Predictors for User Satisfaction in Enterprise Resource Planning Implementation in Technical Educational Institutions

Shivani Goel[1], Ravi Kiran[2], Deepak Garg[3]
[1]Assistant Professor, Computer Science and Engineering Department,
Thapar University, Patiala, Punjab, India-147001
shivani@thapar.edu ,91-0175-2393371(corresponding author)

[2] Professor, School of Behavioral Sciences and Business Studies,
Thapar University, Patiala, Punjab, India-147001
rkiran@thapar.edu, 91-0175-2393133

[3] Associate Professor, Computer Science and Engineering Department,
Thapar University, Patiala, Punjab, India-147001
dgarg@thapar.edu, 91-0175-2393007

ABSTRACT

Enterprise resource planning is becoming the essence of Technical educational institutions. It provides facilities like centralized administration, coordination and communication among various departments, better resource management along with easy information flow. The user satisfaction is an important consideration while accessing the success of ERP implementation. This paper highlights the data quality dimensions considered important for increasing the satisfaction level of users in technical educational institutions.

Keywords: Enterprise Resource Planning,User satisfaction,Security,Quality**.**

1. Introduction

Enterprise Resource Planning (ERP) software is an application software. Business solutions provided by ERP software support core processes of business and administrative tasks. 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. [1]. For technical educational institutions(TEIs), the ERP solution is integration of student administration, financial management and human resource management modules [2]. ERP software is chosen by TEIs to operate more effectively and efficiently. There are many benefits which any TEI can get by ERP implementation. Many researchers have identified benefits of ERP implementation for TEIs. In a survey from 12 higher educational institutions planning to ERP implementation, the benefits expected from ERP implementation are better functionality, improved security, efficiency and communication, enhanced technology and reporting, integrated information providing easier access to data along with user friendly interface [3].

Prior to ERP implementation, all the operations in TEIs are performed in traditional ways. Transforming all the operations to online mode is a tedious job and require many organizational changes. So the TEIs must be able to manage organizational change for successfully implementing ERP systems [4]. 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 [5]. 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 [6].

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. The earlier case studies in industries show that the ERP projects did not produce the expected benefits because they were lacking data quality [7],[8]. Data quality focuses on the quality of information which any information system produces as output [9]. With increase in the number of users, the user's data increase day by day. The growing volume of data may result in inefficiency in storing, managing and processing of information [10]. This growing volume of data may also cause the problem of scalability [11].

TEIs involve planning, administration and evaluation of efforts in order to incorporate data quality. Total quality management in educational management is important for institutions to be successful [12]. Thus, data quality is an important consideration for ERP implementation success ([13],[14],[15]). 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.[9]. 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 [16]. There is a need to develop a standard user satisfaction criteria to assess users' satisfaction with ERP system implementation success [17],[3]. As data quality is found to be an important consideration for TEIs, this paper aims to identify the predictors of data quality in ERP which are considered important for user satisfaction.

2. Literature review

ERP has been implemented by many universities. The satisfaction of users can be measured by the quality provided by the ERP systems. Many of the universities have used different ERP solutions from different vendors. There are ERP software like SAP University Alliance program which provides good functions for technical institutions but the constraint of cost is hindrance in its use by all the technical institutions. The solution to cut the cost is open source ERP. But there are many problems and risks in using open source ERP software [18]. All of the ERP solutions have focus on different aspects of quality. There are various dimensions in which data quality can be measured. Table 1 shows the data quality dimensions considered by many researchers.

Table 1 Literature Review

	[2]	[6]	[9]	[19]	[20]	[21]	[22]	[23]	[24]	[25]	[26]	[27]	[28]	[29]	[30]
Accuracy	√			√	√	√		√		√		√	√		
Accessibility		√			√		√				√	√			√
Availability							√	√	√	√					√
Amount of data					√			√			√		√		
Authority									√						
Consistency	√						√					√			
Completeness	√		√		√		√	√			√		√		
Concise representation					√		√	√			√	√			
Efficiency			√			√	√							√	√
Interoperability					√	√	√	√		√	√			√	
Maintainability	√					√						√			
User readiness									√						
Reliability			√			√		√							
Reputation			√		√			√			√				
Security	√		√		√	√	√	√		√	√	√			
Timeliness					√		√	√			√	√	√		√
Usability			√			√								√	√
Usefulness		√												√	
Understandability					√			√		√	√			√	√
Value addition					√		√	√			√				

3. Research design and methodology

User satisfaction is an important part of ERP success ([3] Davis and Huang, 2007) . In the context of ERP in technical educational institutions in India, the user satisfaction in data quality provided by ERP system is to be evaluated. For this, the important data quality dimensions considered are accuracy, accessibility, adaptability, amount of data, authority, availability, completeness, concise representation, consistency, convenience, interactivity, interoperability, maintainability, User readiness, reliability, reputation, safety, security, speed, timeliness, understandability, value addition. These have been included after a survey of important data quality dimensions identified by many researchers and by advice from various domain experts.

