koch, C. (2001). BPR and ERP : realizing a vision of process with IT. *Business Process Management Journal*, 7,(3), 258-265.

Koh, S.C.L., Simpson, M., Padmore, J., Dimitriadis, N. & Misopoulos, F. (2006). An exploratory study of enterprise resource planning adoption in Greek companies. *Industrial Management & Data Systems*, 106(7), 1033-1059.

Kumar, M.N. Vijaya, Suresh A.V. & Subramanaya K.N. (2010). Application of an Analytical Hierarchy Process to Prioritize the Factors Affecting ERP Implementation. *International Journal of Computer Applications*, 2(2), 1-6.

Kumar, V., Maheshwari, B. & Kumar, U. (2003). An investigation of critical management issues in ERP implementation: Empirical evidence from Canadian organizations. *Technovation*, 23, 793–807.

Kvavik, R. B., Katz, R. N., Beecher, K., Caruso, J. , King, P., Voloudakis, J. & Lore-Anne W. (2002). The Promise and Performance of Enterprise Systems for Higher Education. *EDUCAUSE* , 4, 5-123.

Kwon H. (2008). Security Engineering in IT Governance for University Information System. *In proceedings of International Conference on Security and Assurance*, 502.

Lee, J.S.K. & Hong S. (2003). Enterprise Integration with ERP and EAI. *Communications of the ACM*. 46(2), 54-60.

Mahalaxmi, D. S. and Raju, S. V. (2011). Revolutionary Approach from Protecting the Software. *International Journal of Engineering Research and Applications*, 1(4), 1579-1582.

Maheshwari, B., Kumar, V. & Kumar, U. (2010). Delineating the ERP institutionalization process: go-live to effectiveness. *Business Process Management Journal*, 16(4), 744-771.

Maheshwari, S. P., Singh, P. & Tripathi, L. K. (2011). ERP Implementation in Educational Institutions: Challenges and Opportunities. *Eighth AIMS International Conference on Management*, January 1-4, 2701- 2709.

Manson, D., Meldal S., Sledge C.et al. (2006). Panel Session - Learning Modules for Security, Privacy and Information Assurance in Undergraduate Engineering Education, *36th ASEE/IEEE Frontiers in Education Conference*, October 28 – 31, 2006, San Diego, CA, session S3 B.

Marnewick, C. & Labuschagne, L. (2005). A conceptual model for enterprise resource planning (ERP). *Industrial Management and Computer Security*, 13(2), 144-155.

McConachie, J. (2001). The Effect of Sub-cultures on the Implementation of an Enterprise System: An Australian Regional University Perspective. *QJER*, 17.

Mehlinger, L. B. (2006). Indicators of Successful Enterprise Technology Implementations in Higher Education Business Morgan state Morgan state University, Ph.D Thesis, 1-147, 3216235.

Meldal, S., & Luckham, D. C. (1997). Defining a Security Reference Architecture, Technical Report CSL–97–728 Program Analysis and Verification Group Report No. 76, pp. 1-25.

Mohamed, M., Murray, A., Mohamed, M. (2010). The role of information and communication technology (ICT) in mobilization of sustainable development knowledge: a quantitative evaluation. *Journal of Knowledge Management*, 14(5), 744-758.

Mohamed, S. and McLaren, T. S. (2009). Probing the Gaps between ERP Education and ERP Implementation Success Factors. *AIS Transactions on Enterprise Systems*. 1(1), 8-14.

Mohan, Ed. (2009). Implementing an ERP on Time and Budget: An Innovative, inclusive Approach. *EDUCAUSE* (10), 1-13.

Momoh, A., Roy, R. & Shehab, E.(2010). Challenges in Enterprise Resource Planning implementation: state of the art. *Business Process Management Journal*, 16 (4), 537-565.

Nah, F.F., H. Lau, J.L.S. & Kuang, J. (2001). Critical factors for Successful implementation of Enterprise Systems. *Business Process management Journal*, 2(2), 285-296.

Naumann, F. et al. (2000). Assessment methods for information quality criteria. *In Proceedings of 5th International Conference on Information Quality*, 148–162.

