


Article

Critical Success Factors (CSFs) for e-Procurement Adoption in the Nigerian Construction Industry

Adedeji Afolabi ^{1,*} , Eziyi Ibem ², Egidario Aduwo ², Patience Tunji-Olayeni ¹ and Olufunke Oluwunmi ³

¹ Department of Building Technology, Covenant University, Ota 112233, Nigeria; pat.tunji-olayeni@covenantuniversity.edu.ng

² Department of Architecture, Covenant University, Ota 112233, Nigeria; ibem.eziyi@covenantuniversity.edu.ng (E.I.); egidario.aduwo@covenantuniversity.edu.ng (E.A.)

³ Department of Estate Management, Covenant University, Ota 112233, Nigeria; funke.oluwunmi@covenantuniversity.edu.ng

* Correspondence: adedeji.afolabi@covenantuniversity.edu.ng

Received: 5 November 2018; Accepted: 11 December 2018; Published: 18 February 2019



Abstract: Previous research works on the integration of e-Procurement technologies in the construction process in Nigeria showed that it has been slow and low. However, there are few empirical studies on the duration for which it has permeated the construction industry, the actual proponents and the metrics that can engender successful integration of e-Procurement technologies, applications, and tools in the construction procurement process, especially in a developing country like Nigeria. The study was aimed at evaluating the critical success factors (CSFs) for e-Procurement adoption in the Nigerian construction industry. The study was carried out in the six geo-political zones in Nigeria using a survey research design. Construction stakeholders were selected using purposive and random sampling techniques. A total of 1092 questionnaires were retrieved in this study, but the data of 759 actual users of e-Procurement systems were analyzed in this study using descriptive statistics and principal component analysis (PCA). An assessment of the duration users have been participating in the e-Procurement environment revealed that most Quantity Surveyors have been exposed to the use of e-Procurement technologies for over 10 years. A large proportion of the construction stakeholders picked up the use of the technology within the last 5 years. Further analysis showed that contracting firms have the largest participation in the use of e-Procurement systems. The study also revealed that construction stakeholders perceived the availability of reliable, affordable, and fast Internet services as the most critical success factor for the adoption of e-Procurement technologies. The critical success factors (CSFs) were further classified into management support for physical infrastructure, and human factors and characteristics of the technology. The study showed that these critical success factors (CSFs) are crucial for the adoption of e-Procurement systems in the Nigerian construction industry. The study recommended that there is still a need for increased awareness of the e-Procurement tools and technologies and the benefits that are accrued from their use among public sector construction participants. This will in turn influence the provision of the required information and communication technology (ICT) physical infrastructure and formulation of appropriate policies and standards for successful e-Procurement integration in the Nigerian construction industry.

Keywords: construction industry; critical success factors; e-Procurement; Nigeria; survey

1. Introduction

The innovativeness of information and communication technologies (ICTs) explored the unique characteristics of the construction industry to produce e-Procurement systems. Characteristics such as

large volumes of paper works, life-cycle process of the construction activities, and large number of project stakeholders ensure that the e-Procurement tool can find footing in the construction industry. The presence of ICTs in the construction industry has helped professionals to create a competitive niche in their activities compared to their traditional counterpart. Notably, the introduction of the Internet has been harnessed to solve productivity issues and bridge the supply chain of many contractors in the construction sector. In spite of this, studies from early 2000 showed that e-Procurement has had low usage due to unawareness and low e-maturity of construction stakeholders [1]. Although, Afolabi et al. [2] noted that construction stakeholders presently possess the adequate ICT investment (hardware, software and other facilitating conditions) to actively participate in an e-Procurement environment, however, before these ICT investments are deployed, it is important to highlight the crucial factors that would ensure its success.

An evaluation of the benefits of an e-Procurement platform in the construction industry shows that it is an innovative tool that can reduce many of the challenges in the Nigerian construction industry. According to Tindsley and Stephenson [3], e-Procurement systems can address the challenges experienced in the traditional processes of procuring goods and services in the construction sector. E-Procurement systems build on the activities in the traditional procurement strategies to deliver a seamless process for the construction firm and prospective bidders [4]. Oyediran and Akintola [5] affirmed that e-Procurement platforms increase productivity in the construction cycle while empowering construction stakeholders to closely monitor the procurement process. In addition, their study identified the benefits of cost-saving as a result of fewer paper-based transactions and increased efficiency. Kajewski and Weippert [1] opined that the e-platforms increase competitiveness and opportunities among construction organizations. In developed countries, the use of e-Procurement is emphasized due to its ability to optimize cost while in South Korea the underlying benefits of increasing transparency and minimizing procurement transactional cost encourage the use of the platform [6]. In spite of the numerous benefits, it is important to measure the success or failure of the system from time to time, in order to evaluate performance.

Critical success factors (CSFs) play a crucial part in the success of many systems. It is vital to continually investigate CSFs in any system in order to measure productivity and performance. For e-Procurement systems to be assumed to be successful, the CSFs must have been tested and established [7–9]. CSFs are defined in this context as creating a central point of reference in measuring the success or failure in the use of e-Procurement systems. By this, industry participants are provided with the focus metrics in terms of activities and priorities that should be achieved for the successful integration of web-based systems in the construction procurement process. The focus metrics in the CSFs is to provide an uncommon strategic tool that helps businesses to be precise, which also ensures their success [10]. As highlighted in this study, these CSFs can be internal or external in relation to the organization's operations. Construction firms must measure the level of performance of the CSFs before proceeding to acquire the web-based systems in their operations. Therefore, the study aims to evaluate the critical success factors (CSFs) for e-Procurement adoption in the Nigerian construction industry. The following objectives have been coined to justify the importance of this study:

- To evaluate the actual users of e-Procurement systems in the Nigerian construction industry.
- To assess the duration users have been participating in the e-Procurement environment.
- To examine the critical success factors (CSFs) crucial for the adoption of e-Procurement systems in the Nigerian construction industry.

