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Research Paper

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ABSTRACT

This paper reports on a study that uses a combination of techniques to formally characterize and determine the critical success factors influencing the effective usage of enterprise resource planning (ERP) systems, with special reference to higher education institutions. The thirty-seven ERP success factors identified from the literature are classified into: Critical, Active, Reactive and Inert categories. The classification of decision factors can generally support organizations to explore their current challenges and to adequately prepare decisions in a more participatory way for future endeavors. This study suggests a possible alternative that decision makers should take when a factor or a set of factors dominates during the implementation of ERP systems.

Keywords:

Critical Success Factors, CSF Classification, Higher Education, ERP

INTRODUCTION

The overarching objective of this study is to identify the critical success factors influencing the effective usage of enterprise resource planning (ERP) systems in the context of higher educational institutions. The pervasiveness of information and communication technologies (ICTs) and the need to automate organizational processes have led to innovations in higher educational institutions. The academic sector has joined the business, finance, and manufacturing enterprises to leverage the power of ICT to gain differentiation and competitive advantages (Karande, Jain, & Ghatule, 2012; Kumara & Guptab, 2012). The higher educational institutions across the world have introduced enterprise resource planning (ERP) systems to automate and integrate their business processes, including recruitment, admission, financial aid, student records, and most academic and administrative services (Ghuman & Chaudhary, 2012). The concept of "ERP entails gaining the knowledge of the best business practices and applying these practices to improve or completely replace existing legacy practices" (Ram, 2013). Kumar & Hillegersberg (2000) have defined ERP systems as "configurable information systems packages that integrate information and information-based processes within and across functional areas in an organization." Such a system may include customer relationship management (CRM), human resource management (HRM), marketing and accounting software (MAS), students and academic resources (SAR), supply chain management (SCM), and library information system (LIS) (Kwahk, 2006; Gumussoy, Calisir & Bayram, 2007).

The desire to produce better ERP systems to meet the demands of different organizations has caused stiff competition in the ICT market. This has led to a dilemma in effectively deciding on which ERP system to implement, when to implement the system, and how to implement it. Moreover, the decision to select, buy, or implement an ERP system is a difficult undertaking for any business endeavor (Fauscette, 2013). The lack of ICT contextualization has led many organizations to have their specific needs not well met by ICT utilization. In addition, many ERP implementation projects have ended up in overspent budgets and delays. To worsen the case, they have been prematurely terminated because of their complexity, high cost, and high failure rate (Xia, Yu, Lim & Hock, 2010; ALdayel, Aldayel & Al-Mudimigh, 2011; Al-Shamlan & Al-Mudimigh, 2011; Candra, 2012; Kumara & Guptab 2012; Ahmad & Cuenca 2013). In the wake of these challenges, the managements of higher educational institutions have tried as much as possible to devise different strategies to improve organizational efficiency, but previous efforts have provided little solution to the problems. The prime research question that guides this study is the following: What factors are critical for the successful implementation of ERP systems?

There are many factors already identified that could influence the successful implementation and use of ERP systems. However, little research has been conducted on ERP systems implementation success in the higher education sector (ALdayel, Aldayel & Al-Mudimigh, 2011; Karande, Jain, & Ghatule, 2012). This research, with this gap in mind, would like to use a combination of techniques to identify, validate, rank, and classify ERP success factors. This study makes a significant contribution to the methodology for identifying, validating, ranking, and classifying ERP success factors. In practice, the methodological scheme of this study would serve as a reference point for planning, implementing, and using ERP systems.

LITERATURE OVERVIEW

Higher educational institutions have previously depended on their bespoke student record systems (SRS) to improve efficiency of student services. However, increasing global competitiveness has made many educational institutions acquire customizable software, whereas others are buying software as a service (SaaS) because of the emergence of innovative cloud computing, which is considered the future of ICT (Petrides, 2004). Developments in ICT have seen a remarkable increase in ERP systems investment in education domain with the following benefits (Shang & Seddon, 2000; King, Kvavik & Voloudakis, 2002; Shang & Seddon 2002; Spathis & Ananiadis, 2005; Xu & Quaddus, 2013):

a) Enabling a faultless integration of data flows and business processes as well as enhancing information sharing in all sections of an institution.

b) Helping to develop teaching and learning pedagogies where, for instance, a lecturer teaches a given concept in the normal classroom setting and later uses an ERP system to demonstrate what is being taught.

c) Improving internal efficiency of workflow such as a student online registration procedure. For instance, when a student successfully completes a registration form, the workflow is automatically sent to the right authority for timely approval.

d) Increasing access to diverse information sources such that members of an institution could seamlessly work with data originating from different sources.

e) Enabling a centralized data storage capability that could assist to enhance control, manage information, and optimize storage.

f) Optimizing hardware resources, enhancing efficiency, and reducing the overhead costs in an institution.

g) Improving operations planning within an institution by providing relevant information required by managements to support strategic decisions.

h) Increasing information sharing, which leads to: enhanced workflow, increased efficiency, reduced reliance on paper and printed materials.

i) Managing communication and program alerts effectively, for instance, to monitor e-mail flows and alerts.

j) Providing an easy-to-use the web interface system to support interactivity. Such an interface can enhance integrated portals with one-stop shopping for a wide range of administrative functionalities.

k) Enabling an effective conduct of a new business process, such as: e-procurement, e-portfolio, e-learning, e-government, and e-commerce.

Despite the numerous benefits of ERP systems, their successful implementation has been better said than done (Venkatesh, Morris, Davis & Davis, 2003; Marchewka, Liu & Kostiwa, 2007). It becomes essential therefore to painstakingly investigate ERP success factors and give higher precedence to the most critical ones. Since the beginning of the inception studies of critical success factors (CSFs) (Daniel, 1961; Rockart, 1979), researchers have investigated several factors influencing the successful implementation and the effective use of ERP systems. However, despite several studies on ERP systems, few conceptual or theoretical frameworks are in existence to guide the implementation of ERP systems (Esteves & Pastor, 2000; Hedman, 2010). Some researchers have asserted that many of the studies on CSFs have based their findings on the literature reviewed rather than on empirical findings. In addition, certain researchers who have exclusively studied ERP systems in the education domain have established that vendors such as SAP, Oracle, PeopleSoft, Microsoft, Siemens AG, and Sungard have developed different ERP systems for higher educational institutions (King, Kvavik & Voloudakis, 2002; Pollock & Cornford, 2004; Abugabah & Sanzogni, 2010). However, much as the ERP vendors are different, the purposes and processes of their ERP implementations as well as the factors influencing ERP system failures and successes are also similar.

