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Developing Internet Online Procurement Frameworks for Construction Firms

Rafikullah Deraman ^{1,2}, Chen Wang ^{3,*} , Jeffrey Boon Hui Yap ⁴ , Heng Li ⁵ and Faizul Azli Mohd-Rahim ⁶

¹ Intelligence and Automation in Construction Fujian Province Higher-Educational Engineering Research Centre, College of Civil Engineering, Huaqiao University, Xiamen 361021, China; rafikullah@yeah.net

² Department of Construction Management, Universiti Tun Hussein Onn Malaysia, Parit Raja 86400, Batu Pahat Johor, Malaysia

³ Intelligence and Automation in Construction Fujian Province Higher-Educational Engineering Research Centre, College of Civil Engineering, Huaqiao University, Xiamen 361021, China

⁴ Department of Surveying, Lee Kong Chian Faculty of Engineering and Science, Universiti Tunku Abdul Rahman (UTAR), Kajang 43000, Selangor, Malaysia; bhyap@utar.edu.my

⁵ Chair Professor, Department of Building and Real Estate, Faculty of Construction and Environment, the Hong Kong Polytechnic University, 999077, Hong Kong; bshengli@polyu.edu.hk

⁶ Faculty of Built Environment, University of Malaya, Kuala Lumpur 50603, Malaysia; faizala@163.com

* Correspondence: derekisleon@gmail.com

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Abstract: Electronic purchasing or e-procurement saves millions of dollars yearly in transaction costs. E-procurement helps to cut down the supplier base, promotes paperless transactions, and increases transparency and accountability in the procurement process. Nonetheless, studies report that around 80% of e-procurement initiatives have met with failure and failed to achieve the desired results. Although studies to better understand the Critical Success Factors (CSFs) of e-procurement implementation involving various industries have been on the rise, little is known about architecture engineering and construction (AEC) practices, which has led to limited development of pragmatic frameworks to uncover the factors. Thus, this study aims to identify those CSFs (predicting variables) which significantly contribute to e-procurement implementation success in the construction sector and to put forward for better implementation. Results from multiple regression analysis revealed five factors to be statistically significant predictors of success. Three factors were determined to be predictors of user satisfaction. Finally, internet online procurement frameworks were developed for the success of e-procurement implementation in the construction sector.

Keywords: electronic purchasing/e-procurement; AEC firms; critical success factors (CSFs); predicting variables; multiple regression analysis

1. Introduction

Developments in the Information and Communication Technology (ICT) have greatly influenced the way organizations conduct their businesses, particularly concerning supply chain management [1]. Many organizations have invested large sums of money on supply chain management systems to improve supply chain efficiency and to attain a competitive advantage [2,3], especially in the current era of the fourth industrial revolution (Industry 4.0) [4]. Among these efforts, electronic business (e-business) and electronic commerce (e-commerce) are the most cost-effective and time-saving [5] through digitalization technologies [6]. In line with this notion, digital transformation significantly strengthens the leading edge of organizations [7] and adds value through enhancements in supply chain efficiency and effectiveness [8–10].

In the e-Business environment, one of the most prominent business-to-business (B2B) applications to have received worldwide attention is electronic procurement (e-procurement) [11–13]. This kind of application streamlines the corporate purchasing process by eliminating traditional paper-based documents such as purchase orders and requisition forms [14]. The e-procurement system enables enterprise users to gain direct access to the supply system by conducting purchasing electronically. E-procurement involves integrating Internet-based technologies to manage the upstream portion of the supply chain to reduce costs, shorten the time and raise productivity [15].

Notwithstanding the significant value of e-procurement to business practices, low adoption of e-procurement has been reported by various research across different industries (e.g., Au et al. [16] in hospitality; Mettler and Rohner [10] in healthcare; Toktaş-Palut et al. [1] in retail business; and Vitrauskaite and Gatautis [17] in construction). It is also worthwhile noting that little headway has been made in research pertaining to architecture engineering and construction (AEC) firms, which has led to the limited development of research frameworks to uncover the critical success factors (CSFs) responsible for e-procurement implementation [18,19]. Recent studies in the construction industry of developing countries by Altayyar and Beaumont-Kerridgea [20] in Saudi Arabia, Aduwo et al. [21] and Afolabi et al. [22] in Nigeria, and Ibem and Laryea [23] in South Africa further echoed the limited use of e-procurement practices. Over in Canada, the majority of respondents surveyed perceived unreliability of technologies as the most critical disadvantage [24]. In the case of Malaysian construction industry, e-procurement is still underutilized as compared to other developed economies [25]. To accelerate the industry-wide diffusion of e-procurement and leverage on its benefits owing to significant technological advancements today, the sensible approach is to examine the CSFs in AEC firms empirically with the following research questions: What are the organizational CSFs specific to construction organizations? and How do these organizational CSFs affect e-procurement in terms of project management success and user satisfaction? Thus, the current study contributes to the literature by proposing an e-procurement implementation success (ePIS) framework for user satisfaction to assist stakeholders in making more healthy and robust decisions and strategic preparations before embarking on any system initiative. Although the focus is on AEC firms, the findings offer useful insights to other project-based industries (PBIs) such as defense, ICT, aerospace, among others.

2. E-Procurement and Construction Sector

There is vast potential for AEC organizations to leverage e-procurement to steer the sector towards considerably enhancing the overall efficiency by benchmarking on the success of e-business methods and solutions across various industries. E-procurement could save costs ranging from 4% to 8% of the total purchasing value [26]. It could also reduce the supplier base, promote paperless transactions, and enhance spending transparency and accountability [27]. A study by Eadie et al. [28] in the United Kingdom surveyed 775 construction organizations and observed that the leading benefits were ‘Process, transaction, and administration cost savings’ and ‘Convenience of archiving completed work.’ This is consistent with Toktas-Palut et al.’s [1] claim that e-procurement systems significantly facilitate integrated information sharing. They further explain that an enhancement in integrated information sharing engenders transparency, swift response to issues, real-time access to information, collaboration, improved communication as well as enhanced intelligence. According to Dallasega et al. [29], the uses of electronic applications enable synchronization between various stakeholders and suppliers. The ‘virtual proximity’ concept, which has emerged since the advent of Industry 4.0 and digitization technologies, bridges the challenges due to geographic distance and major problems relating to fragmented processes, routines, and procedures. In a separate study in Singapore by Thompson et al. [14] employing questionnaire survey to collect data from 141 companies and using logistic regression analysis concluded that size of firm, support from top management, perceived usefulness, and pressure from business associates significantly guided organizations’ endeavors to revolutionize their procurement process to leverage on the potentials of the Internet and other web-based technologies. In Nigeria, Ibem et al. [30] revealed seven underlying dimensions based

on 29 factors in which the three most significant predictors of e-procurement adoption are relating to the benefits of use, awareness among the users and operational cost involved. In this vein, the inclination towards the electronic tendering system in construction is influenced by people-, process-, work environment-, technology- and service provider-related factors [31].

Although e-procurement has been widely adopted by enterprises, its implementation poses many challenges, particularly in the construction sector [21,32,33]. The challenges faced during implementation often cause failures to meet the stated organizational objectives. This may be attributed to the highly fragmented ICT usage within the sector [33] and slowness in adopting ICT innovations due to the high capital investment involved [19,20]. Likewise, Rankin et al. [24] advocate that the AEC organizations inherited the following challenges: “fragmentation, highly pragmatic, cost conscious, little institutional leadership, and no standards in technology and business models.” As such, the annual expenditure on e-procurement is still low [21,24,33].