2. Review of Literature

According to Croom and Johnston [11], e-Procurement systems are simply the application, tools, and technologies used to carry out procurement activities via the Internet. This definition was corroborated by [7,12] in that, the main instrument that makes e-Procurement possible is the innovation of the Internet. In the context of construction activities, e-Procurement involves placing, submitting, and receiving tenders, sourcing and ordering of materials, exchanging emails between construction

clients and contractors/suppliers for contract management or other transactions via the internet [13]. E-Procurement platforms are not new technologies to a developing economy like Nigeria. Rather it is the level of use and the availability of the relevant infrastructure across stakeholders in the Nigerian construction industry that researchers try to understand. Comparing statistics with developed countries, Aduwo et al. [14] identified the barriers that reduce the use of e-Procurement systems in the Nigerian environment as majorly cost of providing the physical infrastructure and skill to run it. The study further identified the predictors of low uptake of e-Procurement by construction stakeholders. In South Africa, Laryea and Ibem [15] explained the major inhibitors to the partial utilization of e-Procurement systems in the public sector are mainly attributed to policies, reliability, cost, and impact on small firms including employment of construction stakeholders.

In the study by Ibem et al. [16], the digital technologies that aid the use of e-Procurement systems in the Nigerian construction industry were identified. The digital technologies mostly used were emails by construction stakeholders rather than a custom or third-party web-based/cloud procurement system. Their study argued that there are critical factors that spur the choice of digital technologies implemented in the e-Procurement process. The authors noted that construction stakeholders adopted e-Procurement technologies due to its ability to eliminate location barrier of procurement participants, increased efficiency, improved procurement data management, and improved transfer of information during the procurement process. Afolabi et al. [2] developed a customized e-Procurement system for a private firm connecting it to its several contractors. In the study by Afolabi et al. [2], the procurement stakeholders had the necessary digital technologies to participate in an e-Procurement process. These findings are corroborated by Oladapo [17], that more than 90 percent of construction professionals had access to their personal computers. The Nigerian construction industry that used to be traditional is fast embracing the use of digital technologies. This is due to the increased awareness of the measurable benefits attributed to the use of ICT in construction activities [2,14].

Aduwo et al. [18] opined that in the Nigerian space, the main users of e-Procurement were quantity surveyors and construction/project managers, particularly, those in the consulting sector. The authors further identified the organizational factors prompting e-Procurement adoption. The organizational factors include the nature of organizations, support of top management and attitude towards the use of the technology. Other organizational factors identified in [19] are related to planning, change management, human resource management (HRM), and commitment to continuous staff development. With more emphasis on organizational factors, Patel et al. [20] pointed out that budgetary allocations and employees' knowledge base in managing e-Procurement technologies are also factors to consider. Apart from the organizational factors, Teo et al. [21] opined that the superficial gains from using the technology and external influence such as the people working with the organization can influence if the organization will adopt a technology. Furthermore, Daud et al. [22] argued that the individual's intent was the crucial attribute among Malaysian contractors. In Kenya, Obat [8] identified key areas of Internet, supplier, and change as strategic points for e-Procurement integration in the construction sector. He argued that the Internet services must be reliable and suppliers must be integrated in the e-Procurement process. In addition, a proper change management plan should be drawn up while moving from the traditional to ICT-based tools. In the Iranian automobile industry, CSFs such as employee participation, safety of the platform, availability of the required information technology (IT) setup, recalibration of the e-Procurement process, and component supplier involvement are critical in the implementation of e-Procurement technologies [9]. From the aforementioned CSFs, there are few studies that have concentrated on developing countries in sub-Saharan Africa such as Nigeria. More of the CSFs have been focused on the organizational factors. This study identified generalized CSFs beyond the organization's characteristics thereby capturing realistic variables (internal and external) that can influence the adoption of e-Procurement system in a developing country.

3. Research Methods

In order to deliver the outlined objectives in this study, the research procedure was mapped out to understand the participants, location, instrument, reliability of the data, and the tests to be conducted. The quantitative nature of the data sought in the evaluation of the critical success factors (CSFs) for e-Procurement adoption in the Nigerian construction industry required the use of a cross-sectional survey research design. This helped to draw up adequate sample from the population of registered and unregistered construction stakeholders. Due to the characteristics of the population, a two-stage sampling technique was used. The adoption of the e-Procurement was targeted at stakeholders in the construction industry using purposive sampling technique. The construction stakeholders include Architects, Builders, Engineers, Contractors, Construction/Project Managers, Quantity Surveyors, Estate/Facilities Managers, Supply Chain Managers/Procurement Officers, and Construction Materials/Equipment Vendors. Simple random sampling procedure was used to select those to whom the research instrument was administered. Due to the inadequacies in obtaining a comprehensive list of registered and unregistered construction stakeholders in the construction industry and the researchers being unsure of the actual users of e-Procurement, the Cochran [23] equation was used to give a representative sample of the participants of the study. Simple random sampling for an undefined population using the Cochran formula in Equation (1) was used, where the $p = 0.5$ i.e., the maximum variability at 95% confidence level. The value of 95% is used because the researchers do not know the variability in the proportion of the actual users of e-Procurement systems in the construction industry. In Equation (1), e is the level of precision desired for the sample size which is at ± 5 percent, z is the abscissa of the normal curve given as 1.96 and q represented by $(1 - p)$ which is equivalent of 0.5. Therefore, the minimum sample size was calculated at 385 construction stakeholders.