In the past, several efforts were made to identify CSFs to help guide the implementation of ERP systems in organizations. In particular, Esteves & Pastor (2000) used the grounded theory methodology to identify 20 ERP success factors, which were categorized into: Organizational, Technological, Strategic, and Tactical. This categorization was later extended to include People, Vendor, and Cultural characteristics (Zhang, Lee, Zhang & Banerjee, 2003; Zhang, Lee, Huang, Zhang & Huang, 2005). Much as Zhang, Lee, Zhang & Banerjee (2003) examined 10 success factors, their study showed some improvement using partial least squares technique to rank the factors investigated. Similarly, using linear regression analysis, Spathis & Ananiadis (2005) established 20 success factors, but their study was limited to organizational factors. The authors Wong, Scarborough, Chau & Davison (2005) identified 14 success factors, but werelimited in the methodology employed because their findings were based on results from the extant literature. The methodology of identifying critical failure factors (CFF) was extended by analyzing 7 success factors identified using the analytical hierarchical processing (AHP) technique (Tsai, Chien, Hsu & Leu 2005). The AHP is a good technique for determining the importance of factors rather than their criticality and it is most appropriate for a small set of factors. Although the study by Kwahk (2006) is limited to the factors of perceived ease of use and perceived usefulness of ERP systems, there was an improvement because of the structural equation modeling (SEM) technique employed to determine the impact between factors. The SEM technique also was used to investigate whether CSFs for ERP contribute to implementation success and post-implementation performance (Ram, Corkindale, & Wu, 2013).

The studies in the literature have shown considerable improvement in the search for ERP systems CSFs (Finney & Corbett, 2007; Ngai, Law & Wat, 2008). While Finney & Corbett (2007) recommended 26 ERP success factors, which they identified using content analysis, the use of scientific methods was suggested to determine CSFs. In addition, Ngai, Law & Wat (2008) reviewed 48 articles to explain the disparity between the countries surveyed and the recommended empirical evidence for criticality of the 18 ERP success factors they identified. The study by Dezdar & Sulaiman (2009) analyzed 95 articles over a period of 10 years (1999-2008) to rank the 17 ERP success factors they identified using the frequency count method. The study by Supramaniam & Kuppusamy (2010), which established 22 ERP success factors in 7 categories, also showed little improvement in the methodology of determining the criticality of success factors. Although certain authors have defended the use of the literature method for determining ERP critical factors, there remains a gap in the analytics of establishing the interdependencies between factors. This gap provides the immediate motivation for establishing why and how the suggested ERP success factors are critical and showing their impacts on organizations.

METHODOLOGY

The participatory iterative procedure, which is compactly summarized in Figure 1, constitutes the methodology of this study. The procedure is iterative because the issues related to ERP success factors have to be continually identified over a certain period of time. The important objects participating in the iterative procedure are the researchers and the respondents, including the experts. The researchers are responsible for the initial identification of the ERP success factors, usually through the literature search over a period of time and with the aid of a search engine (finder). The respondents are individual users of ERP systems who provide ratings of the importance of the ERP success factors identified. The experts are professional ERP users whom the researchers consult to assist in validating the identified ERP success factors. An automated software (ranker) was used to rank ERP success factors on the basis of their importance. In addition, an automated software (classifier) was used to help classify the ranked ERP success factors into categories. The cardinal techniques used to implement the operations of ERP success factors identification procedure are thereafter discussed.