The failure rate of B2B e-business is between 68% and 80% within the first year of its implementation [34,35]. It was also found that over 75–85% of e-procurement initiatives were unable to meet enterprise objectives [36]. Some multinational businesses suspended or abandoned their e-procurement initiatives after failing to generate any quantifiable benefits [37]. The high percentage of e-procurement failures reported has led researchers to investigate the reasons for their failures. One of the major problems the lack of understanding of the success factors [38,39]. Success in business requires the fulfilment of organizational factors, such as people and process requirements, coupled with the support of technological resources [40]. The structure of the organization, existing processes, and people skill sets and behaviors are some other considerations that also need attention [41]. Over in the UK, Eadie et al. [28] found that the most critical barriers to construction e-procurement include ‘prevention of tampering with documents—changes to documents,’ ‘confidentiality of information—unauthorized viewing’ and ‘resistance to change’. These are issues relating to responsibility, integration, security, and authentication [24].

Vitkauskaite and Gatautis [33] assert that the sector is beleaguered with insufficient knowledge of the process of interoperability due to lack of ICT skills and awareness of ICT benefits and potentials. Another more recent study by Aduwo et al. [21] in the Nigerian building construction sector also reported comparable findings relating to technical infrastructure issues, lack of technical competency in ICT tools, and poor top management support. There also seem to be common traditions and cultures for employing a conventional way of doing things in this sector. Therefore, the construction industry still exhibits trepidation towards extensively rolling out the implementation of e-procurement [24].

For e-procurement implementation success, managers are required to evaluate the progress of the projects carefully and to understand clearly the factors that lead to successful initiatives [42,43]. For any e-procurement initiative to be successful, there are some factors that an organization must critically consider [44]. Many studies have shown that little attention has been given to the investigation of the critical success factors (CSFs) of e-procurement implementation [8,45–47]. This is in agreement with Aduwo et al.’s [21] recent claim that there is lack of evidence on the CSFs in the construction sector to call for critical mass uptake of e-procurement for maximum exploitation. Based on the evaluation of existing literature, a knowledge gap exists on the subject of organizational CSFs of e-procurement implementation in the construction sector [48]. It is evident that the success of e-procurement implementation can be viewed from many perspectives [49,50]. Deraman et al. [18] provided a framework of the eight components of organizational factors that consists of fifty-two CSF items for e-procurement implementation success. However, project management success and user satisfaction have been widely discussed and used in previous studies as criteria for measuring the success of the implementation [6,51–59]. Following a detailed literature review, Table 1 [18] summarizes the 52 predicting variables most commonly cited to influence the successful implementation of e-procurement in the construction sector.

Table 1. Predicting variables of e-procurement implementation success.

Component	No. of Predicting Variables	Predicting Variables
Group Factor 1 Organizational Commitment And Relationship Development	10	<ol style="list-style-type: none"> 1. Relationship of trust with trading partners 2. Employee cooperation 3. Good quality employee works outcomes 4. Loyalty to the organization 5. Provides an appropriate organizational structure 6. Commitment of employees to the organization’s objectives 7. Top management provides a pro-active communication channel 8. Communication with trading partners 9. Establishes a partnership agreement 10. Employees’ positive attitude towards e-procurement
Group Factor 2 Change Management	3	<ol style="list-style-type: none"> 1. Willingness of organization to change 2. Well managed process of change 3. Have change management programs
Group Factor 3 Technical Outsourcing And Top Management Responsibilities	9	<ol style="list-style-type: none"> 1. IT Consultant owns a business and technical knowledge 2. IT Consultant able to recommends appropriate e-procurement system 3. IT Consultant support project teams during the implementation process 4. Establishes appropriate milestones for performance measurement 5. Top management offers leadership 6. Creates performance measures 7. Users’ knowledge and skills 8. Conducts post-implementation review 9. Top management willingness to spend time and resources
Group Factor 4 Project Team Planning	6	<ol style="list-style-type: none"> 1. Project activity properly coordinated and monitored 2. Project plan consistent with IS plan 3. Provides of detail project 4. Project team has strong domain knowledge 5. Roles and responsibilities of project team properly defined and delegated 6. The organization has a clear mission, vision, strategies, and direction
Group Factor 5 Organizational Learning	2	<ol style="list-style-type: none"> 1. Organization’s experience enables effective implementation of IT systems 2. Organization’s experience becomes a base of knowledge for guiding initiatives
Group Factor 6 Stakeholder and Composition	8	<ol style="list-style-type: none"> 1. Stakeholders provide information and set requirements 2. Identifies level each stakeholder can get involved 3. Stakeholder’s early involvement 4. Project team uses effective project management techniques 5. Readiness of trading partners 6. Various cross-functional team members selected 7. Users’ previous experience using IT application 8. Project team has an experienced and reputable Project Manager
Group Factor 7 Organizational Policy and Strategic Plan	6	<ol style="list-style-type: none"> 1. Alignment of e-procurement strategy with IT strategy 2. Incorporates of e-procurement policy into existing procurement policy 3. Reinforces commitment of employees 4. Availability of strategic plan which sets deadlines, responsibilities, and financing 5. Provides adequate training and education program 6. Steering committee provides directions and guidance of the implementation process
Group Factor 8 Business Process Innovation and External Collaboration	8	<ol style="list-style-type: none"> 1. Changes the process according to organizational needs 2. Simplifies processes and eliminate redundancy activities 3. Designs and documents important business processes 4. Encourages innovation and learning processes 5. Mutual understanding of needs and capabilities with trading partners 6. Encourages the sharing of knowledge and information 7. Allows work cultural transformation towards initiatives 8. Encourages organization to build long term relationship with trading partners
Total predicting variables	52	

3. Research Methods and Procedures

This research employs a mixed methods design for data collection and analysis, beginning with an exploratory/pilot qualitative study and followed by a quantitative study. Mixed methods research is a procedure that collects and analyzes both qualitative and quantitative data based on priority and sequence of information [60]. The exploratory/pilot study was carried out to identify essential and unknown underlying variables for quantitative study [60]; hence, the qualitative data is not presented and analyzed in this paper. There were three phases involved in data collection and analysis: first, a preliminary study conducted through telephone surveys; second, a qualitative study via face-to-face interview; and third, a questionnaire survey through postal mail. A purposive non-probability sampling procedure was employed to garner the sample of Malaysian construction contractors Class G7 (G7 is the top class). The selection criteria elements are a) Size of companies, b) Well-established companies, and c) Consistency of project on-hand (3 years continuously and upwards).

The preliminary study involved five large construction companies, represented by their senior managers, who are familiar with e-procurement matters to provide an overview of the current construction practices. Subsequently, personal interviews were used to determine the relevance of the organizational CSFs identified from literature to the Malaysian context. The interview participants comprised of ten industry experts, who had an average of 17 years of construction experience and at least 6 years of involvement with e-procurement systems. For the quantitative study, the sample was made up of large G7 Malaysian construction companies registered with the Construction Industry Development Board (CIDB). There were 4413 companies registered under G7, but only 2181 contractors were registered as civil engineering contractors. Referring to CIDB's online website database, an investigation was made on a thousand (1000) contractors' profiles out of the total population 2181. Of this number, in turn, only one hundred and twenty-four (124) contractors participated in this study. Majority of the respondents are holding managerial positions (80.5%) and 61.8% had more than 10 years of working experience in construction. Approximately 43% had been involved in construction e-procurement/e-purchasing practices for more than 5 years.