3.1. Sample

The sample for the survey on accessing user satisfaction are the technical educational institutions. These are classified in two categories viz. engineering institutions and institutions imparting education in engineering and management both. Further they are categorized as either public or private. The definition of information is viewed from various users like students and faculty. The students represented various groups like undergraduate, postgraduate and research scholars. Here the satisfaction level of the users is judged. The data has been collected

from through a self structured questionnaire. The questionnaire was sent to top 50 TEIs in North East India. The response was received from 22 TEIs, which has been taken for analysis. A total of 900 individual responses were received from these 22 TEIs comprising of faculty (14%), PhD students(10%), post graduate students (33%) and undergraduate students(43%) from 10 public TEIs and 12 private TEIs.

3.2 Tool

A self structured questionnaire was used to gather data. The questionnaire was constructed based on an extensive review of the literature in the areas of ERP implementation and data quality. Many survey questions were adopted from previous literature and suggestions from academicians. The questionnaire consisted of two parts. The first part involved demographic questions designed to solicit information about the respondents and their level of satisfaction in using the ERP system. The values of level of satisfaction were 1-low, 2-medium and 3-high. The second part involved a question about the respondent's satisfaction with the ERP system by measuring 22 important factors considered for data quality. The users were asked about the actual level of satisfaction for these on a 5-point Likert-type scale which varied from 1=strongly disagree to 5=strongly agree.

3.3 Methodology

Factor analysis has been used to classify the twenty two items into three main categories namely Overall functionality, overall security and overall quality. These three have been further classified into six factors viz. operational efficiency, user accessibility, user security, system security, usability and scalability. Validity analysis was done using Cronbach Alpha. Factor Analysis, Linear Step- wise regression was used to design a model to find the relation between these factors and user satisfaction of users. The independent variable of the model was level of satisfaction of various users. The dependent variables included in the model are: system functionality (user accessibility, operational efficiency), overall security (user security, system security) and service quality (usability and scalability). Logistic step-wise regression was done to find the factors which differentiate between public and private TEIs.

4. Results and discussion

4.1. Instrument validity

The psychometric properties of the instrument were evaluated in terms of reliability and construct validity. Reliability was calculated for all multi-item variables. The content validation and face validation of the questionnaire was done by the domain experts. The pilot survey was done with 100 users. The reliability of the questionnaire was found to be 0.96 using Cronbach Alpha. The entire instrument, as well as the individual variables, achieved high levels of reliability, as shown in Table 1.

Table 1 Descriptive statistics and Cronbach's Alpha coefficients for the 22 item instrument

Factors	Mean	S.D	Cronbach's alpha
System Functionality(20)	4.029	1.276	0.937
Overall Security(12)	4.045	1.522	0.859
Service Quality(12)	3.944	1.198	0.848

4.2 Factor analysis

Construct validity was assessed by principal component analysis. The analysis produced three components namely functionality, security and quality. The factors for functionality explained 74% of the overall variance. The two factors for Security also explained 74% of the total variation and the two factors for quality explained 71% of the total variation. All items loaded significantly higher on the variables they were designed to measure than on other variables. Furthermore, the factor loadings were greater than 0.50, with most of them above 0.70, indicating high construct validity (Table 2).

Table 2 : Factor analysis

Factor Loading	User Accessibility	Operational Efficiency	User Security	System Security	Usability	Scalability
1.Understandability	0.916					
2.Completeness	0.794					
3.Convenience	0.725					
4.Value addition	0.641					
5.Interactivity	0.566					
6.Relevancy		0.636				
7.User readiness		0.882				
8.Concise representation		0.69				
9.Amount of data		0.616				
10.Adaptability		0.699				
11.Authority			0.908			
12.Authenticity			0.901			
13.Accessibility			0.842			
14.Consistency				0.903		
15.Reliability				0.629		
16.Safety				0.607		
17.Availability					0.897	
18.Accuracy					0.872	
19.Efficiency					0.807	
20.Timeliness					0.701	
21.Scalability						0.945
22.Interoperability						0.34

4.3 Logistic step-wise regression analysis

In the survey presented here, both public and private TEIs are considered. The In order to find the attributes which can be used to differentiate between the two types of TEIs, binary logistic regression analysis was done. The results are shown in table 3.

Table 3 Logistic Regression Analysis for Public and Private TEIs

	B	S.E.	Wald	df	Sig.	Exp(B)
Understandability	.878	.198	19.760	1	.000	2.406
Convenience	.709	.194	13.400	1	.000	2.031
Interactivity	-.830	.192	18.690	1	.000	.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	.000	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	.000	.000

In order to find the predictors of user satisfaction in both types of TEIs, linear step wise regression was done with responses from all the TEIs. The analysis took 11 steps. The results of step 11 are shown in table 3. Here all the parameters are useful to model because Wald statistic is small(<0.05). The ten attributes shown in table 3 differentiate public and private TEIs.