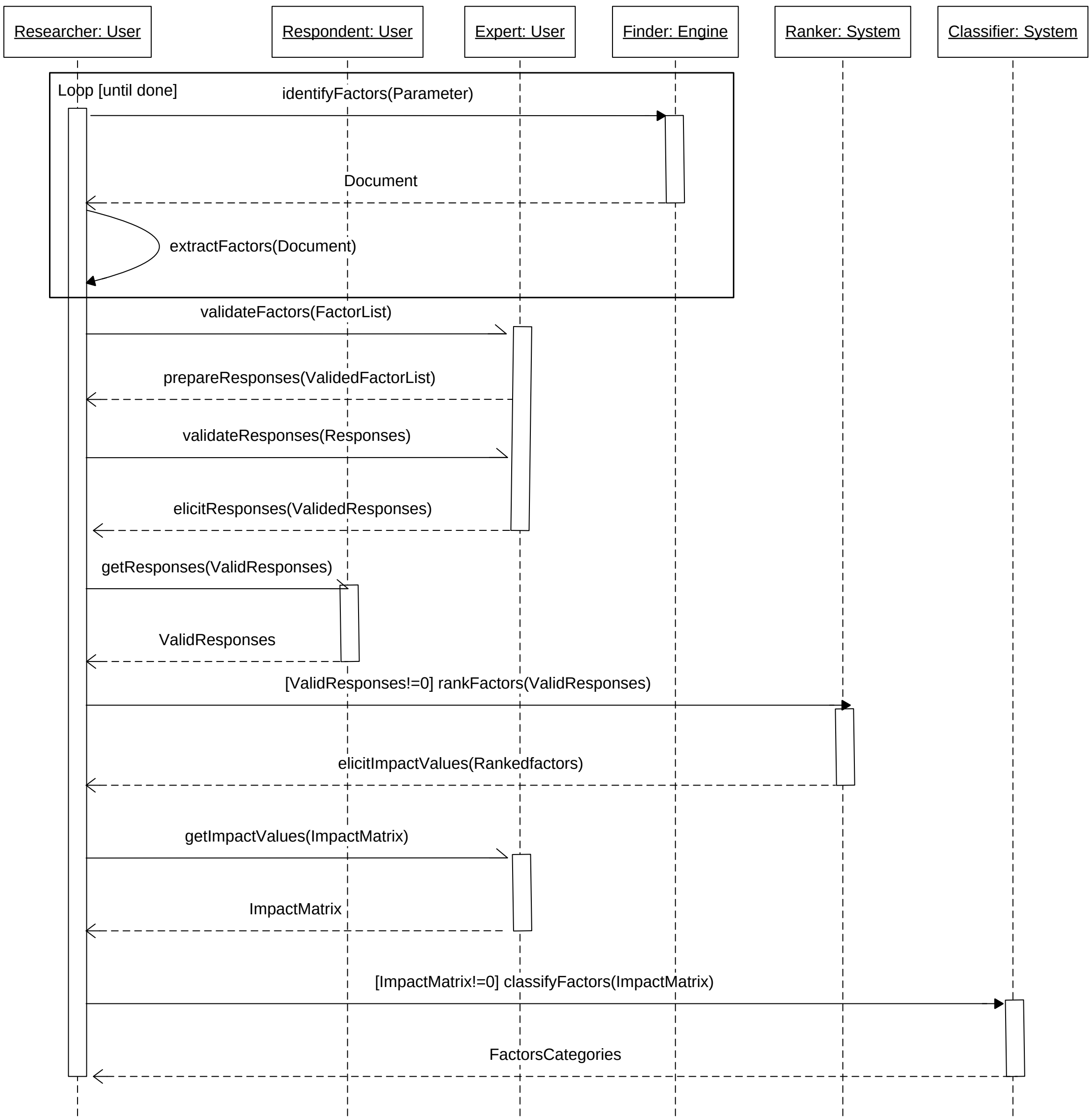

Figure 1: The participatory iterative procedure

Identification

The researchers used the analysis technique of scoping review, which follows the systematic review steps (Khan, Kunz, Kleijnen & Antes, 2003; Odunaike, Olugbara & Ojo, 2014) to identify ERP success factors previously discussed in the literature. In orderto gain a wider outlook, we used search engines to retrieve related research papers from scholastic electronic databases of information systems. The databases sufficiently cover the most related journals and conference proceedings within ERP studies. The search parameters and synonyms that were used to logically guide the search engines included "critical success factors ERP," "success factors ERP," "success factors ERP implementation," "ERP success," "ERP implementation success," and "enterprise resource planning." The search engines returned documents whose contents were analyzed to discover ERP success factors.

Validation

The expert judgment elicitation technique was used to engage three ERP experts to validate the success factors identified by the researchers. Some ERP success factors were retained with no changes made to them, but others were modified, renamed, or eliminated. The result of the factor validation process gave 43 ERP success factors, which were tabulated with the aid of Microsoft Excel as shown in Table 1.

Category	Success Factors	Count	Action taken
Organizational Factors	Top Management Support	49	Retained
	Management of Expectations	48	Retained
	Change Management	48	Retained
	Business Process Re-engineering (BPR)	45	Retained
	ERP Project Team Composition and Competence	35	Retained
	Education and Training of Users	29	Retained
	Interdepartmental Cooperation and Communication	28	Retained
	ERP Project Management	28	Retained
	Project Champion	28	Retained
	Organizational Environment and Characteristics	24	Organization Politics and Characteristics
	Organizational Structure and Management Style	15	Management style and Decision Making
	User Involvement and Resistance	10	User Involvement in Systems Development and Implementation
	Organization Politics and Decision Making	8	Eliminated
	Alignment with Organizational Vision, Strategies, and Planning	6	Retained
	Funding	4	Eliminated
	Clear Organizational Goals, Objectives, and Scope	3	Eliminated
Technical Factors	Perceived Ease of Use/Complexity	33	Complexity
	Minimum customization	33	Retained
	Data Quality, Analysis, and Conversion	25	Retained
	Software Development, Testing, and Troubleshooting	20	Retained
	Architecture Choices, Technological Implementation, and Infrastructure	16	Retained
	Appropriate business and IT legacy	10	Retained

	systems		
	Perceived Usefulness	8	Flexibility and Efficiency of Use
	Network Reliability	6	Retained
	Suitability and Attitude to Standardization	3	Suitability of the System and Attitude to Standardization
	Robustness and Error Prevention		Introduced
	User Friendliness, Help, and Documentation		Introduced
Individual Factors	Awareness	15	Combined with the education level of users and renamed Learnability
	Satisfaction and Systems Satisfaction	13	User satisfaction
	Attitude	8	Attitude Towards the System
	Behavior	7	Retained
	Motivation	5	Retained
	Education Level of Users	4	Combined with awareness
	Trust	2	Eliminated
Social Factors	Interest groups	18	Retained
	Roles	12	Retained
	Norms	4	Retained
	Values	2	Eliminated
Cultural Factors	National and Organizational Cultures	8	Retained
	Rules and Practices	7	Retained
	Cultural resistance	3	Culture of Resistance
Vendor factors	Vendor and Consultant Support	17	Combined with Vendor Customer-Partnership and Retained the name
	Systems Changes and Upgrade	15	Retained
	Use of Vendors' Tools	8	Retained
	Vendor Customer- Partnership	6	Combined with Consultant support
Political and National Level Factors	Governmental Policies	3	Policies and Standards
	Obsolescence of Hardware and Software	2	Availability of applications
	Political Influence	2	Retained

Table 1: Category of success factors, success factors, count of number of research papers that discussed the factor, and action taken by the current researchers after initial analysis

Ranking

In order to rank the validated ERP success factors, a closed-ended questionnaire was designed based on the Likert scale, asking respondents to give their opinions about the importance of each factor. The questionnaire's scale was from 0 to 5, where "0" meant completely not important, "5" highly important, and "1, 2, 3 and 4" represented the intermediate values for an ERP success factor. The questionnaires for data collection were administered to participants in higher educational institutions where ERP systems are used. The purpose of the data collection was to confirm from a user perspective whether the ERP success factors established in the literature are of any relevance in higher educational institutions. Data was collected from the integrated tertiary software (ITS) respondents who were team leaders mainly from the African universities sampled from (www.itsug.org.za) website. ITS is an ERP system designed with the intention to benefit higher educational institutions with modern functionalities to support their daily work. The reliability and the validity of the measurements have to be determined because the conceptualization of questionnaires for further data analysis was based on related studies on ERP systems. The content validity of the questionnaire was evidently strong with factor loadings exceeding the recommended threshold of 0.5 (Tabachnick, & Fidell, 2007). The internal consistency reliability of the questionnaire was 0.868, which is greater than the recommended value of 0.7 (Pallant, 2005).