The National Bank of Malaysia categorizes contractors as large companies if their turnover is more than RM 25 million. The selection of companies was also based on any recognition that they had received from established institutions, such as prestigious management awards and MS ISO certifications. Among the sample, seven companies were recipients of prestigious awards of excellence from CIDB, Small and Medium Industries Association of Malaysia and The Brand Laureate for their leadership, strategic management and innovation. Examples of awards include the MCI Excellence Awards, which include the G7 Contractors Award and the Special Award for Innovation. The contractors were evaluated for the existence of continuous projects for three consecutive years at a total value of more than RM 30 million. The limit of RM 30 million was chosen because this amount indicates a fairly large amount of materials being purchased to construct the end products. This figure took into account the deductions for Prime Cost (PC) Sum works, and Provisional Sum (PS) works. If the cost of the projects selected were less than RM 30 million, the final amount after the said deductions would be considerably less, and this will affect the quantum of material purchases. Organizations would be less interested in adopting an e-purchasing solution if their purchases of raw materials were small, or if they did not consistently get new projects, or the projects were not so complicated, and the time frame was flexible.

Multiple regression analysis was performed to investigate which predictor from the eight groups of organizational factors contributes the most to e-procurement implementation success. This study involved fifty-two predictors and two dependent variables, i.e., project management and user satisfaction. The eight groups of organizational factors are: (i) organizational commitment and relationship development, (ii) change management, (iii) technical outsourcing and top management responsibilities, (iv) project team planning, (v) organizational learning, (vi) stakeholder and composition, (vii) organizational policy and strategic plan, and (viii) business process innovation and external collaboration. The stepwise multiple regression method relies purely on a mathematical criterion

to generate a model that best predicts the outcome variables. It was chosen to get the best model with maximum R2 and standardized beta coefficient. The R2 measures the proportion of the total variance on the dependent variables (e-procurement implementation success). It also explains how well the model fits the dataset. R2 above 0.37 is considered high enough [61]. The coefficient values (standardized beta coefficient) provide insights into how each predictor contributes to the e-procurement implementation success. After completing the multiple regression analysis, the validity of the regression models was tested to ensure that the models satisfy the goodness-of-fit and are appropriate to use as prediction models.

This study determined the criteria used to check the validity of the prediction model by looking at the model coefficient, normality of dataset, standard residual and Cook's Distance. Model coefficient refers to an assessment of the predicted model coefficient and associated Variance Inflation Factors (VIF). The VIF indicate whether a predictor's variable has a strong linear relationship with another predictor's variable. The tolerance value is the reciprocal of the corresponding VIF. The cut-off points for determining the presence of multicollinearity are tolerance values greater than 0.1 and VIF values less than 10 [62,63]. If the predictor's tolerance value is greater than 0.1 and the VIF value is less than 10, it indicates that no multicollinearity is present, and the predicted regression model is valid and satisfies goodness-of-fit. The next diagnosis is looking at the data sets normality. The simplest diagnostic check for normality is to look at the histogram and normal (P-P) plot of regression standardized residuals. The histogram shows a bell-shaped and symmetrical standardized residual, and a normal probability (P-P) shows the points as tending to cluster around a straight line that indicates the model does not violate the normal distribution. These diagnostic patterns are an indication of a situation in which the assumption of normality has been met for both predicted regression models. What follows next is an examination of the standard residual and Cook's Distance values. The observed dataset does not fit the predicted model well if the standardized residual value does not fall within the suggested range of ± 3.0 . In such a case, Cook's Distance would be used to assess the influence of outliers in the regression model. Values of Cook's Distance larger than 1.0 will influence the model. This is tantamount to saying that if the value of Cook's Distance is less than 1.0, there are no outliers present, and therefore one can conclude that the predicted model has achieved goodness-of-fit. Finally, the Path Model was used in this study to portray the predicted model of e-procurement implementation success via a graphical connection between sets of important predictors.

4. Data Interpretations and Analysis

Using the survey data, these predicting variables are used in the multiple regression analysis. The empirical results of the correlation analysis indicate small and moderate relationships between the variables, as shown in Figure 1. There are moderate relationships between independent variables and dependent variables (project management and user satisfaction) in the case of organizational policy and strategic plan ($r_s = 0.395$ and 0.438), technical outsourcing and top management responsibilities ($r_s = 0.382$ and 0.432), change management ($r_s = 0.392$ and 0.407), stakeholder and composition ($r_s = 0.341$ and 0.373), business process innovation and external collaboration factor ($r_s = 0.343$ and 0.364) and organizational commitment and relationship development factors ($r_s = 0.313$ and 0.316). A small relationship exists in the case of project team planning ($r_s = 0.230$ and 0.284) and organizational learning factors ($r_s = 0.201$ and 0.183).

The small relationships are related to the low ratings given to the indicators. For project team planning, the following ratings were assigned to the indicators making up this factor: clear definition of project scope (mean score = 4.07 and rated 26 out of 58); project properly coordinated (mean score = 4.07 and rated = 28/58), project plan consistent with IS plan (mean score = 4.04, rated = 34/58), availability of detailed project (mean score = 4.05, rated = 33/58), project team has strong domain knowledge (mean score = 4.05, rated = 31/58), and properly defined roles and responsibilities of project team (mean score = 4.06, rated = 30/58). In the case of organizational learning, the following ratings are assigned to the indicators making up this factor: organization's experience with technology application

(mean score = 3.96, rated = 46/58), organization’s experience enables effective implementation of IT systems (mean score = 3.98, rated = 42/58), and organization’s experience becomes a base of knowledge for guiding initiatives (mean score = 3.96, rated = 47/58). Figure 2 shows that the majority of the 52 items of organizational CSFs possess correlation coefficients that reflect a strong affinity with the two elements of the dependent variable, in addition to possessing a linear relationship that seems to be normally distributed.

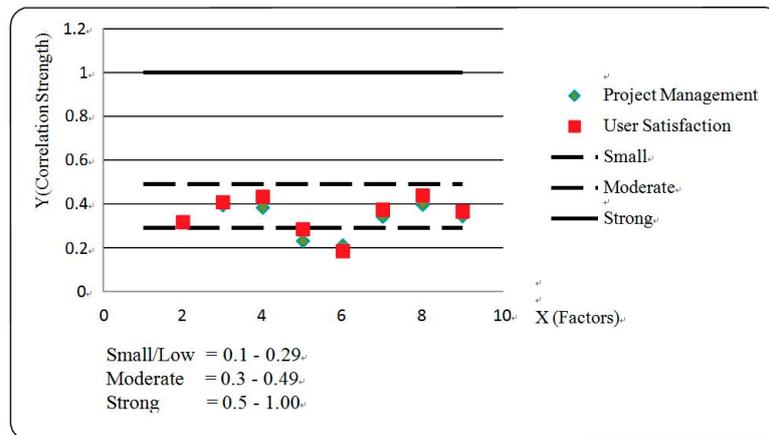


Figure 1. Scatter plot of variables in correlation analysis.