Nicolaou, A. I. (2004). ERP Systems Implementation: Drivers of Post-Implementation Success. In *DSS2004 Conference Proceedings*, 589- 597.

Nielsen, J. L. (2002). Critical success factors for implementing an ERP system in a University environment: A case study from the Australian HEs, Faculty of Engineering and Information Technology. Brisbane, Griffith University. Bachelor: 189.PhD thesis.

Parr, A.N. and Shanks, G. (2000). A Taxonomy of ERP Implementation Approaches. *Proceedings of the 33rd Hawaii International Conference on System Sciences IEEE 2000*, 1-10.

Piramuthi S., & Shaw M.J. (2009). Learning-enhanced adaptive DSS: a Design Science perspective. *Information Technology Management*, 10, 41-54.

Pollock, N. & Cornford, J. (2004). ERP systems and the University as a "unique" organization. *Information Technology & People*, 17(1), 31-52.

Rashid, M. A., Zekeriya-Nas, S., Muiz-ud-Din, Muhmood, Uzma, Ceylan-Oklu,Naila-Gul. (2009). Windmills & CSFs for EP-diffusion of technovation in academia-industry:a qualitative analysis, *PICMET 2009 proceedings, August 2-6, Portland, Oregon USA*, 2711-2721.

Redman, T. C. (1998). The Impact of Poor Data Quality on the Typical Enterprise. *Communications of the ACM*, 41(2), 79–82.

Roberts, N.C. (2010). Tracking and disrupting dark networks: Challenges of data collection and analysis. *Information Systems Frontiers*, 13, 5–19.

Salmeron, J. L. and Lopez C. (2010). A Multicriteria Approach for risks assessment in ERP maintenance. *Journal of Systems and Software*. 83(10), 1941-1953.

Scott, J. & Vessey, I. (2002). Managing risks in enterprise implementations. *Communications of the ACM*, 45(4), 74-81.

Seng, D. & Churilov, L. (2003). Business Process-Oriented Information Support for a Higher Education Enterprise. *7th Pacific Asia Conference on Information Systems*, 10-13 July 2003, Adelaide, South Australia, 1055-1074.

Shafiei, F., Sundaram D. & Piramuthu S. (2009). Implementing a Multi-Enterprise Collaborative DSS, IEEE Enterprise Distributed Object Computing Conference Workshops, 2009. 1-4 September 2009, Auckland, 220-229.

Shang, S., & Seddon, P. (2000). A Comprehensive Framework for Classifying the Benefits of ERP Systems. *Proceedings of the 6th Americas Conference on Information Systems*, August :10-13, Long Beach, CA, 1005-1014.

Sharma, N., Singh, K. & Goyal, D. P. (2012). Adoption of Knowledge Management Practices in Software Engineering Organizations, *2012 IEEE Second International Conference on Advanced Computing & Communication Technologi*es,7 – 8 Jan, 2012, Rohtak, Haryana, India, 24–29.

She, W. and Thuraisingham, B. (2007).Security for Enterprise Resource Planning Systems. *Information Systems Security*.16: 152-163.

Shyur, H. J. (2003). A Semi Structured Process for ERP Systems Evaluation: Applying Analytic Network process. *Journal of e-Business*. 5(1): 33-49.

Singh, A., Wesson, J. (2009). Evaluation Criteria for Assessing the Usability of ERP Systems. *In proceedings of SAICSIT'09, Vanderbijlpark, South Africa, ACM*, 87-95.

Singh, R, and Singh K. (2010). A Descriptive Classification of Causes of Data Quality Problems in Data Warehousing. *International Journal of Computer Science Issues*, 7(3: 2), 41-50.

Singla A.R. (2008). Enterprise Resource Planning, Cengage learning.

Skibniewski, M. J. & Zeng Y. (2010). Enterprise Resource Planning Systems for Project-Based Firms: Costs, Benefits & Implementation Challenges. In proceedings of "Concepts, Tools & Techniques for Managing Successful Project, *Advancing Project Management for the 21st Century* , 29-31 May 2010, Heraklion, Crete, Greece, 687-697.