$$\text{Minimum Sample size, } n_0 = \frac{Z^2 pq}{e^2} \quad (1)$$

However, 2000 questionnaire instruments were administered in the zones studied. The research was carried out in the six geopolitical zones in Nigeria. Figure 1 shows the mapping of the six geopolitical zones in Nigeria. This helped in giving a general representation of construction stakeholders in the Nigerian built environment. Specifically, physical administration of the research instrument was done in cities such as Kaduna, Abuja, Lagos and its environs, Ibadan, Port-Harcourt, Uyo, Owerri, and Enugu. For the North-East, where there are issues with insecurity, email distribution of the research instrument was used.

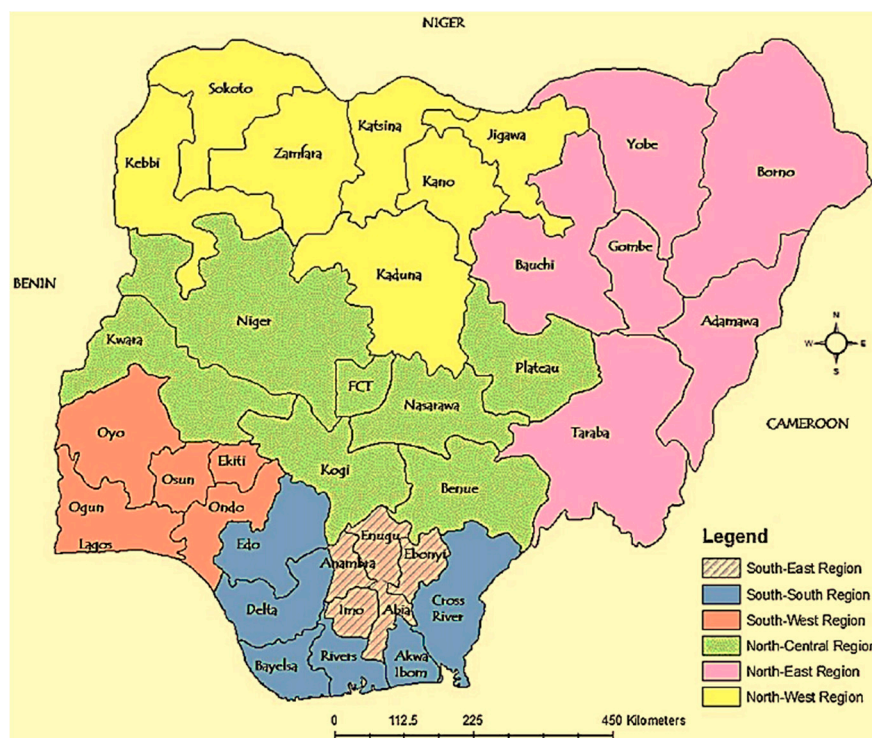


Figure 1. Mapping of the six geopolitical zones in Nigeria ([google.com.ng](https://www.google.com.ng)).

A total of 1092 questionnaires were retrieved between November 2017 to August 2018. This represented 55 percent of the total questionnaires sent out by the researchers. The design of the questionnaire instrument was mainly in two sections of the background information of the respondents and the 21 critical success factors (CSFs) identified from [7,18,21]. The variables of the CSFs were tested using Cronbach alpha reliability which gave a value of 0.880 which is greater than the acceptable value of 0.70 as shown in [24]. This shows that the scale of measurement and the structure of the questions are not related. The scale of measurement used for the CSFs was a 5-point Likert scale of 5 = very high influence, 4 = high influence, 3 = undecided, 2 = very low influence, and 1 = no influence. Previous authors [7,14,18] had used similar scale in their respective studies.

Moreover, the study is concerned with actual users of e-Procurement technologies in the Nigerian construction industry. Therefore, there was a need to sieve out the reliable data of actual users in the retrieved questionnaires. In the background information, a question of 1 = Yes and 2 = No was used to separate those that have participated in construction projects that have used e-Procurement technologies as shown in Table 1. From Table 1 it is evident that a total of 759 construction stakeholders in the Nigerian construction industry which represented 69.6 percent actual users of e-Procurement systems in the Nigerian construction industry. This formed the actual respondents that were analyzed in this study. Previous study in [7] showed that there were only 39 percent actual users of e-Procurement systems in the building sector.

Table 1. Participation in construction projects using e-Procurement technologies.

Response	Frequency	Percent	Cumulative Percent
No	308	28.2	28.2
Yes	759	69.5	97.7
No Response	25	2.3	100
Total	1092	100	

The data obtained in this study were analyzed using descriptive statistics and principal component analysis (PCA). Firstly, the descriptive statistics used were frequency distribution and percentages, and these were very helpful in understanding the distribution of the participants according to their personal profiles, such as educational qualification, industry work experience, professional inclination, type of organization they work for, areas of their construction procurement experience, and their use of e-Procurement. In addition, mean scores and ranking of the 21 items investigated were used to measure the CSFs for e-Procurement adoption. Previous authors have used similar approach see [7,14,18]. Secondly, the various dimensions of the CSFs were investigated using principal component analysis (PCA). This was necessary in providing understanding of how the stakeholders in the Nigerian construction industry construe the CSFs for e-Procurement adoption. Prior to executing the PCA, it was important to investigate the suitability of the dataset for this analysis. This was done using Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy. The result of KMO test as shown in Table 2 supported the use of principal component analysis due to the adequacy at 0.946 which is greater than the acceptable value of 0.7 recommended by Pallant [24]. Furthermore, the Bartlett’s test of sphericity ($\chi^2 = 5661.517$; $df = 210$) showed that the p value was significant at 0.000, meaning that the population was not an identity correlation matrix. These two tests supported the use of principal component analysis used in investigating the dimensions of CSFs for e-Procurement adoption in the study area [24]. The results of these analyses are presented using frequencies, stacked bar chart, and tables for easier understanding by readers.