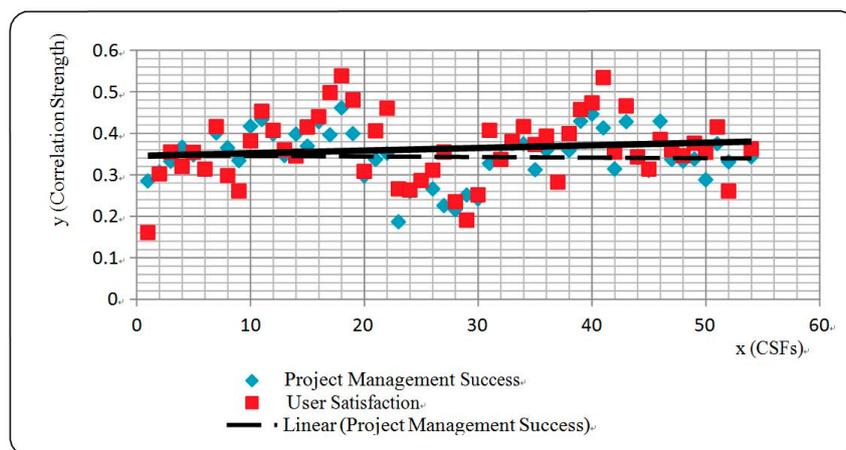


Figure 2. Scatter plot of correlation and linearity.

4.1. Project Management Success as Dependent Variable

Table 2 shows the multiple stepwise regression analysis for project management success as the dependent variable. The values of the unstandardized regression coefficient (B), standardized regression coefficient (β) and degree of significance (p-value) of each predictor, df, R, R2, adjusted R2, significance, and Durbin-Watson value for all the predictors in the linear regression analysis for project management success are presented in Table 2. The R2 measures the proportion of total variance on the dependent variable that is accounted for by the set of predictors. It explains how the model fits the data set. The R2 value is 0.384, which indicates that 38.4% of the variance in e-procurement implementation success is explained by the five predicting variables. The F-value for this model is 14.571 and significant ($p < 0.05$). Moreover, the multiple correlation coefficient, R, for this model is 0.619 ($R > 0.50$), and this shows the strength of the association that these five predictors have with the dependent variable. An R2 value of about 0.37 is considered high according to Cohen [61]. Thus, it indicates that the regression line fits the data set well and that there is a strong linear relationship between the predicting variables and the dependent variable. A Durbin-Watson value at 1.921 indicates that the serial correlation of

residual falls within the acceptable range of 1.5 and 2.5, thereby suggesting that the conditions of there being no autocorrelation problem [64] and the observations being independent of predicted values [65–67] are satisfied.

Table 2. Stepwise hierarchical regression models (project management success).

Predicting Variable	Dependent Variable: Project Management Success		
	Unstandardized Coefficient (B)	Standardized Coefficient (β)	Sig. (p-Value)
1) Incorporation of e-procurement policy into existing procurement policy	0.243	0.315	0.001
2) IT consultant supports during the implementation process	0.201	0.233	0.009
3) Willingness of the organization to change	0.156	0.218	0.012
4) Defines the level each stakeholder can get involved	0.166	0.208	0.014
5) Project activity properly coordinated and monitored	−0.203	−0.246	0.006
n		123	
df		5117	
F		14.571	
R		0.619	
R ²		0.384	
Adjusted R ²		0.357	
Sig.		0.000	
Durbin-Watson		1.921	

Note: significant when $p < 0.05$.

Five predicting variables are found to be significant in explaining e-procurement implementation success based on project management success criteria. These are the incorporation of e-procurement policy into existing procurement policy (X1), IT consultant support during implementation process (X2), the willingness of the organization to change (X3), the definition of the level each stakeholder can get involved (X4), and project activity that is properly coordinated and monitored (X5). As depicted in Table 2, the predicted model generated from this study is shown in Equation (1):

$$\text{Project management success} = 1.612 + 0.243(X1) + 0.201(X2) + 0.156(X3) + 0.166(X4) - 0.203(X5) \quad (1)$$

Table 2 also shows that the largest beta coefficient (β) relates the item “incorporating e-procurement policy into existing procurement policy” with the value of 0.315. This says that the item makes the strongest unique contribution to explaining the dependent variable when the variance explained by all other predicting variables in the model is controlled for. The β-value for the item “IT consultant support during implementation process” with the value of 0.233 is the second highest, followed by the item “willingness of the organization to change” with the value of 0.156. Ranked fourth is the item “defines the level each stakeholder can get involved” with the value of 0.166 and the item “project activities properly coordinated and monitored” with the value of −0.203 is ranked last.

4.2. User Satisfaction as Second Dependent Variable

Table 3 shows the multiple stepwise regression analysis results pertaining to user satisfaction as the dependent variable. The value of unstandardized regression coefficient (B), standardized regression coefficient (β) and degree of significance (p-value) of each predictor, df, R, R², adjusted R², significance, and Durbin-Watson value for all the predictors in the linear regression analysis for user satisfaction are presented in Table 3. The R² value is 0.408 indicating 40.8% variance in user satisfaction is explained by the three predicting variables. The F-value for this model is 27.346 and is significant ($p < 0.05$). The multiple correlation coefficient, R, for this model is 0.639 ($R > 0.50$), indicating a strong

association between the predicting variables and the dependent variable. The R2 value of about 0.37 is considered high according to [68], which indicates that the regression line fits the data set well and that there is a strong linear relationship between the predicting variables and the dependent variable. The Durbin-Watson value of 1.847 indicates that the serial correlation of residual falls within the acceptable range of 1.5 and 2.5, suggesting that the conditions of no autocorrelation problem [56] and observations being independent of predicted values [2,10] are satisfied. Three predicting variables are found to be significant in explaining user satisfaction, which are the reinforcement of the commitment of employees (X1), the establishment of appropriate milestones for the project (X2), and the willingness of the organization to change (X3). As depicted in Table 3, the predicted model generates Equation (2):

$$\text{User Satisfaction} = 1.293 + 0.227(X1) + 0.247(X2) + 0.160(X3) \tag{2}$$

Table 3. Stepwise hierarchical regression for user satisfaction.

Predicting Variable	Dependent Variable: User Satisfaction		
	Unstandardized Coefficient (B)	Standardized Coefficient (β)	Sig. (p-Value)
1) Reinforces the commitment of the employees	0.227	0.287	0.003
2) Establishes appropriate milestones	0.247	0.271	0.004
3) Willingness of the organization to change	0.160	0.213	0.011
n		122	
df		3119	
F		27.346	
R		0.639	
R ²		0.408	
Adjusted R ²		0.393	
Sig.		0.000	
Durbin-Watson		1.847	

Note: significant when $p < 0.05$.

Table 3 also shows that the largest beta coefficient (β) at 0.287 is with the item “reinforcement of the commitment of the employees”. This predictor has the strongest unique contribution to explaining the dependent variable. The β-value at 0.271 for the predictor “establishment of appropriate milestones is the second highest, followed by the predictor “willingness of the organization to change” at 0.213.

4.3. The Path Model of E-Procurement Implementation Success

Path analysis is a straightforward extension of multiple regression analysis that is used to represent the magnitude and significance of the causal relationship between sets of important predictors. The path coefficient values derived from the outcome of stepwise multiple regression were used in this analysis. These values refer to the standardized regression coefficient (beta weight). Table 4 shows the path coefficient values of five important predictors for project management success and three important predictors for achieving user satisfaction. Figure 3 illustrate the predicted path models of e-procurement implementation success.