Soh, C., Kien, S.S. & Tay-Yap, J. (2000). Cultural fits and misfits: is ERP a universal solution?. *Communication of the ACM*, 43(4), 47-51.

Spathis, C., Constantinides, S. (2003). The usefulness of ERP systems for effective management. Industrial Management and Data Systems, 103(9), 677-685.

Sun, A. Y.T., Yazdani A. & Overend, J. D.(2005). Achievement assessment for enterprise resource planning (ERP) system implementations based on critical success factors (CSFs). *International Journal of Production Economics*, 98, 189-203.

Swartz, D. and Orgill, K. (2001). Higher education ERP: Lessons learned – Using This Framework for ERP Could Save Your University Millions of Dollars. *Educause Quarterly*, 2, 20–27.

Thavapragasam, X. T. (2003). ERP Systems and User Perceptions: An Approach for Implementation Success. *Issues in Informing Science and Information Technology*, 521-531.

Themistocleous, M., Irani, Z. & O'Keefe, R. M. (2001). ERP and application integration. *Business Process Management Journal*, 7(3), 195–204.

Tsinidou, M., Gerigiannis, V. & Fitsilis, P. (2010). Evaluation of the factors that determine quality in higher education: an empirical study. *Quality Assurance in Education,* 18(3), 227-244.

Umble, E. J., Haft, R. R. & Umble M. M. (2003). Enterprise resource planning: implementation procedures and critical success factors. *European Journal of Operational Research*, 146(2), 241-57.

Vathanophasa, V. & Lindsay, S. (2009). Enterprise Resource Planning: Technology Acceptance in Thai Universities. *Enterprise Information Systems,* 3(2), 133–158.

Vayghan, J.A. et al. (2007). The internal information transformation of IBM. *IBM Systems Journal*, 46:4 (2007), 669-684.

Wang, Xin-li. (2010). Study on Academy-Oriented Resource Planning, *2nd international Conference on Education Technology and Computer (ICETC)*, 252-255.

Wang, R.Y. et al. (1996). Beyond accuracy: What data quality means to data consumers. *Journal of Management Information Systems*, Spring, 5–33.

Wei, C., Liou, T. and Lee, K. (2008). An ERP Performance Measurement Framework using a fuzzy integral approach. *Journal of Manufacturing Technology Management,* 19:5, 607-626.

Weir, B. and Mickool, R. (2003). For Enterprise Applications and Data, the Question is Not make Versus Buy… *EDUCAUSE Quarterly*, 1, 5-9.

West, R. & Daigle, S. (2004). Total Cost of Ownership: A Strategic tool for ERP planning and implementation. *EDUCAUSE Research Bulletin,* 1, 1-14.

Weiss, A. (2007). Computing in the clouds. *netWorker* 11 (4), December 2007,16-25.

Willcocks, L. P. & Sykes R. (2000). The Role of the IT Function. *Communications of the ACM*, 43(4), 32-38.

Willis, T. H. & Willis-Brown, A. H.(2002). Extending the value of ERP. *Industrial Management and Data Systems.* 102(1), 35–38.

Wu, J. & Wang, Y. (2006). Measuring ERP success: the ultimate users' view. *International Journal of Operations and Production Management*, 26(8), 882-903.

Xu, H., Nord, J. H., Brown, N. & Nord, G. D.(2002). Data Quality issues in implementing an ERP. *Industrial Management and Data Systems*, 102(1), 47-58.

Yakovlev, I. V.(2002). An ERP Implementation and Business Process Reengineering at a Small University. *EDUCAUSE*, 2, 52-57.

Youngberg, E., Olsen, D. and Hauser, K. (2009). Determinants of professionally autonomous end user acceptance in an enterprise resource planning system environment. *International Journal of Information Management*, 29,138-144.

Zhang, S. & Zhang, X. (2010). Characteristics of Enterprise Training and the Comparison with Academic Education. *2010 International Conference on E-Business and E-Government*, 5396-5398.

Zhang, Z., Lee, M.K.O., Zhang, L., & Huang, X. (2005). A framework of ERP systems implementation success in China: An empirical study. *International Journal of Production Economics*, 98(1), 56-80.