Table 2. Kaiser–Meyer–Olkin (KMO) measure and Bartlett’s Test on the critical success factors (CSFs).

Kaiser–Meyer–Olkin Measure of Sampling Adequacy		0.946
Bartlett’s Test of Sphericity	Approx. Chi-Square, χ^2	5661.517
	Degree of freedom, df	210
	Sig.	0.000

4. Results and Discussion

In order to determine the critical success factors (CSFs) of e-Procurement adoption in the Nigerian construction industry, it was essential to survey actual users of e-Procurement technologies. A review of the background characteristics of the construction stakeholders was carried out. Figure 2 shows the highest educational qualification of the respondents. From Figure 2, most of the construction professionals had Bachelors’ degree (36.6%) and Masters’ degree (35.2%).

This shows that the respondents had the required academic qualification to respond adequately to the questions in the research instrument. The industry work experience of the construction stakeholders is shown in Figure 3. In Figure 3, more than half of the study participants had over 5 years work experience in the built environment, while more than 30% had between 6 years and 10 years work experience in the built environment.

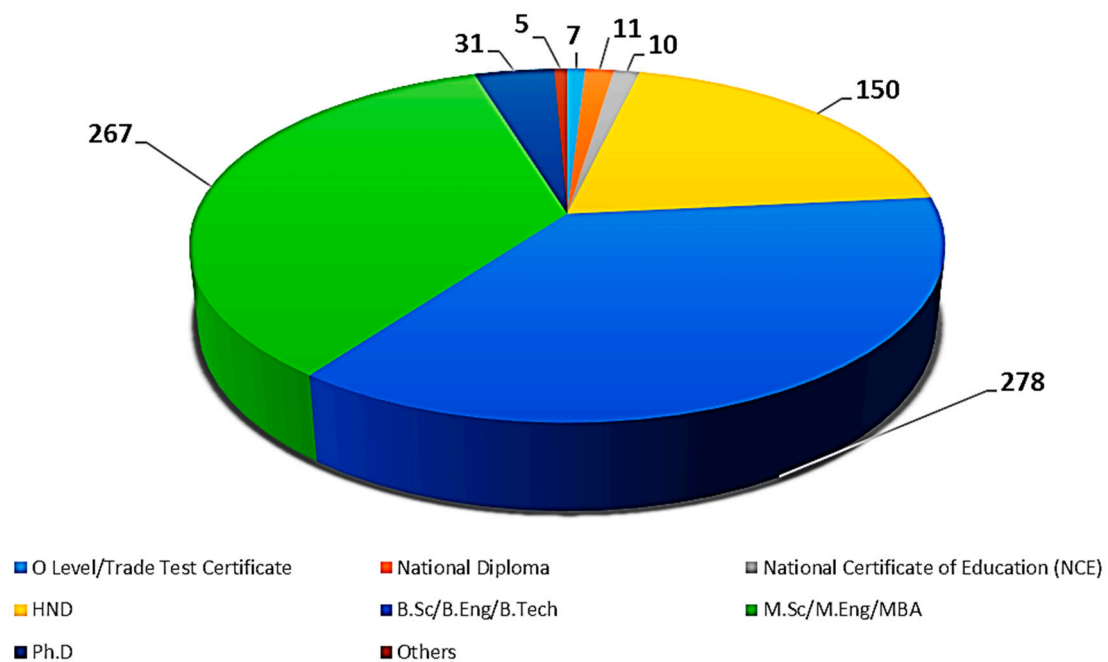


Figure 2. Highest academic qualification of construction stakeholders.

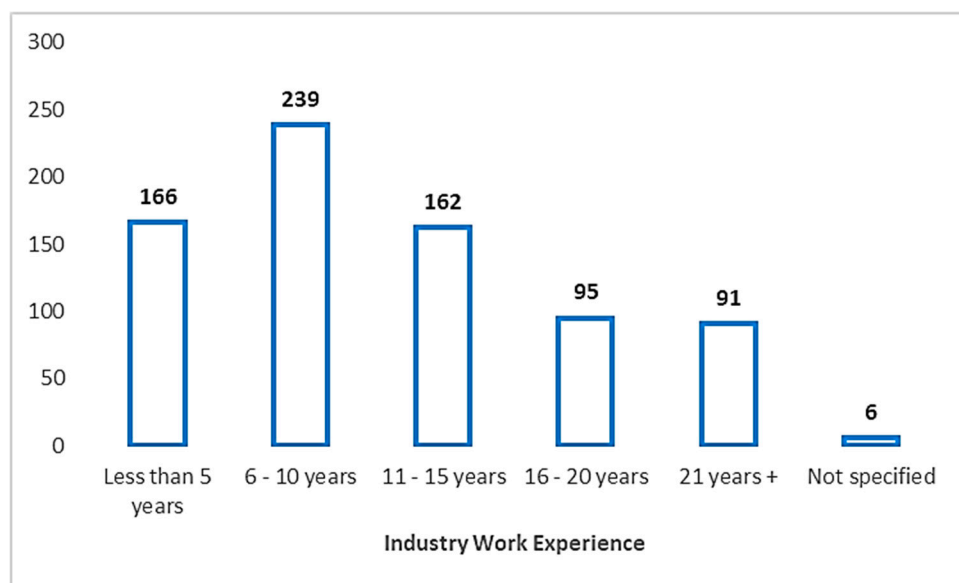


Figure 3. Industry work experience of the construction stakeholders.