Table 4. Path coefficient (β -weight).

Predictors for Project Management Success	Beta Weight (β)	Error Value/Error Variance (e) = $\sqrt{(1-R^2)}$
Incorporation of e-procurement policy into existing procurement policy (X_1)	0.315	$\sqrt{(1-R^2)}$ $= \sqrt{(1-0.384)}$ $= 0.7849$
IT consultant supports during implementation process (X_2)	0.233	
Willingness of the organization to change (X_3)	0.218	
Defines the level each stakeholder can get involved (X_4)	0.208	
Project activity properly coordinated and monitored (X_5)	-0.246	
Predictors for User Satisfaction	Beta weight (β)	Error Value / Error Variance (e) = $\sqrt{(1-R^2)}$
Reinforces commitment of the employees (X_1)	0.287	$\sqrt{(1-R^2)}$ $= \sqrt{(1-0.408)}$ $= 0.7694$
Establishes appropriate milestones (X_2)	0.271	
Willingness of the organization to change (X_3)	0.213	

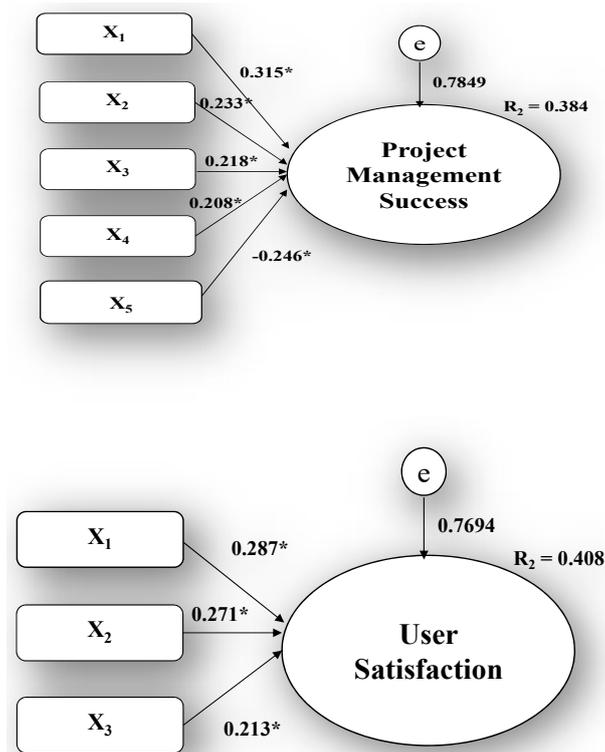


Figure 3. Predicted path model of e-procurement implementation success.

4.4. Checking the Validity of Predicted Regression Model

The predicted regression models were subjected to validity checking to ensure that they satisfied goodness-of-fit criteria and were appropriate to use for prediction or control. The criteria used to check the validity of the predicted models were: a) Model Coefficients, b) Normality, and c) Standard Residual and Cook’s Distance.

4.4.1. Model Coefficients

An assessment of the predicted models' coefficient and associated Variance Inflation Factors (VIF) provides clues concerning the validity of models. Table 5 shows the collinearity statistics of tolerance and VIF of the observed data set. VIF indicates whether a predictor's variance has a strong linear relationship with other predictors' variances, while the tolerance value is the reciprocal of the corresponding VIF. The cut-off points for determining the presence of multicollinearity is tolerance value greater than 0.10 and VIF value of less than 10, according to Pallant [62] and Salkind [63]. All the predictors' variances have tolerance values greater than 0.1 and VIF values less than 10, thereby denoting that both parameters are in the acceptable range, and hence the absence of multicollinearity. Therefore, the predicted regression models for this study satisfy goodness-of-fit and are valid.

Table 5. Collinearity statistics.

Predicting Variable for Project Management Success	Tolerance	VIF (Variance Inflation Factor)
Incorporation of e-procurement policy into existing procurement policy	0.633	1.580
IT consultant supports during implementation process	0.688	1.454
Willingness of the organization to change	0.714	1.400
Project activity properly coordinated and monitored	0.672	1.488
Defines the level each stakeholder can get involved	0.767	1.305
Predicting Variables for User Satisfaction	Tolerance	VIF (Variance Inflation Factor)
Reinforces commitment of the employees	0.571	1.751
Establishes appropriate milestones	0.578	1.731
Willingness of the organization to change	0.735	1.361

4.4.2. Normality

Hair et al. [69] suggested the use of histogram and normal (P-P) plot of regression standardized residuals to check model normality. Figures 4 and 5 show the histogram and normal (P-P) plot of regression standardized residuals for the data sets. The histograms were bell-shaped and symmetrical. The values in the normal probability (P-P) plot are clustering around a straight line, indicating that the models do not violate normal distribution. For both predicted regression models, these diagnostic patterns indicate that the assumption of normality has been met according to Norusis [70].

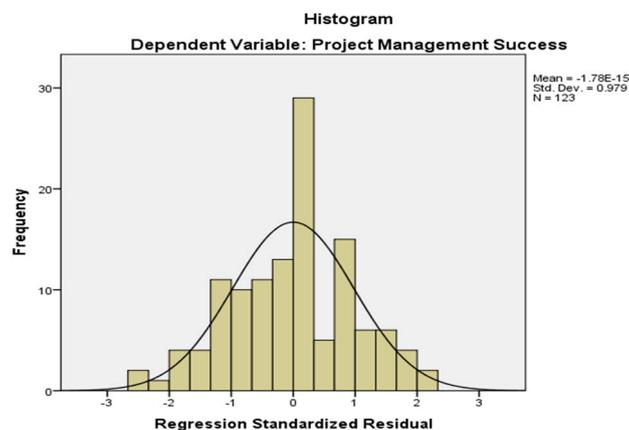


Figure 4. Cont.

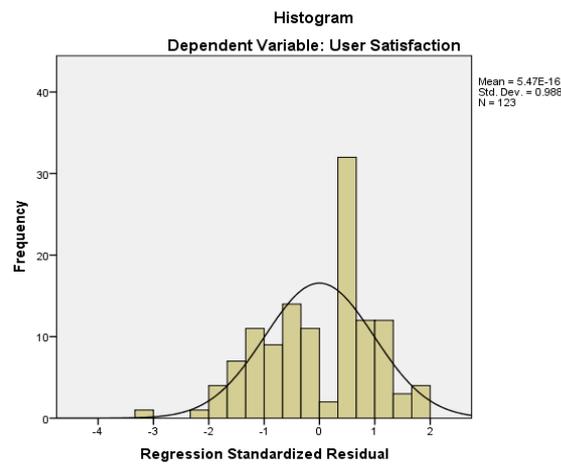


Figure 4. Histogram regression standardized residual.