Zornada, L. & Velkavrh, T. B. (2005). Implementing ERP Systems in Higher Education Institutions. *27th Int. Conf. Information Technology Interfaces ITI, June 20-23, 2005, Cavtat, Croatia.*

Ziaee, M., Fathian, M. & Sadjadi, S.J.(2006). A Modular Approach to ERP System selection: A Case study. *Journal of Information Management and Computer Security*, 14(5), 485-495.

Designing a Framework for an Efficient ERP Implementation in TEIs

Questionnaire for users: UG / PG / PhD / Faculty

1. Institute's name:
   _____

2. Satisfaction Level: 1:Low 2:Medium 3:High _____

3. Please Tick the following attributes according to their priority while using the ERP solution **(1-Lowest 5-Highest)**

	Required Level					**Actual Level**				
	1	2	3	4	5	1	2	3	4	5
Functionality:										
1.Ease with which you can use the ERP system										
2.Ease with which you can handle problems during the use of the system										
3.Number of features implemented in the system										
4.The amount of work reduced because of ERP system										
5.Time required for training so that users get trained to use the system										
6. Amount of Documentation/manual/online help available to users so that they can handle problems by themselves										
7. Are all users ready to use the ERP system, i.e. isn't there any culture difference when you use the ERP system?										
8. Are the persons available online easily with ERP system?										
9. Can you now store data for longer duration with the ERP system?										
10. Can you easily use/adapt/customize your ERP system on various platforms?										

Security:											
11.Is the data secure when transmission over the network?											
12. Are there sufficient safety measures for authentication/authorization of users											
13. How many number of times the server is not in responding to queries of the users											
14.What are the chances of failure of entire network / system / module											
Quality:											
15.What are the average number of hours the services of ERP system are available?											
16. What are the average number of errors while using the system?											
17.What is the increase in time efficiency for carrying out all transactions using ERP system?											
18. How much time is taken to correct the errors by vendors or technical users?											
19.How much easy is it to add any new application to the system?											
20.Can you operate ERP system on any type of OS/ environment?											

3. Please indicate on a scale from 1 to 5 how much important do you think the given reasons are for various problems faced in ERP implementation:

(1-Not important 5- Most important)

	1	**2**	**3**	**4**	**5**
1. The way of using the ERP system (i.e. sequence of steps taken) is difficult					
2. Sufficient training is not provided to users so that they can use ERP system correctly					
3.All the activities have become time consuming with the ERP system					
4.The constraint of completing the activities by a particular date and time is making the ERP system not so popular					
5.The dependency o n Internet to access ERP system has created rigidity for network usage					
6. It is really difficult to update the information once entered using ERP system					
7. Personal interactions has decreased with ERP system					
8. You need to consult technical persons for solving day to day problems					

4.Please tick the implementation status of the following modules :

(1-upto 20% 2-20 to 40% 3-40 to 60% 4-60 to 80% 5-80 to 100%)

	Required Level					**Implemented till date**				
	1	2	3	4	5	1	2	3	4	5
Academic Management										
HR management										
Finance management										
Customer relationship management										
Inventory management										

Cost Benefit Analysis :

Please tick the cost and benefit according to their priority:

(1-Least priority 2-Medium priority 3-High priority 4-Very High priority 5-Highest priority)

		1	2	3	4	5
C1	Cost of developing interfaces					
C2	Cost of training					
C3	Cost of Technology					
C4	Cost of Customization					
C5	Cost of updates					
C6	Cost of Integration					
C7	Cost of standardization					
C8	Cost of Change management					
C9	Cost of risk management					
C10	Cost of regular monitoring					
C11	Cost of ERP consultant					
B1	Improved data quality					
B2	Coordination and communication among users					
B3	Competitiveness					
B4	User satisfaction					
B5	System Security					
B6	Enhanced Flexibility of the system					
B7	Organizational culture					
B8	System stability					
B9	Improvement in IT skills of employees					

Questionnaire for validation of Proposed factors in ERP Framework

Dear Madam/Sir,

As you all are aware that all the technical educational institutions (TEIs) are using the ERP solutions for managing information in TEIs. Many problems faced by users and many success factors are identified from research.