Figure 4 shows the areas where the respondents have had experience in construction procurement in the built environment. Most of the construction stakeholders have procurement experience in construction of residential buildings (474; 62.5%) and non-residential buildings (187; 24.6%).

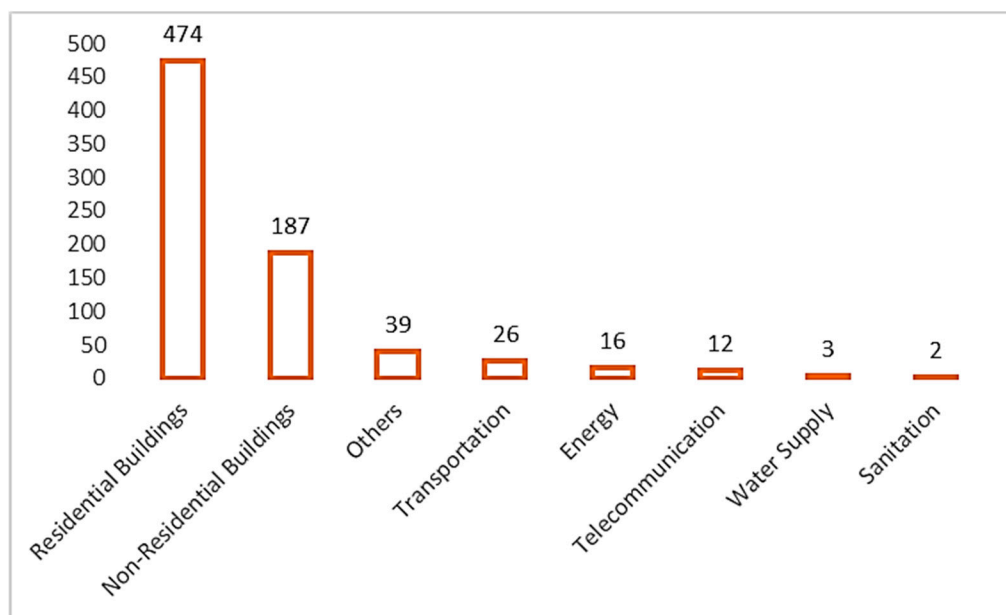


Figure 4. Areas of respondents' construction procurement experience.

4.1. Actual Users of E-Procurement Systems in the Nigerian Construction Industry

The study evaluated the actual users of e-Procurement systems in the Nigerian construction industry. The actual users were presented based on the profession and type of organization. In Aduwo et al. [18], there was a clear relationship between the professional background of construction stakeholders and their use of e-Procurement systems. Figure 5 presents actual users of e-Procurement technologies based on their professions. In Figure 5, across the six zones investigated in Nigeria, 192 (25.3%) Architects, 69 (9.1%) Builders, 120 (15.8%) Engineers, 52 (6.9%) Contractors, 37 (4.9%) Construction/Project Managers, 200 (26.4%) Quantity Surveyors, and 55 (7.2%) Estate/Facilities Managers had participated in the use of e-Procurement systems. The result revealed that Quantity Surveyors were mostly involved in the use of e-Procurement technologies compared to other professionals. This result follows the findings of [5,18] that Quantity Surveyors were the most users of e-Procurement technologies in the Nigerian construction industry. This may be attributed to the exposure of the Quantity Surveyors to the innovative tool by their professional bodies through the continuous professional development (CPD) trainings. This notion is spurred by the early awareness of electronic tendering among Quantity Surveyors as shown in the study by [5].