The principal component analysis (PCA) technique implemented in IBM statistical package for the social sciences (SPSS) version 19.0 was used to reduce dimensions and to calculate factor loadings that provide rankings of ERP success factors. The orthogonal varimax rotation routine of PCA was used to more clearly differentiate factor loadings. The PCA produced an output on all the 43 ERP success factors in 7 iterations and reduced the 43 factors to 37 ERP success factors, which make a contribution of 77.729% of the total variance. Table 2 indicates that ERP success factors in the categories of organizational as well as political and national level respectively make the highest and the lowest contributions of 18.355% and 7.427% of the total variance explained. Although the ERP success factors of political and national level have the lowest contribution, their overall total percentage contribution of 7.427% is not negligible. In addition, the result in Table 2 shows the rankings of ERP success factors based on their independent contributions to the corresponding category. In the organizational category, change management factor ranked higher (0.897), whereas organizational politics and characteristics ranked lowest (0.504). In the technological category, complexity factor received the highest ranking of 0.921, whereas the factor of software development, testing, and troubleshooting had the lowest ranking of 0.502. The factor of vendor and consultancy support emerged highest in the vendor category. In addition, factors of learnability, rules and practices, interest groups, and availability of applications were respectively the highest in the categories of individual, cultural, and social as well as the political and national levels.

Category	Success Factors	Loadings	Total Variance Explained
Organizational	Change Management	0.897	18.355
	Top Management Support	0.884	
	Management of Expectations	0.881	
	Business Process Re-engineering (BPR)	0.853	
	Education and Training of Users	0.712	
	ERP Project Team Composition and Competence	0.708	
	User Involvement in Systems Development and Implementation	0.679	
	Management Style and Decision Making	0.543	
	Organizational Politics and Characteristics	0.504	
	Interdepartmental Cooperation and Communication	-0.646	
Technological	Complexity	0.921	14.523
	Network Reliability	0.875	
	Flexibility and Efficiency of Use	0.743	
	System's Response Time to Users' Requests	0.741	
	Data Quality, Analysis, and Conversion	0.658	
	Minimum customization	0.641	
	User friendliness, Help, and Documentation	0.511	
	Visibility of the System's Status	0.509	
	Robustness and Error Prevention	0.507	
	Software Development, Testing and Troubleshooting	0.502	
Vendor	Vendor and Consultancy Support	0.939	10.796
	Systems Changes and Upgrade	0.921	

	Use of Vendors' Tools	0.741	
Individual	Learnability	0.855	10.357
	Attitude Towards the System	0.817	
	User Satisfaction	0.654	
	Behavior	0.589	
	Motivation	-0.762	
Cultural	Rules and Practices	0.801	8.707
	Culture of Resistance	0.612	
	National and Organizational Cultures	0.507	
Social	Interest groups	0.746	7.564
	Roles	0.505	
	Norms	-0.683	
Political and National Level	Availability of Applications	0.775	7.427
	Policies and Standards	0.578	
	Political Influence	-0.583	
Extraction method : *Principal component analysis* ***Rotation method :*** *Varimax with Kaiser Normalization* ***Rotation Convergence:*** *7 iterations*			

Table 2: Category of success factors, success factors, loadings and total variance explained

Classification

The cross impact analysis (CIA) technique performs calculation with the 37 ERP success factors ranked. This follows the recommendation that for an effective use of CIA, the number of factors to be considered for the pairwise comparison in a cross impact matrix should be less than or equal to 40 (Schlange & Jüttner, 1997; Heuer & Pherson, 2011). The CIA employs a system-metaphor to make the system factors and their interdependencies comprehensible and understandable (Cole, Allen, Kilvington, Fenemor & Bowden, 2007). The purpose of the CIA was to determine the impact of a factor on another factor by asking the ERP expert the question "if a factor F1 changes, what will be its direct impact on factor F2?" We use 4 intensity levels where '0' represented 'no impact', '1' is 'weak impact', '2' is 'medium impact' and '3' is 'strong impact' (Schlange & Jüttner, 1997). The principal diagonal of the cross impact matrix (CIM) was filled with arbitrary value 'x' because a factor cannot impact itself. Figure 2 shows the CIM model for classifying the success factors that potentially influence effective ERP system usage.