We have proposed a framework for ERP implementation in TEIs which can help in achieving benefits from ERP implementation and eliminate many problems faced by users i.e. to make ERP implementation efficient. We seek your expert opinion for validating the proposed framework.

Proposed Factor	**1 Least Priority**	**2 Medium Priority**	**3 High Priority**	**4 Very High Priority**	**5 Highest Priority**
Increasing Top Management Support					
Increasing Regular Training					
Reducing the Interface Complexity (same data formats)					
Enhancing Online help					
Enhancing Network availability					
Improving Interactivity for better communication (email, sms to parents etc.)					
Improving Data Quality (correctness, completeness and consistency of data)					
Reducing Dependency on vendor					
Increasing Data confidentiality (encryption, passwords, access controls)					
Enhancing Security Measures (using CAPTCHA, Biometric measures)					
Reducing the Customization Efforts (when purchase from vendor)					
Reducing the Implementation Cost					

Enhancing scalability using Virtual Environment (Cloud computing)					

Any other, Please specify:

Thank you for sparing your valuable time for providing us the useful feedback.

List of Publications

SCI/ SSCI Indexed Journals

Shivani Goel, Ravi Kiran, Deepak Garg, "A framework for efficient enterprise resource planning (ERP) implementation in technical educational institutions", African Journal of Business Management, ISSN 1993 8233 (Indexed in SSCI), published by Academic Journals, Nairobi, Victoria Island, Nigeria, Vol. 5, No. 34, pp. 13197-13204, Dec 2011, Impact factor 1.105.

Shivani Goel, Ravi Kiran, Deepak Garg, "Predictors of User Satisfaction in ERP in Technical Educational Institutions", Accepted in INFORMATION, An International Interdisciplinary Journal, Published by International Information Institute, Tokyo, Japan, Indexed by SCIE.(Accepted : July 2012)

Non SCI/ Impact Factor Journals

Shivani Goel, Deepak Garg, Ravi Kiran, "Impact of Cloud Computing on ERP implementations in Higher Education", International Journal of computer Theory and Engineering, IJACSA - ISSN 2156 5570 (Indexed in Google scholar and SCIRUS) published by The Science and Information Organization, Hillside Avenue, NewYork, USA pp. 146-148 Volume 2 Issue 6 June 2011, Impact factor 1.187

Shivani Goel, Ravi Kiran, Deepak Garg, "Vulnerability Management for Enterprise Resource Planning", International Journal of Computer Applications, published by Foundation of Computer Science, New York, USA, Vol 53 No. 4, pp. 19–22, Sept 2012, Impact factor 0.81.

National/ International Conferences/Seminars

Shivani Goel, Ravi Kiran, Deepak Garg, "Risks in Enterprise Resource Planning in Technical Educational Institutions: A Quality Perspective", in National Seminar on e-Governance in Technical Education – National, State and Institutional Perspectives, organized by Media and Continuing Education Centre at National Institute of Technical Teachers Training and Research, Chandigarh, Sep 6th and 7th 2011.

Shivani Goel, Ravi Kiran, Deepak Garg, "Survey on Current Status of ERP Implementation Modules in Technical Educational Instititions", National Conference on Changing Perspectives and Paradigms in Business Scenarios, organized by School of Behavioral Sciences and Business Studies and LM Thapar School of Management, at Thapar University, Patiala, 27-28 April, pp. 189-193, 2012.

Shivani Goel, Ravi Kiran, Deepak Garg, "Technologies for Cost Efficient ERP: A theoretical Perspective ", International Conference on Advances in Computing, Bangalore, 3-4 July, 2012, Proceedings of ICAdC, SPRINGER, AISC 174, pp. 113–120. Also selected for publication in Advances in Intelligent and Soft Computing Series (ISSN 1867–5662) by Springerlink**.**

Shivani Goel, Ravi Kiran, Deepak Garg, "Learning through ERP in Technical Educational Institutions", IEEE 15th International Conference on Interactive Collaborative Learning and 41st International Conference on Engineering Pedagogy, Villach, Austria, 26-28 September, 2012, to be published in IEEE Explore, Indexed in EI compendex, Elsevier SCOPUS.