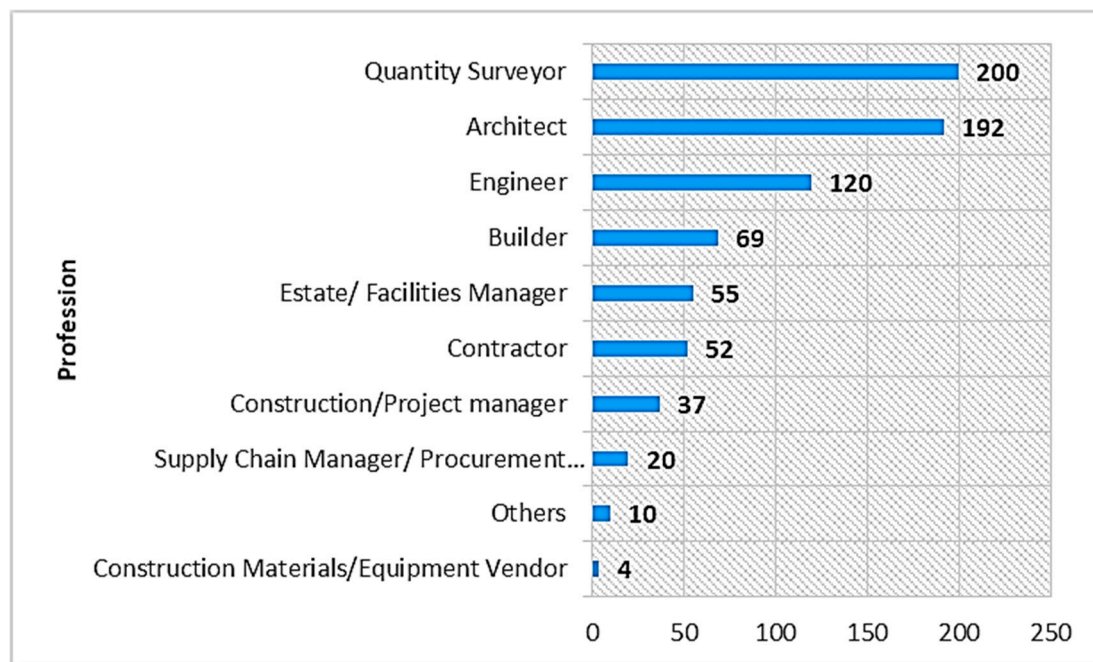


Figure 5. Actual users of e-Procurement systems according to profession.

Further analysis on the type of organizations that were mostly involved in the use of e-Procurement in the built environment is shown in Table 3. In Table 3, contracting firms have the largest participation in the use of e-Procurement systems. More than 60% of contracting and consulting firms have participated in the use of e-Procurement technologies in the Nigerian built environment. However, only 20% of government ministry/parastatal/institution have used e-Procurement systems compared to the large number of construction projects that are procured via these institutions as government is the largest client of construction works in the Nigerian construction industry. In previous studies, consulting firms used to take the lead in the uptake of e-Procurement systems [18]. However, contracting firms have overtaken in the use of e-Procurement systems in the Nigerian construction industry. Interestingly, they are closely followed by consulting firms. Findings from [25] in the South African construction industry also support the notion of the private sector which includes contracting and consulting firms leading in the use of e-Procurement systems. Aduwo et al. [18] attributed the similarities in findings from the Nigerian sector and the South African sector to the similar patterns that exist in the socio-economic and technology space of the two countries. However, in the study by Eadie, Perera, Heaney, and Carlisle [26], the reverse is the case. Their study showed that in a developed country like the United Kingdom, the government plays a crucial role in the high adoption of e-Procurement technologies by the public sector compared to their private sector counterparts. Aduwo et al. [18] suggested that for e-Procurement systems' usage to be entrenched in the culture and procurement process of the Nigerian construction industry, the governments need to provide the required leadership and seamless legal and policy backing for the uptake of e-Procurement technologies. Since the Nigerian government is the largest construction client, an uptake of e-Procurement systems by its ministries, agencies, and departments (MADs) would go a long way in increasing the adoption of the innovative tool. In addition, once e-Procurement systems have been integrated in the procurement of public projects, there would be more commitment in providing the reliable, affordable, and fast Internet services and other ICT infrastructure needed for an unbroken construction procurement process.

Table 3. Actual users of e-Procurement systems according to organizations.

Category of Organization	Frequency	Percent	Cumulative Percent
Consulting firm	242	31.9	31.9
Contracting firm	265	34.9	66.8
Client Organization	58	7.6	74.4
Government Ministry/Parastatal/Institution	171	22.5	96.9
Building Materials Manufacturer/Vendors	3	0.4	97.3
Others	20	2.7	100
Total	759	100	

4.2. Duration of Using E-Procurement Technologies

With the understanding of the actual users of e-Procurement systems, it is essential to know how long the systems have been in use by the construction stakeholders in the built environment. This would help to understand how the technology has permeated the construction industry. Table 4 is a presentation of the result on how long the construction stakeholders in the built environment in the study area have taken up e-Procurement technologies for use in their construction projects.

Table 4. Duration of using e-Procurement technologies.

Duration (Years)	Frequency	Percent	Cumulative Percent
Not sure	89	11.7	11.7
>1	155	20.4	32.1
1–5	363	47.8	80.0
6–10	112	14.8	94.7
Over 10	40	5.3	100.0
Total	759	100.0	

The result from Table 4 showed that most of the construction stakeholders in Nigeria have used e-Procurement technologies within the last 5 years. It is insightful to note that only about 5% of construction stakeholders in Nigeria have used e-Procurement technologies for over 10 years. Furthermore, it was necessary to breakdown the duration of using e-Procurement technologies based on the construction stakeholders. This helped to understand the set of people that have had an early start with the technology and the professionals that may still be lagging behind. Table 5 compared the roles of the construction stakeholders and the duration of their uptake of e-Procurement technologies. The result in Table 5 showed that most Quantity Surveyors have been using e-Procurement technologies for over 10 years which is closely followed the Architects. A large proportion of the construction stakeholders picked up the use of the technology mostly within the last 5 years. In the last 1 year, the study revealed that 20 percent of construction stakeholders have just been exposed to the use of e-Procurement technologies.

Table 5. Cross-tabulation of the construction stakeholders and the duration of using e-Procurement technologies.