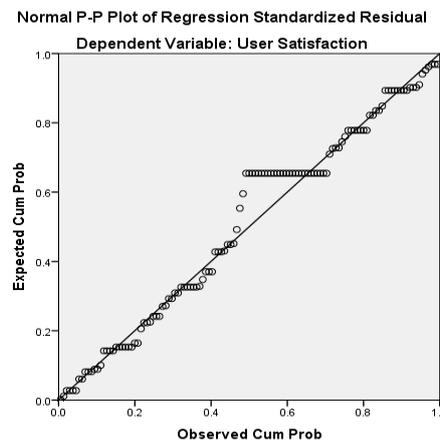
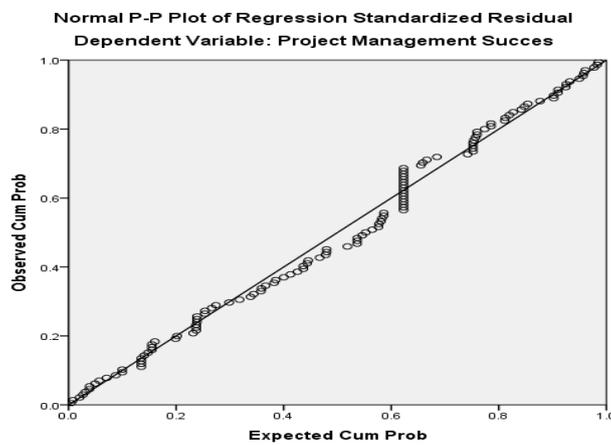


Figure 5. Normal (P-P) plot of regression standardized residual.

4.4.3. Standard Residual and Cook’s Distance

An observed dataset appears to fit the predicted model well if the standardized residual value falls within ± 3.0 , according to Pallant [62]. Table 6 shows the standardized residual values fall within the range suggested, thus there is no outlier to the dataset, and the predicted model is deemed well fitted. Cook’s Distance was used to assess the influence of outliers in the regression model. According to Tabachnick and Fidell [71], if the value of Cook’s Distance is larger than 1.0, there would be influential points, and thus require either deletion or further investigation. Table 6 shows that the maximum value of Cook’s Distance at 0.076 is less than 1.0, which means that there are no outliers present and that the

predicted model achieves goodness-of-fit. For the user satisfaction dependent variables, one particular case had a residual value of -3.018 , which was less than the suggested value of ± 3.0 . Moreover, Case Diagnosis of regression analysis output showed that the respondent (case number 89) had recorded a user satisfaction value of 3, but the model predicted a value of 4.30. It is clear that the model does not predict the respondent well, since this particular respondent’s rating was less than what the study predicted. However, this study decided to evaluate this strange case further to determine if it influences the results of the predicted model as a whole. This was done by assessing the value of Cook’s Distance. The maximum value of Cook’s Distance at 0.088 did not exceed the cut-off value of 1.0. Therefore, this study decided to retain the respondent, as it did not influence the predicted model. In general, there appears to be no violation of the underlying assumption of a linear model, and this leads to the conclusion that the predicted regression models for this study are adequate, fit and reliable.

Table 6. Residuals Statistics.

Project Management Success	Minimum	Maximum	Mean	Std. Deviation	N
Std. Residual	-2.617	2.173	0.000	0.979	123
Cook’s Distance	0.000	0.076	0.009	0.013	123
User Satisfaction	Minimum	Maximum	Mean	Std. Deviation	N
Std. Residual	-3.018	1.865	0.000	0.988	123
Cook’s Distance	0.000	0.088	0.009	0.013	123

5. Developed Frameworks and Discussions

Analytical results show that five predictor variables have significant positive relationship with e-procurement project management success, namely, the incorporation of e-purchasing policy into existing procurement policy, IT consultant support for the project team during the implementation process, the willingness of the organization to change, definition of the level at which each stakeholder can get involved, and the need for activities to be properly coordinated and monitored. A close examination of Figure 3 reveals that 38.4% (adjusted R2 = 35.7%, F-value = 14.571, $p < 0.05$) of e-procurement implementation success in the context of project management success are explained by five predicting variables. The prediction model for the multiple linear regression equation generated in the context of project management success is:

Project Management Success (\hat{Y}_1) = 1.612 + 0.243 (incorporation of e-procurement policy into existing procurement policy) + 0.201 (IT Consultant supports for the project team during the implementation process) + 0.156 (willingness of the organization to change) + 0.166 (defines the level each stakeholder can get involved) – 0.203 (project activity is properly coordinated and monitored).

Three predictor variables are demonstrated to have strong positive relationships with e-procurement implementation success in terms of fulfilling user satisfaction. These are the actions taken by the organization to reinforce the commitment of employees to the implementation initiatives, the establishment of appropriate milestones for performance measurement, and the willingness of the organization to change. The results as shown in Figure 3 also imply that 40.80% (adjusted R2 = 39.3%, F-value = 27.346, $p < 0.05$) of e-procurement implementation success in the context of user satisfaction fulfilment can be explained by three predicting variables. The prediction model for the multiple linear regression equation generated in the context of user satisfaction is:

User Satisfaction (\hat{Y}_2) = 1.293 + 0.227 (reinforcement of the commitment of the employees) + 0.247 (establishment of appropriate milestones for the project) + 0.160 (willingness of the organization to change).

Project management success and user satisfaction do not have significant differences in R2 values (38.4% versus 40.8%, respectively) and multiple correlation coefficient R values (0.619 versus 0.639,

respectively), which suggests that the respondents have given almost similar rank to these two sets of measurement of e-procurement implementation success. As a result, the predicting variables that build up the regression model of these two sets of dependent variables give almost similar readings on the strength of the relationship. In general, the regression models established in this study are adequate and reliable because the constructed models achieve a goodness of fit and fulfil the underlying criteria of regression validity, such as collinearity value (tolerance > 0.1, VIF value < 10), normal distribution, standard residual threshold (observed data set within ± 3.0 limit) and Cook's Distance value (<1.0).

The findings are summarized into predicted frameworks of e-procurement implementation success shown in Figures 6 and 7. Five component factors out of eight significantly contribute to project management success, namely: (i) organizational policy and strategic plan, (ii) technical outsourcing and top management responsibilities, (iii) change management, (iv) stakeholder and composition, and (v) project team planning. These five component factors comprise of thirty-two predicting variables, of which five are predictors of e-procurement implementation success. The five predictors are: a) incorporation of e-procurement policy into existing procurement policy, b) IT consultant support during the implementation process, c) the willingness of the organization to change, d) the definition of the level each stakeholder can get involved, and e) proper coordination and monitoring of project activities. The remaining three component factors such as organizational commitment and relationship development, organizational learning, and business process innovation and external collaboration that comprise in total twenty predicting variables are statistically shown no contribution to the successful implementation of e-procurement. There, these factors are considered non-predictors to e-procurement implementation success measured in terms of project management success.

In Figure 7, three component factors out of eight, namely: (i) organizational policy and strategic plan, (ii) technical outsourcing and top management responsibilities, and (iii) change management, contribute statistically to user satisfaction. From the 18 predicting variables that make up the three component factors, only three items are shown to be predictors of user satisfaction. They are: a) management reinforcement of employee commitment to the e-procurement initiative, b) the establishment of appropriate milestones, and c) the willingness of the organization to change. The remaining five component factors such as stakeholder and composition, project team planning, organizational commitment and relationship development, organizational learning, and business process innovation and external collaboration, which made up of thirty-four variables, are statistically shown to make no contribution to user satisfaction.

The findings from this study suggest that if organizations pin the success of their e-procurement systems implementation on the overall performance of the project as the indicator of success, they need to control the five predicting variables mentioned earlier as supported by Lind and Culler [72]. Conversely, if they pin the success of their e-procurement systems implementation on the ability of the systems to satisfy the users' feelings and attitudes, as suggested by DeLone and McLean [51], and to meet their requirements as suggested by Somers et al. [73], they then need to control the three predicting variables.