SN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	AS	P
1	x	2	2	1	2	3	2	1	1	3	0	1	1	0	0	3	0	0	1	1	0	2	2	1	3	1	1	1	0	1	2	3	1	1	2	2	0	47	2444
2	2	x	1	2	2	3	1	1	2	3	0	2	1	0	0	2	0	0	0	2	0	2	1	1	3	1	1	1	0	1	1	3	2	2	2	3	0	48	2832
3	3	2	x	1	2	3	2	3	3	2	0	1	0	1	0	3	0	0	0	1	0	3	1	2	3	2	2	1	1	3	2	2	2	1	1	3	2	58	1624
4	3	2	1	x	3	2	2	1	2	2	1	2	1	0	1	2	0	0	0	2	1	2	2	1	1	1	2	0	1	3	1	2	2	1	1	1	1	50	2100
5	3	2	1	2	x	1	2	1	2	2	1	2	3	2	2	1	0	0	0	2	3	3	2	1	2	1	1	0	0	1	1	1	1	3	1	1	0	51	2499
6	2	3	1	1	3	x	2	1	1	2	1	0	1	0	2	0	0	0	0	2	3	2	3	1	2	1	2	0	0	1	1	1	0	2	0	0	1	42	2100
7	2	2	1	1	2	2	x	1	2	2	1	0	1	0	1	0	0	0	0	1	2	2	2	1	2	1	2	0	1	1	2	1	0	2	0	0	1	39	1638
8	3	2	2	2	3	2	2	x	3	2	0	1	0	0	0	2	0	0	0	1	2	2	2	1	3	3	2	3	3	2	2	2	1	1	1	2	3	60	1620
9	2	1	3	2	2	2	1	2	x	2	0	1	0	0	0	3	0	0	0	1	1	2	2	1	3	3	2	1	1	2	2	2	3	2	1	3	2	55	1980
10	1	3	1	2	3	3	2	1	1	x	2	1	2	1	2	0	0	0	0	2	3	3	3	2	3	1	2	1	0	1	2	1	2	2	1	0	1	55	2530
11	2	1	0	3	2	1	0	0	0	1	x	2	1	1	1	0	0	0	0	3	3	2	2	1	1	0	1	0	0	0	3	3	2	1	0	0	0	37	851
12	1	1	0	1	1	1	0	0	0	0	1	x	1	1	3	0	1	1	1	2	2	1	2	1	0	0	1	0	0	0	0	1	2	1	0	0	0	27	675
13	0	0	0	1	1	0	0	0	0	0	1	0	x	0	2	0	0	0	0	2	2	1	2	0	1	0	0	0	0	1	0	1	1	1	0	0	0	17	374
14	2	1	1	1	0	2	1	0	0	1	1	0	0	x	2	0	3	3	3	3	2	1	1	0	1	0	0	0	0	0	1	2	2	2	1	0	0	37	592
15	0	2	0	1	1	1	1	0	0	1	1	1	0	1	x	0	1	1	3	3	3	2	2	1	1	0	1	0	0	0	1	1	1	1	0	0	0	32	1408
16	1	2	0	1	0	0	1	0	0	0	0	0	1	0	2	x	3	2	0	2	1	2	2	1	1	0	0	0	0	0	1	1	0	1	0	0	0	25	550
17	0	2	0	0	0	0	1	0	0	0	1	0	2	1	3	0	x	2	0	2	2	2	1	1	2	0	0	0	0	0	0	1	1	0	0	0	0	24	480
18	0	2	0	0	0	1	1	0	0	0	1	0	1	0	2	0	1	x	0	2	1	1	1	0	1	0	0	0	0	0	1	1	1	0	0	0	0	18	360
19	0	2	0	0	1	1	0	0	0	0	1	1	0	1	2	0	1	1	x	2	2	1	2	1	2	0	0	0	0	0	1	1	1	2	0	0	0	26	442
20	0	2	0	0	0	1	1	0	0	1	1	1	1	0	2	0	1	1	1	x	2	2	2	1	1	0	0	0	0	0	1	0	1	1	0	0	0	24	1320
21	0	2	0	0	2	1	1	0	1	1	1	0	0	0	1	0	0	0	0	1	x	2	2	1	2	0	2	0	0	0	1	1	0	2	0	0	0	24	1560
22	1	2	0	2	2	1	2	0	0	2	1	0	0	0	1	0	0	0	0	2	3	x	2	1	2	0	2	0	0	0	1	1	0	2	0	0	1	31	1829
23	2	2	0	1	1	1	2	1	1	2	1	0	0	0	1	0	0	0	0	1	3	2	x	1	1	0	1	0	0	1	1	0	0	2	0	0	0	28	1736
24	1	1	1	1	1	1	1	1	2	1	0	0	0	0	1	0	0	0	0	1	2	2	2	x	2	1	1	0	0	1	2	1	0	1	1	0	0	29	986
25	1	2	0	1	2	1	2	1	1	2	1	0	0	0	2	0	0	0	0	1	3	2	2	1	x	0	1	0	0	1	1	0	0	1	0	0	0	29	1537
26	2	1	1	1	2	1	1	2	1	2	0	1	0	0	1	0	0	0	0	1	3	2	3	2	2	x	1	0	2	1	2	2	2	1	0	1	1	42	1134
27	2	2	2	1	1	1	2	1	1	1	0	1	0	0	1	0	0	0	0	1	2	2	2	1	1	1	x	0	1	1	1	1	1	1	0	0	0	32	1152
28	1	0	1	1	1	1	1	2	2	1	0	0	0	0	1	0	0	0	0	1	2	2	3	3	1	1	1	x	1	2	2	1	0	0	0	0	1	33	396
29	2	1	3	1	2	3	2	2	2	1	0	1	0	0	0	3	0	0	0	0	1	1	1	2	1	2	1	2	x	2	3	2	1	1	3	2	3	51	816
30	2	2	3	1	1	1	2	2	2	1	0	1	1	0	0	1	0	0	0	1	1	1	2	2	2	1	1	1	1	x	1	1	0	1	1	0	1	38	1254
31	2	1	2	2	1	2	1	1	2	2	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	3	1	2	1	1	x	2	1	1	1	0	1	40	1720
32	2	3	1	1	2	3	1	0	1	2	1	2	1	2	3	2	2	2	2	3	3	2	2	1	1	1	1	0	1	1	1	x	2	3	0	2	0	57	2736
33	2	2	0	3	2	2	1	0	1	3	2	1	2	3	3	0	2	2	2	3	1	1	1	0	1	0	1	0	0	1	1	2	x	3	1	0	0	49	1813
34	1	2	0	1	0	2	1	0	0	0	1	1	0	0	2	0	2	2	2	2	2	2	1	0	1	0	2	0	0	1	0	2	1	x	1	0	0	32	1568
35	1	1	0	2	2	2	1	1	1	1	0	1	1	1	0	1	1	1	1	0	0	0	0	0	0	1	1	0	0	1	0	2	2	2	x	2	0	30	600
36	1	2	0	0	0	0	0	0	0	1	1	1	1	1	0	0	1	1	1	1	2	1	2	0	1	0	0	0	0	2	0	2	2	2	0	x	0	26	598
37	2	1	2	2	1	1	1	2	2	2	0	0	0	0	0	1	0	0	0	0	1	0	1	0	1	2	0	0	2	1	3	1	0	0	3	3	x	35	665
	52	59	28	42	49	50	42	27	36	46	23	25	22	16	44	22	20	20	17	55	65	59	62	34	53	27	36	12	16	33	43	48	37	49	20	23	19	PS	
	90	81	207	119	104	84	93	222	153	120	161	108	77	231	73	114	120	90	153	44	37	53	45	85	55	156	89	275	319	115	93	119	132	65	150	113	184	Q x 100	

0 No Impact 1 Weak Impact 2 Medium Impact 3 Strong Impact

AS = Active sum = Sum of row = $\sum n_i$ PS = Passive sum = Sum of column = $\sum n_j$ P = product = $\sum ni \sum nj$ Q = quotient = $\sum ni / \sum nj$

Figure 2: The cross impact matrix of thirty seven ERP success factors classified in this paper

The CIM is a square matrix of a dimension n x n where n=37 in this study is the number of factors participating in the impact analysis. After filling the CIM, the active sum (AS) and the passive sum (PS) were calculated from the CIM using equations (1) and (2) respectively. The AS represents the influence of a factor on the system and is calculated as the sum of impacts in a row of the CIM. The PS shows how a factor is affected by other factors and is given as the sum of impacts in a column of the CIM. The CIM can be denoted as A = $\{a_{ij}\}$ where a_{ij} is the impact of a factor i on a factor j. The AS and PS metrics are respectively given by the following equations:

$$AS = \sum_{i=1}^{n} a_{ij} \tag{1}$$

$$PS = \sum_{j=1}^{n} a_{ij} \tag{2}$$

Table 3 shows the calculation of AS and PS from the cross impact matrix for the extracted factors influencing ERP system usage.