		Duration of Use of E-Procurement Technologies					Total
		Not Sure	>1 Year	1–5 Years	6–10 Years	Over 10 Years	
Roles in the Construction Industry	Architect	46	54	62	22	8	192
	Builder	3	15	32	18	1	69
	Engineer	10	22	52	31	5	120
	Contractor	10	12	19	8	3	52
	Construction/Project Manager	4	8	16	6	3	37
	Quantity Surveyor	0	23	145	18	14	200
	Estate/Facilities Manager	9	10	31	2	3	55
	Supply Chain Manager/Procurement Officer	4	5	4	5	2	20
	Construction Materials/Equipment Vendor	0	1	2	1	0	4
	Others	3	5	0	1	1	10
Total		89	155	363	112	40	759

4.3. Critical Success Factors for the Adoption of E-Procurement Technologies

This section identified critical success factors crucial for the adoption of e-Procurement technologies. The 21 CSFs were identified from literature as affecting a developing country such as Nigeria in [7]. It is important to identify factors that are peculiar to the terrain in order to guide the successful adoption of e-Procurement by Nigerian construction stakeholders. The uniqueness of this study is using actual users to identify the CSFs to identify the adoption parameters of e-Procurement technologies. Table 6 presents the mean score rating of the CSFs for the adoption of e-Procurement technologies based on the 5-point Likert scale used. The result in Table 6 was then ranked accordingly. From Table 6, all the CSFs have high influence on the adoption of e-Procurement technologies in the Nigerian construction industry. The result revealed that construction stakeholders perceived the availability of reliable, affordable, and fast Internet services as the most critical success factor for the adoption of e-Procurement technologies. E-Procurement technologies are web-based systems and therefore require Internet facilities to function. In fact, the Internet services must be one that is reliable, affordable, and fast. These findings are corroborated in the studies by [5,14], that the poor internet facilities play a crucial barrier to the uptake of e-Procurement technologies by construction stakeholders.

The study by [8] in Kenya showed that a reliable internet service provider is a crucial component in the execution route of e-Procurement systems. The challenge of slow internet connection is also visible among users of cloud computing technologies in the Nigerian construction industry [27]. In the study by [14], they noted that despite the diffusion and large population of internet users in the Nigerian environment, the internet services are rather on the low side. Currently, there are very few internet providers supplying Internet services to the population of over 190 million Nigerians. The Internet services are also very limited and restricted to urban cities and relatively very high to maintain by the users in terms of high monthly data subscription. For the success of e-Procurement in the construction process, there is a need for adequate investments in the internet infrastructure. Construction firms that want to adopt e-Procurement technologies must therefore subscribe to the best internet provider because the use of e-Procurement systems can only exist or function via internet facilities.

Table 6. Critical success factors for the adoption of e-Procurement technologies.

Critical Success Factors (CSFs)	Mean Score	Std. Deviation	Ranking Index	Remark
Availability of reliable, affordable and fast Internet services	4.00	1.12	1st	Very High Influence
Availability of reliable ICT Infrastructure	3.92	1.13	2nd	High Influence
Availability of skilled personnel to handle e-Procurement tools and processes	3.92	1.08	2nd	High Influence
Constant power supply	3.92	2.25	2nd	High Influence
Knowledge of the benefits of e-Procurement use	3.91	1.04	5th	High Influence
Effective change management plan and training of all the stakeholders	3.91	1.50	5th	High Influence
High level of computer literacy among construction stakeholders	3.90	1.09	7th	High Influence
Confidentiality in e-Procurement transactions	3.89	1.89	8th	High Influence

Table 6. Cont.

Critical Success Factors (CSFs)	Mean Score	Std. Deviation	Ranking Index	Remark
Security and authentication of e-Procurement transactions	3.85	1.09	9th	High Influence
Top management commitment and support to e-Procurement adoption	3.84	1.07	10th	High Influence
Availability of affordable e-Procurement tools and applications	3.79	1.17	11th	High Influence
High level of trust on e-Procurement technology by industry stakeholders	3.76	1.17	12th	High Influence
High level of awareness of e-Procurement in the construction industry	3.73	1.13	13th	High Influence
Ease of use of e-Procurement tools, applications and processes	3.73	1.10	13th	High Influence
Compatibility of e-Procurement with the existing procurement processes	3.72	2.23	15th	High Influence
Acceptance of the legality of electronic contracts	3.71	2.21	16th	High Influence
Government support for e-Procurement adoption	3.71	2.28	16th	High Influence
Interoperability of e-Procurement software packages, applications and systems	3.70	1.06	18th	High Influence
Existence of supportive e-Procurement policies and legislation	3.66	1.15	19th	High Influence
Employees' commitment to success of adoption	3.62	1.06	20th	High Influence
Existence of a uniform standard for describing, displaying and specifying construction materials, works and services	3.62	1.10	20th	High Influence

The study sought further to classify and reduce the CSFs in order to understand the similarities and characteristics of the factors. Extraction was performed using principal component analysis on the 21 CSFs.

The scree plot in Figure 6 helped to identify the number of components to be considered in the principal component analysis by retaining those above the elbow in the line plot. In Figure 6, it is noted that the direction of the scree plot differs after the third component. This is also confirmed in Table 7, which showed the total variance explained a three-component solution in the component transformation matrix.

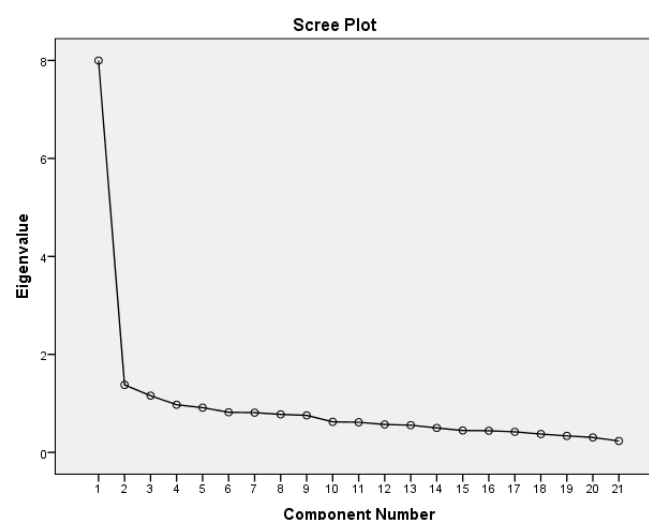


Figure 6. Scree plot of critical success factors for adoption of e-Procurement systems.