The Logistic regression model is

Satisfaction Level = -9.069 + 0.878*Understandability+ 0.709*Convenience -0.830* Interactivity+ 0.496* Value addition +0.384* User readiness +0.511 * Adaptability + 0.569* Authority +0.693* Reliability – 0.554* Efficiency+0.555* Interoperability. (1)

It is able to predict whether the TEI is public or private based on the above regression equation. The cut value is 0.5. If the value is less than 0.5, it represents public TEi while a value more than 0.5 indicates a private TEI. The improvement Chi square value of model at 11^{th} step is 4.237 with df as 1 and is highly significant (sig 0.040).

Table 4 Hosmer-Lemeshow goodness of fit statistic

Step	1	2	3	4	5	6	7	8	9	10
Chi Sq	388.477	27.168	18.292	8.913	10.163	10.665	8.878	8.513	6.719	4.237
Df	1	1	1	1	1	1	1	1	1	1
Sig.	.000	.000	.000	.003	.001	.001	.003	.004	.010	.040

The The Hosmer-Lemeshow statistic indicates a poor fit if the significance value is less than 0.05. Here, the model adequately fits the data. The sensitivity of predicting public TEIs is 75% while that of private TEIs is 97.7%. -2 Log likelihood value is 246.475. Cox and Snell R square is 0.423. Nagelkerke R square is 0.753.
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. These attributes include sub factors of all the six factors namely user accessibility, operational efficiency, system security, user security, usability and interoperability.

4.4 Linear step-wise regression analysis

The means and standard deviations of all variables are summarized in Table 1. 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 as well as 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 5.

The regression result 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 5 Linear Regression Analysis

Var	**B**	**Std Error B**	**β**	**T**	**Sig.**
(Constant)	.607	.055		10.935	.000
Operational Efficiency	.289	.025	.461	11.583	.000
System Security	.104	.019	.185	5.584	.000
Usability	.089	.025	.138	3.496	.000

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 mode is highly significant and R^2 value is 0.516. The linear regression model equation would be written as follows:

Satisfaction Level (SL) = 0.607 + 0.289* Operational efficiency + 0.104* System Security + 0.089 * Usability. (2)

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. The results of individual linear step wise regression analysis are summarized in Table 6, 7 and 8.

Table 6 Linear Regression Analysis for Operational Efficiency

Var	B	Std Error B	β	T	Sig.
(Constant)	.697	.052		13.310	.000
Adaptability	.188	.017	.370	10.795	.000
Concise Representation	.186	.020	.294	9.241	.000
Relevancy	.134	.018	.272	7.446	.000
User readiness	-.108	.023	-.203	-4.712	.000
Amount of data	.065	.017	.130	3.797	.000
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 correlated 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 correlated negatively with operational efficiency is user readiness as shown by the regression coefficient.

Table 7 Linear Regression Analysis for System Security

Var	B	Std Error B	β	T	Sig.
(Constant)	1.149	.053		21.628	.000
Consistency	.197	.015	.429	13.230	.000
Safety	.060	.011	.166	5.525	.000
Reliability	.077	.015	.153	5.163	.000
R=0.612	Adj. R^2 =0.373	S.E. of Reg.=0.471	F(Stats)= 178.480	Sig(FStats) <.001	

The results of the regression analysis shows that in TEIs, the variables that are positively correlated with overall system security are consistency, safety and reliability. The results indicate that all the three sub factors considered for system security are positively correlated 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.

Table 8 Linear Regression Analysis for Usability

Var	B	Std Error B	β	T	Sig.
(Constant)	.961	.051		18.700	.000
Efficiency	.296	.018	.551	16.056	.000
Availability	.069	.016	.148	4.305	.000

R=0.661 Adj. R^2 =0.435 S.E. of Reg.=0.447 F(Stats)= 345.897 Sig(FStats) <.001

The results of the regression analysis shows that in TEIs, the variables that are positively correlated with overall usability are efficiency and availability. The results implies 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 correlated with usability are timeliness and accuracy as indicated by the regression results. The overall model is shown in Fig. 1.