SN	Extracted Factors	Influence (AS)	Dependency (PS)	Product (AS x PS)	Quotient (AS/PS)
1	Top Management Support	47	52	2444	0.90
2	Management of Expectations	48	61	2928	0.79
3	Change Management	58	30	1740	1.93
4	Business Process Reengineering	50	43	2150	1.16
5	Project Team Composition & Competence	51	51	2601	1.00
6	Education & Training of Users	42	53	2226	0.79
7	Interdepartmental Coop. & Communication	39	44	1716	0.89
8	Organizational Politics and Characteristics	60	28	1680	2.14
9	Management Style & Decision Making	55	37	2035	1.49
10	User involvement.	55	49	2695	1.12
11	Complexity	37	23	851	1.61
12	Minimum customization	27	26	702	1.04
13	Data Quality, Analysis & Conversion	17	23	391	0.74
14	Software Dev, Testing & Troubleshooting	37	16	592	2.31
15	Flexibility & Efficiency of Use	32	44	1408	0.73
16	Network Reliability	25	25	625	1.00
17	System Response Time	24	20	480	1.20
18	Visibility of the Sys.Status	18	20	360	0.90
19	Robustness and Error Prev.	26	18	468	1.44
20	User friendliness, Help & Doc.	24	56	1344	0.43
21	Learnability	24	65	1560	0.37
22	User Satisfaction	31	61	1891	0.51
23	Attitude Towards the System	28	64	1792	0.44
24	Behavior	29	35	1015	0.83
25	Motivation	29	56	1624	0.52
26	Interest groups	42	28	1176	1.50
27	Roles	32	37	1184	0.86
28	Norms	33	13	429	2.54
29	National and Organizational Cultures	51	16	816	3.19
30	Rules and Practices	38	34	1292	1.12
31	Culture of Resistance	40	45	1800	0.89
32	Vendor & Const.Support	57	51	2907	1.12
33	System Changes & Upgrade	49	38	1862	1.29
34	Use of Vendors' Tools	32	50	1600	0.64
35	Policies and Standards	30	22	660	1.36
36	Availability of Applications	26	25	650	1.04
37	Political Influence	35	19	665	1.84

Table 3: Summary of the cross impact matrix for ERP success factors

PRESENTATION OF RESULTS

The influence versus dependency graph was plotted in MATLAB on the contour plot and the result is as demonstrated by Figure 3.

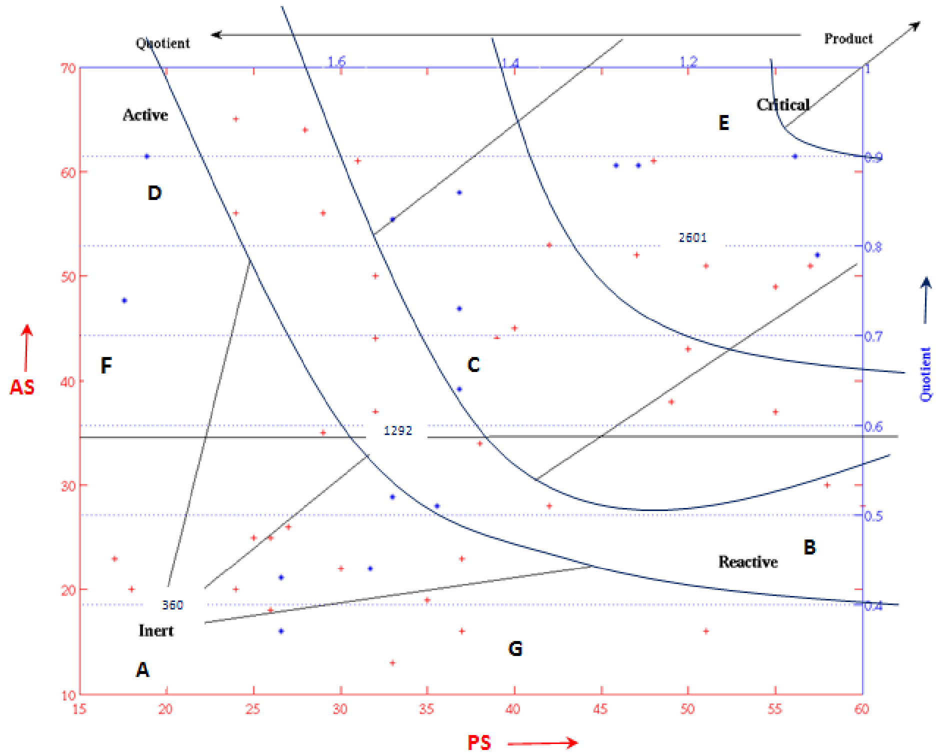

Figure 3: Characteristics of the System of ERP Success factors

KEY
A. Factors that lie in this section are inert and cannot be used to regulate the system.
B. These factors are indicators that represent conditions of the system. They are intended to exhibit the symptoms rather than regulating it.
C. This section contains factors that are neither externally regulating nor indicating the system, but are crucial for self-regulation.
D. These are factors that strongly influence the system and are important in its regulation.
E. This area represents the factors that are crucial for kickoffs. However, care should be taken when dealing with them as the neglect of these factors may lead to uncontrollable consequences. They are highly embedded in the integration of the system.
F. Factors in this section are intended to regulate the system, but they have less of a strong influence.
G. These factors are weak indicators of the conditions of the system.

A strategy matrix model was finally used to summarize the findings of this study, which explain each factor and the role it plays in the implementation of ERP systems. The ERP success factors were classified into four categories of Critical, Active, Reactive and Inert. Figure 4 shows the 2-dimensional strategy matrix perspective of the characteristics of the ERP success factors.