The results of the multiple regression analysis also revealed that 47 organizational CSF items out of 52 do not influence project management success, and 49 of the 52 items do not impact user satisfaction with e-procurement implementation. In the dimension of project management success, the 47 items exhibit small beta coefficients ranging from -0.098 to 0.121 . Examples of such items are 'mutual understanding of needs and capabilities' with a beta coefficient of -0.098 and 'offers leadership in organization's e-Purchasing effort' with a beta coefficient of 0.121 . For the dimension of user satisfaction, the analysis reveals that 49 organizational CSF items have small beta coefficients ranging from -0.097 to 0.172 . Items include 'organizations' ability to effectively employ new information technologies' with a beta coefficient of -0.097 , and 'offers leadership in organization's e-Purchasing effort' with a beta coefficient of 0.172 .

These items with small beta coefficients suggest that they play minor parts in the regression model [74]. For the non-influential factors, a change of one standard deviation for that variable (CSF

items) produces a small change in standard deviation for e-procurement implementation success measured in both project management success and user satisfaction. As a result, 47 organizational CSF items for project management success and 49 organizational CSF items for user satisfaction are recognized as non-influential factors that neither have strong relationships with nor contribute significantly to e-procurement implementation success.

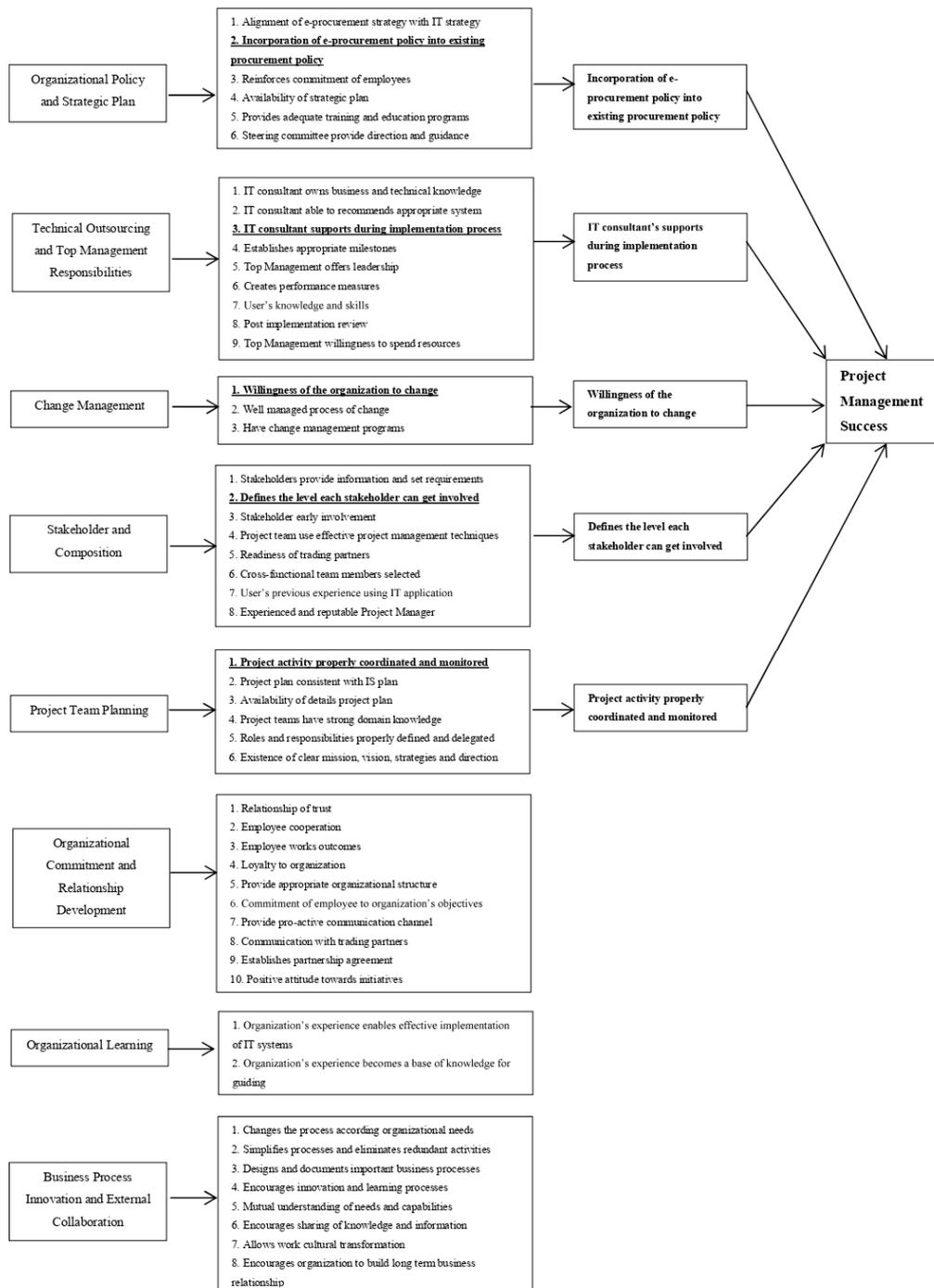


Figure 6. e-procurement Implementation Success (ePIS) framework for project management success.