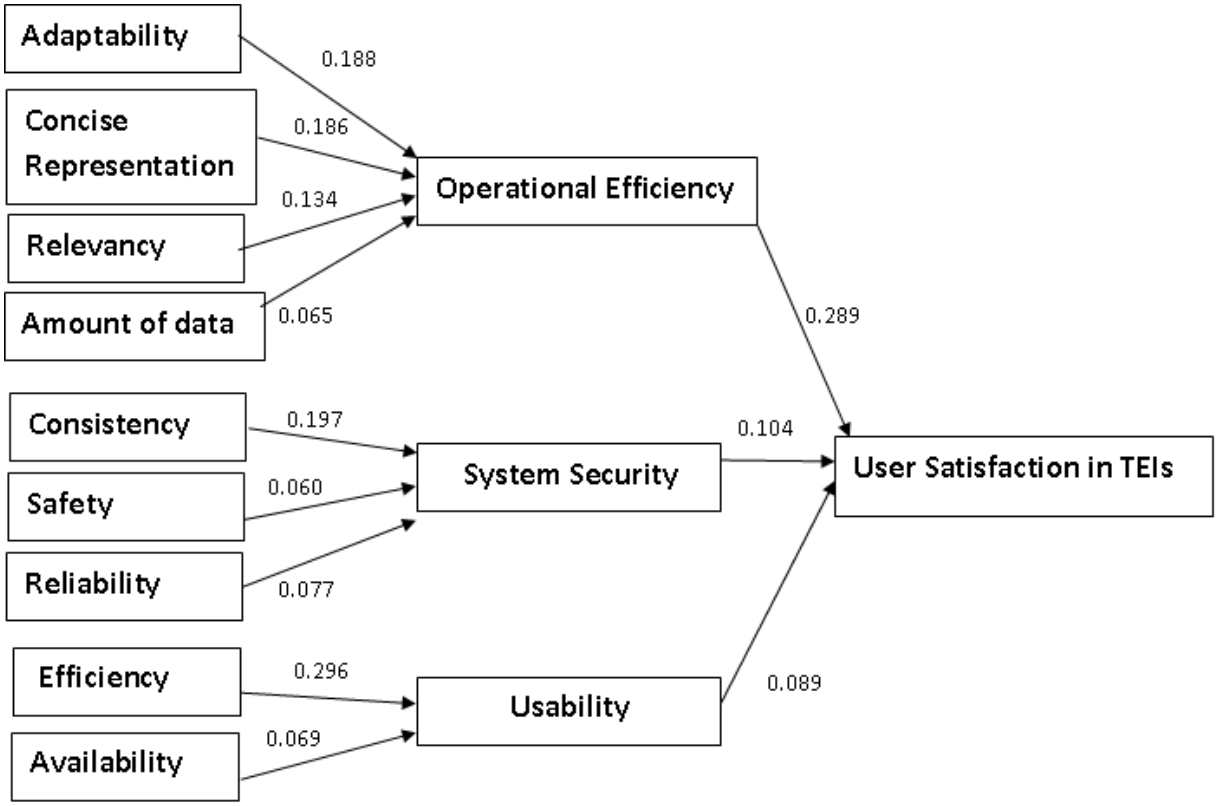

Figure 1: Overall Predictors of user satisfaction in ERP implementation

4.5 Discussion

The survey considered important three factors which can affect the satisfaction of user in using the ERP system in TEIs. These are overall functionality, overall security and overall quality of ERP system. 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 system security including consistency, reliability and safety while user security including authority, authenticity and accessibility. The overall

quality is represented as two sub factors namely usability including availability, accuracy, efficiency and timeliness and scalability which included scalability and interoperability.

The results of the regression analysis points 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 correlated with overall user satisfaction. This result confirms 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 or 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.

CONCLUSION

This case study of an ERP implementation at various technical educational institutions has been designed to gather an overall view from the perspective of 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. Survey tools have been designed and sample populations are randomly selected to be surveyed at some of the TEIs .While the goal of the initial research proposal was effectively designed, the result of this first draft of the research paper is not an example of effective research due to limited number of survey responses. 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. Student's satisfaction is an important factor for the success in higher education institutions [31]. Satisfaction with availability of computing resources is also critical for students [32]. System quality and information quality is also identified as of high importance in ERP systems [33]. But the proposed model has identified that operational efficiency and security are also important along with system quality for increased user satisfaction. 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([5],[13], [14],[15]). 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. Calisir and Calisir also identified determinant of end user satisfaction with ERP systems as reduction in work load i.e. value addition and learnability only [29]. The proposed model emphasizes on other attributes like adaptability, concise representation and accuracy as important predictors for user satisfaction [34]. 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.

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BIOGRAPHY

Shivani Goel, is working as Assistant Professor in Department of Computer Science and Engineering at Thapar University, Patiala, Punjab, India. She is a PhD candidate pursuing her PhD on Efficient ERP Implementation in Technical Educational Institutions. She has 12 years of teaching experience.

Dr. Ravi Kiran is Professor and presently workting as head , in School of Behavioral Sciences and Business Studies at Thapar University, Patiala, Punjab, India. She has 20 years of teaching experience.

Dr. Deepak Garg is Associate Professor in Department of Computer Science and Engineering at Thapar University, Patiala, Punjab, India. He has 11 years of teaching and 2 years of industry experience.