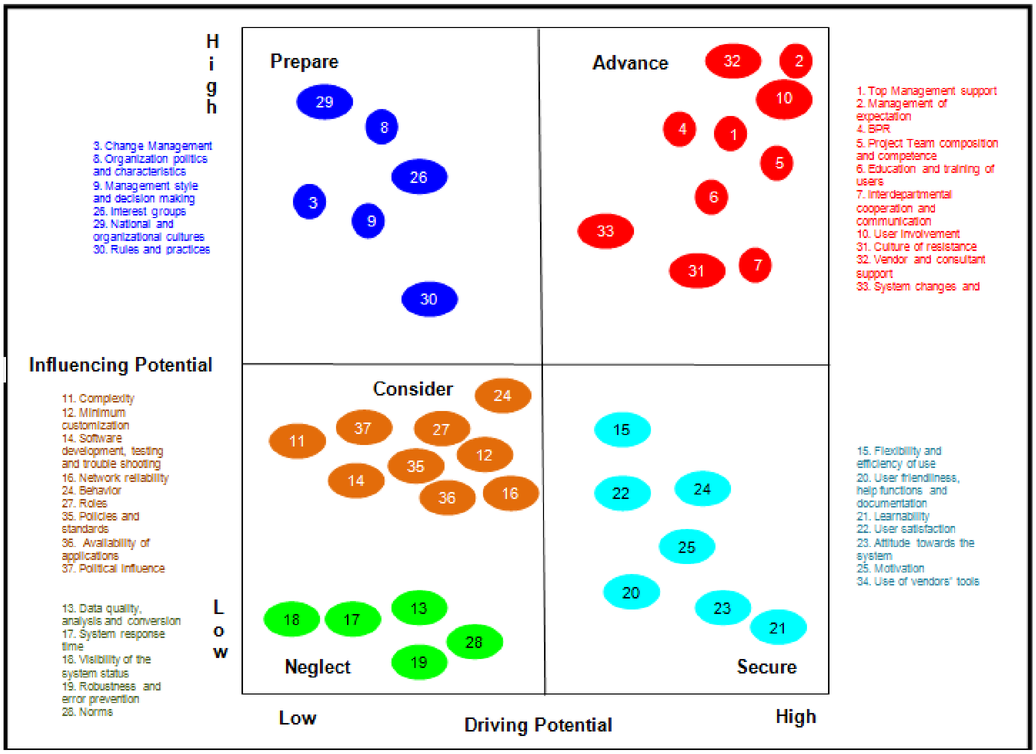

Figure 4: Strategy matrix of ERP success factors classified

Critical factors: these factors strongly impacts other factors and are also being impacted by other factors. This implies that if the number of factors being considered to affect the system is big, the influence of these factors will also be proportionally big because of the high integration within the system (Schlange & Jüttner, 1997). Hence, these factors are represented in the region where the product (AS x PS) > $(n-1)^2$ for n representing the number of factors being analyzed.

i. Top Management support
ii. Management of expectations
iii. Business process reengineering
iv. Project (ERP) team composition and competence
v. Education and training of users
vi. Interdepartmental cooperation and communication
vii. Involvement of users in systems development and integration
viii. Culture of resistance within an organization
ix. Vendor and consultant support to users
x. Systems changes and upgrade to new versions

Active factor: the factors represented in this region are less affected by other factors in the system than the impact they exert on them (Schlange & Jüttner, 1997; Wolff, Gaffron & Flämig, 2010). These include all factors whose quotients are greater than 1. On the graph, these are factors on the horizontal scale of the quotient axis (AS/PS) > 1.0. It is important to note that the values of AS and PS were obtained from the impact of a factor on another factor. The quotient (Q) of active sum and passive sum describes the influence of a factor. This implies that if the quotient is high (AS is much higher than PS), the factor under consideration will have a more regulating effect on ERP system usage. This causes such factors to have a lot of influences on other factors, yet they are not influenced by others.

i. Change management
ii. Organization politics and characteristics
iii. Interest groups
iv. Management style and decision making
v. National and organization cultures
vi. Rules and practices

Reactive factors: the factors in the reactive region behave opposite to those in the active region. They are commonly used as indicators because their influence on other factors is negligible as compared to the effect that other factors impact on them (Schlange & Jüttner, 1997; Wolff, Gaffron & Flämig, 2010). These factors are determined by the inequality quotient (AS/PS) < 1.

i. Flexibility and efficiency of use of ERP
ii. User friendliness of the ERP system and the availability of help functions and documentation in the form of user manuals
iii. Learnability
iv. User satisfaction
v. Attitude towards the system
vi. Motivation
vii. Use of vendors' tools

Inert factors: these factors are less involved in the system dynamics and they behave opposite to critical factors. They are represented in the region of the product $(AS \times PS) < (n-1)^2$. Depending on the degree of their inactiveness, these factors may serve as weak indicators of ERP system usage. They include:

i. Complexity
ii. Minimum customization
iii. Data quality, analysis, and conversion
iv. Software development, testing, and troubleshooting
v. Network Reliability
vi. System response time
vii. Visibility of the system status
viii. Robustness and error prevention
ix. Behavior
x. Roles
xi. Policies and standards
xii. Norms
xiii. Availability of applications
xiv. Political influence

A close examination of the inert factors indicates that many of them are technical factors that influence a system independently with no influence or are being influenced by other factors. From this perspective, care should be taken before these factors are discarded as not playing any role in the system or discontinued from being used for further analysis. It is important to note that the level of influence is independent of the system because it is based on a relationship between active sum and passive sum. Similarly, the level of integration is also dependent on the number of factors analyzed. Consequently, their level of buffering needs to be reexamined whether they are moderately buffering or strongly buffering. If the factors are strongly buffering, it implies they are completely inert and have to be excluded, but when moderately buffering, it means that there is a role they play (Wolff, Gaffron & Flämig, 2010). Such factors may be weak indicators with less influence, yet they may be used in the regulation of the system.

i. Minimum customization
ii. Complexity
iii. Network reliability
iv. Software development, testing, and troubleshooting
v. Behavior
vi. Availability of applications
vii. Policies and standards
viii. Political influence

It is important that managements of institutions devise a better means of using the identified ERP success factors. The managements should use the findings of this study to enhance their vision in the allocation of resources that would support an effective ERP system implementation. The methods to follow when implementing these decisions could be varied by careful examination of the identified ERP success factors.

DISCUSSION

In this study we have identified, validated, ranked, and classified ERP success factors with reference to higher educational institutions. We have thoroughly conducted a review of extant studies that have reported on ERP success factors to provide a good study foundation. We are in complete agreement with previous researchers who have noted that ERP success factors are identified by analytic techniques (Esteves & Pastor, 2000; Hedman, 2010). Consequently, we have used a combination of techniques to realize the overarching objective of the study. Specifically, while we have used scoping review analysis to identify ERP success factors, we have applied the expert judgment elicitation to validate the relevance of the identified ERP success factors to the educational setting. Moreover, while we have used the principal component analysis to reduce dimensions and to rank ERP success factors, we have used the cross impact analysis to classify ERP success factors into Critical, Active, Reactive, and Inert categories. The cross impact analysis provided a compact way of explaining the impact between two factors and the direct implications of these impacts.