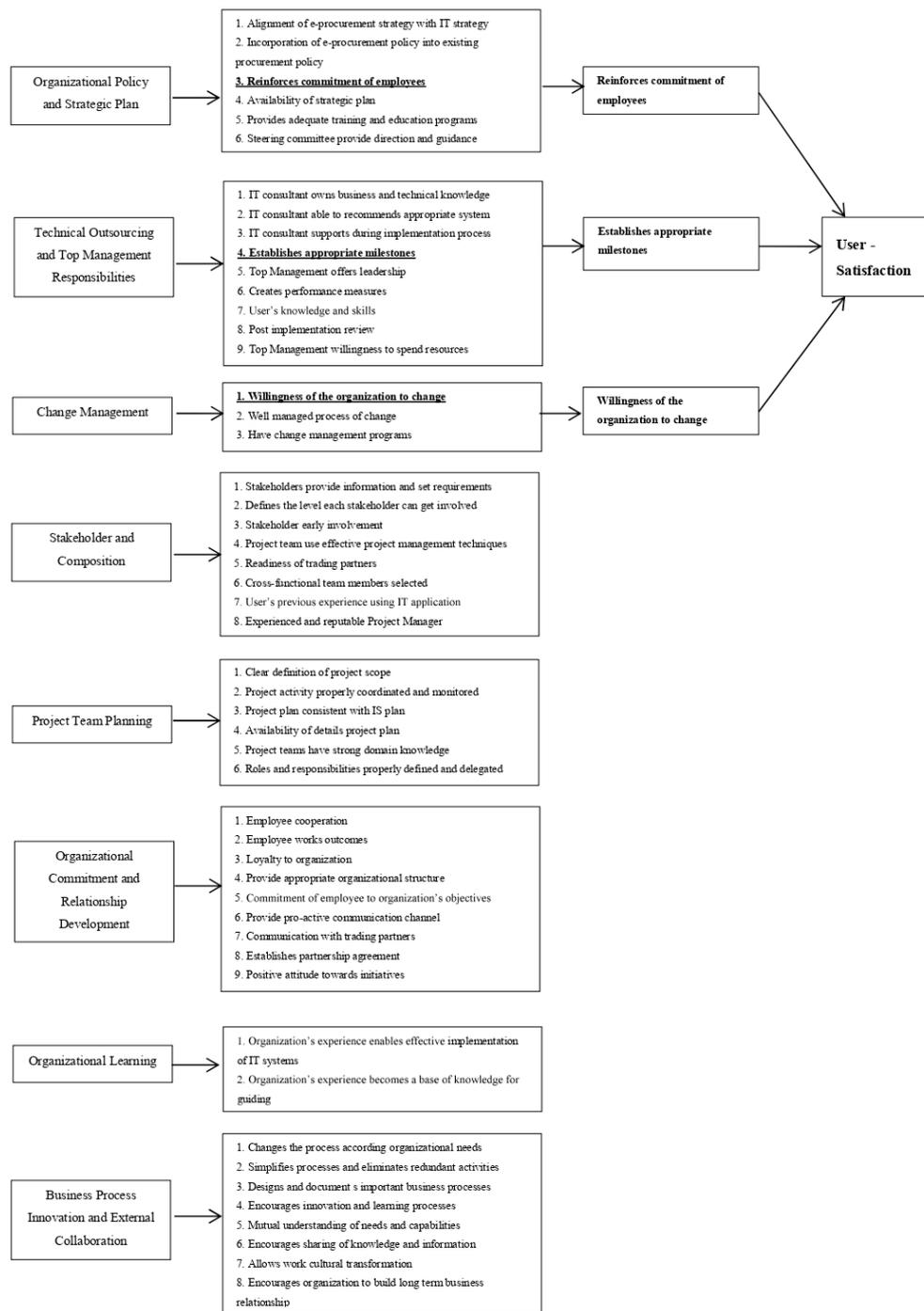


Figure 7. e-procurement Implementation Success (ePIS) framework for user satisfaction.

6. Comparison with Other Selected Studies

Table 7 shows a comparison of the framework yielded from this study and frameworks generated by other researchers. It clearly shows that frameworks differ in their choice of selection criteria and focus areas. Vaidya et al. [47], for instance, proposed a framework of CSFs for e-procurement implementation success in the public sector by focusing on three (3) primary factors, namely organizational and management, practices and process, and system and technology. Their study was based on a literature survey.

Table 7. Comparison of study frameworks.

Sources	Framework/Models	Focus Areas	Dimensions of Success	Industry	Specific Level	Approach
This study (2019)	Framework for e-procurement implementation success	Organizational	<ul style="list-style-type: none"> Project management success User-satisfaction 	Construction (Private sector)	Individual and organization	Mixed methods
Vaidya et al. [71]	Conceptual framework for e-procurement success	<ul style="list-style-type: none"> Organizational & management Practices & process System & technology 	<ul style="list-style-type: none"> User satisfaction Supplier satisfaction 	Public sector	Individual and project	Literature survey
Mose et al. [50]	Conceptual framework for successful e-procurement adoption	Managerial, process & system	E-procurement outcome	Manufacturing	Individual and organization	Cross-sectional survey
Arasa and Achuora [8]	Model for e-procurement implementation success	<ul style="list-style-type: none"> Based on TOE model Technological Organizational Environmental 	E-procurement impact	Textile and apparel	Individual and organization	Mixed methods

Another study by Mose et al. [44] proposed a conceptual framework for the successful use of e-procurement that includes 20 items in different categories of CSFs as independent variables and e-procurement outcome as the dependent variable. Their study focused on online tender and sourcing involving manufacturing firms and was conducted through surveys. Another study by Arasa and Achuora [74] developed a theoretical model on the factors affecting e-procurement implementation success that consists of 12 items based on TOE (technological, organizational and environmental) as independent variables and the e-procurement impact as the dependent variable. Their focus area was the textile and apparel industry, and data were gathered through surveys. Although there are some similarities between enterprise systems, it is expected that different success frameworks may emerge. As pointed out by Liu [68] and Hartman and Ashrafi [75], a framework of critical success factors that have been identified for a particular project may not apply to another because of differences in environment, types of stakeholders and priority of organizational goals. Therefore, the contribution of this study can be found in a deliberate attempt to formulate the e-procurement implementation success framework for the construction sector where projects characterize businesses.

7. Implications for Research and Practice

The findings can be used to create greater awareness of what factors influence the successful implementation of e-procurement, particularly concerning project-based organizations such as the construction sector. Project organizations should emphasize not only the technical and financial aspects of the system undertaking, but should also focus on all the significant factors discussed in this study in order to be more competitive and avoid risking massive losses. The frameworks developed in the current study have implications for both academic researchers and practitioners. It can be deduced that strategic decisions relating to procurement policy, employee commitment, project milestones, change management, stakeholder involvement, and project planning have a great influence on the success of any e-purchasing initiative in the construction industry. This study also provides a unique set of enterprise CSFs that represent the vital activities, concerns, strategies, and goals of upper and middle-level management.

For academic researchers, this study systematically examined and investigated CSFs of e-purchasing implementation in the construction industry to bridge the existing gap in the literature as most studies derived their sets of CSFs from other industries' perspectives, whereby they have not been designed to meet the needs of the construction industry. Additionally, this study expands the investigation by focusing on organizational characteristics which are seen to significantly influence the decision to use e-procurement in previous studies. This study thus adds to the growing body of knowledge of e-procurement implementation and extends the scope of e-procurement application. The proposed frameworks may also assist in the study of other topics related to construction supply chain management systems. It can, for example, provide some exploratory insights on the knowledge types needed to manage the CSFs along the implementation process.

For practitioners, the identification of the critical factors enables managers to obtain a better understanding of issues surrounding e-procurement implementation. Managers can also gauge the relative importance of the CSFs that potentially affect e-procurement implementation process and outcome, specifically in the allocation and management of project resources. Construction organization stakeholders and decision-makers are duty-bound to expand their focus from purely technical factors to organizational factors and to balance the factors that impact an e-procurement implementation. These CSFs must be strategically considered in steering towards project management success and increased user satisfaction.

8. Conclusions

Based on a detailed literature review and following an exploratory/pilot qualitative study, the 52 most relevant predicting variables on e-procurement adoption relevant to the construction industry were identified. By administering and analyzing a broad questionnaire survey, this study evaluated

the effects of the predicting variables on project management success and user satisfaction for the implementation of e-procurement in the construction sector. It can be seen from this study that strategic decisions to implement e-procurement in AEC organizations are significantly influenced by procurement policy, employee commitment, project milestones, change management, stakeholder involvement, and project planning. The framework emerged to focus on organizational competencies that require continual attention and have the most significant impact on initiative implementation success. Organizational competencies make up the five predictors that contribute to successful project management whereas the three predictors that contribute to user satisfaction are resources that yield a competitive advantage for the organization. The frameworks developed in this study could help the practitioners to gain a better understanding of the vital factors that influence e-procurement practices in construction. By taking care of these key predictors, construction organizations can effectively improve project management performance and considerably raise user-satisfaction, which ultimately lead to the successful implementation of e-procurement in the construction sector. Future studies are expected to quantify these frameworks into implementation models through computer-based simulation and to validate through case studies.

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