Figures 3 and 4 represent all the ERP success factors classified according to their leveraging potentials. The managements of institutions have to be aware of the influences of these ERP success factors on the system and what position to stand for as well as what actions to take whenever certain conditions arise. The critical sector that constitutes 27% of the ERP success indicates to the managements that if these factors are neglected, serious consequences may arise because they have a high influence and exert high driving forces on the system. This implies that managements should advance better strategies that could prevent the system from any disaster which could be likely caused by neglecting these success factors. The prepare sector represents those factors with high influence or leverage potential of the system with low driving force. These factors share one commonality that managements have little or nothing to do to control them. The only option available to the managements is to prepare better strategies to counter the influence caused by these factors.

The secure sector that represents 19% of the ERP success factors represents those factors with high driving forces, but with low leveraging or influencing potential. In order to counteract the effects of these factors, managements should secure better strategies for success and maintain better strategies already applied. Consequently, the use of ERP systems in an organization, like any other information systems, is dependent on other factors that may be a result of poor planning, poor definition of user requirements, laxity in management, or a mismatch in user requirements. This may lead to the system factors whose driving force may be latent to cause a low influence on other factors and on the entire system at large. If the forces emitted by these factors are too low, managements have no other option but to neglect them. For such factors, it may be quite hard to propose or plan for better mitigating strategies.

The findings of this study, if leveraged on, will greatly benefit educational institutions and other organizations to improve the success of ERP system implementation and usage. Many of the ERP success factors identified in this study as critical could be managed by organizations. This is with the exception of vendor and consultancy support to users, change in systems, and upgrade to new system versions where higher cognitive skills are required. The remaining ERP success factors could be met by applying good management skills. Moreover, the findings of this study generally indicate that ERP success factors are complex. Consequently, it is particularly germane for managements to select those alternative ERP success factors that best apply to their situations. It also necessitates the managements to establish and maintain good working relationships with all stakeholders. This calls for better planning decisions, including the adoption of a culture of willingness to change and that of involvement of users in the implementation and development processes of the ERP systems.

Implications for Academic Researchers

This research has established that several studies on CSFs for ERP implementation and usage have been marred by repetitions because their recommendations heavily depended on the literature (Finney & Corbett, 2007; Ngai, Law & Wat 2008; Dezdar & Sulaiman; 2009; Supramaniam & Kuppusamy, 2010). This saw a repetitive cycle of citations one after another without empirical evidence of the criticality of the listed ERP success factors. The literature indicates a wider call to use scientific methods to prove the criticality of ERP success factors. However, few studies to date have attempted to do this successfully. This current study uses a variety of techniques to systematically identify, validate, rank, and classify ERP success factors. The methodology of this study implies that a combination of techniques is useful to give a logical conclusive evidence of CSFs for ERP system implementation and usage. The methodology of this study should be taken into cognizance when studying ERP system success.

Implications for ERP Practitioners

This study has established that much as technological factors are not critical to the educational setting, managements and developers of ERP systems should consider leveraging their potential. In addition, the results of this study suggest that practitioners should be aware that most factors labeled as CSFs for the implementation of ERP systems might not generally be critical. This suggestion is in accord with the recent result that some CSFs labeled as critical are not critical for achieving success in ERP implementation (Ram, Corkindale & Wu, 2013). Moreover, while developers should work on the ease of use, increased response time, visibility of status, provision of manuals, and help documents for ERP systems, managements should ensure that all of these happen smoothly. In addition, managements should ensure that users receive constant training and are involved in the decision to upgrade the ERP system. Furthermore, managements and developers should consult with end users on ERP system functionalities that required improvement before any decision is made to implement the system.

Limitations and Future Work

The findings of this study were predominantly based on participants who were integrated tertiary system (ITS) users sampled from the www.itsug.org.za database. Much as ITS is an ERP system, it should be noted that not all ERP systems are developed with the same innovative functionalities. The results of this study may not generalize to all ERP systems. In addition, the participants were sampled among a team of leaders who were mainly from African universities. Much as team leaders help in the daily use of ITS, their perceptions may not adequately represent the understanding of users in a particular university. In addition, as discussed earlier, factors impeding the success of ERP systems are complex, cumbersome, costly, and may arise at any phase of implementation. It is important, therefore, to note that the sampled users were not at the same intensity level of ERP system usage. Moreover, technology is changing quickly and at the same time, user perception of technology could whimsically change over time. Caution should be taken when interpreting the findings of this study because the opinions of three experts who validated the success factors could be a source of limitation to the general findings.

This study has only carried out a cross-sectional survey, which implies that any change in the system usage, from user perception after a given period, was neglected. This study recommends that future work should consider using longitudinal surveys to account for continuing technological developments. The literature used in this study was mainly based on research conducted using the lens of developing countries of the world. Much as this study has revealed that many of the ERP success factors are universally applicable, irrespective of countries, care should be taken when generalizing the results of this study. This is because the diversity in social-technical or social-cultural terrains of countries may impede the results of this study. The future studies should therefore carefully investigate the influence of social-technological or social-cultural differences between developed and developing countries for ERP system usage. Future studies should consider extensive survey involving different categories of users at different educational institutions. In addition, simulation experiments should be conducted in future using different combination of techniques to investigate the consistency of ranking and classification algorithms discussed in this study. The CIA technique, for instance, is effective for determining direct relationship among factors, but does not consider indirect relationship, which demands further investigation in this direction.

CONCLUSION

This paper presents a comprehensive discussion on a systematic methodology of identifying, validating ranking and classifying ERP success factors with reference to higher educational institutions. The classification of ERP success factors into Critical, Active, Reactive, and Inert categories is a significant contribution of this study to the ERP literature. In this study, the researchers identify ten critical success factors influencing the effective implementation of ERP systems in higher education institutions. These factors are: top management support, management of expectations, business process reengineering, project team composition and competence, education and training of users, interdepartmental cooperation and communication, involvement of users in systems development and integration, culture of resistance within an organization, vendor and consultant support to users, as well as system changes and upgrade to new versions. This study proposes the way forward for decision makers regarding the dominance of a factor or a set of factors during the implementation of ERP systems. However, much as this study has tried to mitigate all the shortcomings of the extant ERP success factors studies, some limitations are uncovered for further investigation.

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