From Table 7, a cumulative variance of 50.2% variance was explained where factor 1 contributed 38.1% variance, factor 2 contributed 6.6% variance, and factor 3 contributed 5.5% variance after extraction. The study specified a factor cut-off point of 0.45. From this, the three-factor components were presented in Table 8. Table 8 presented the rotated component matrix of the critical success factors (CSFs) for adoption of e-Procurement systems in the construction industry. The three-factor components were titled management support for physical infrastructure, and human factors and characteristics of the technology. By this, the aim of the principal component analysis was fulfilled by classifying and reducing the 21 CSFs identified into 3 components and 20 factors. The first component which explained a variance of 38.1% is titled management support in the provision of the physical infrastructure needed for the success of e-Procurement systems in the construction industry. The number and nature of variables loaded on this factor as shown in Table 8 did not come as a surprise. This is simply because the availability and accessibility as well as type and quality of physical infrastructure, such as Internet facilities, e-Procurement tools, and application, ICT infrastructure in terms of hardware, skilled personnel, and power supply in any organization is a function of top management attitude towards the use of such facilities and its readiness to invest in their acquisition. In the same vein, the level of awareness of e-Procurement technologies amongst staff members is also partly a function of the quality of IT savvy personnel recruited and the type of in-service training they are exposed to within the organizations. These issues are mainly within the purview of top management of firms and organizations in terms of policies and strategic decisions; and are essential components that should be put in place for effective deployment and sustained use of e-Procurement tools, technologies, and processes. According to [28], these CSFs can be regarded as organizational related factors and constitute a barrier to the adoption of e-Procurement by construction stakeholders. This infrastructure needs management support due to the high financial commitment in the short-term needed to put them in place. This finding is supported by [26], in that lack of upper management support and lack of access to IT infrastructure were major barriers among contracting firms in Northern Ireland.

Table 7. Component transformation matrix on the CSF for e-Procurement adoption.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.997	38.081	38.081	7.997	38.081	38.081	3.763	17.920	17.920
2	1.378	6.563	44.643	1.378	6.563	44.643	3.515	16.740	34.660
3	1.158	5.512	50.156	1.158	5.512	50.156	3.254	15.496	50.156
4	0.972	4.630	54.786						
5	0.913	4.348	59.134						
6	0.819	3.899	63.033						
7	0.812	3.865	66.898						
8	0.775	3.691	70.589						
9	0.756	3.600	74.190						
10	0.623	2.967	77.156						
11	0.615	2.931	80.087						
12	0.571	2.717	82.805						
13	0.555	2.642	85.447						
14	0.499	2.378	87.824						
15	0.446	2.125	89.950						
16	0.442	2.105	92.054						
17	0.419	1.997	94.051						
18	0.375	1.786	95.836						
19	0.337	1.603	97.440						
20	0.305	1.454	98.894						
21	0.232	1.106	100.000						

Extraction Method: Principal Component Analysis.

Studies by [29,30] showed that a major constraint to construction firm's integration of ICT with their procurement process was the inability to access a friendly and technically sound e-Procurement system at the right price. Another major impediment in physical infrastructure is constant power supply as reported in [17], sadly, it is still an issue [12].

Table 8. Rotated Component Matrix ^a on CSFs for the adoption of e-Procurement systems.

Critical Success Factors		Component		
		1	2	3
Management Support for Physical Infrastructure	Availability of reliable, affordable and fast Internet services	0.780	0.261	0.208
	Availability of reliable ICT Infrastructure	0.764	0.221	0.174
	Availability of affordable e-Procurement tools and applications	0.727	0.288	0.206
	Availability of skilled personnel to handle e-Procurement tools and processes	0.579	0.337	0.343
	Constant power supply	0.558	0.078	−0.027
	Top management commitment and support to e-Procurement adoption	0.540	0.268	0.415
	Interoperability of e-Procurement software packages, applications and systems	0.499	0.272	0.474
	High level of awareness of e-Procurement in the construction industry	0.491	0.277	0.432
Human Factors	Knowledge of the benefits of e-Procurement use	0.310	0.736	0.114
	High level of computer literacy among construction stakeholders	0.351	0.678	0.101
	High level of trust on e-Procurement technology by industry stakeholders	0.210	0.654	0.308
	Employees' commitment to success of adoption	0.163	0.652	0.284
	Existence of a uniform standard for describing, displaying and specifying construction materials, works and services	0.112	0.588	0.367
	Effective change management plan and training of all the stakeholders	0.241	0.546	0.023
Characteristics of the Technology	Security and authentication of e-Procurement transactions	0.293	0.272	0.623
	Ease of use of e-Procurement tools, applications and processes	0.288	0.307	0.591
	Acceptance of the legality of electronic contracts	0.017	0.114	0.589
	Existence of supportive e-Procurement policies and legislation	0.137	0.461	0.563
	Confidentiality in e-Procurement transactions	0.154	0.080	0.510
	Compatibility of e-Procurement with the existing procurement processes	0.201	−0.042	0.507

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

^a Rotation converged in 6 iterations.

Crucial to the provision of all this ICT infrastructure is management support and commitment. This suggestion is in line with [18] that those that would mostly adopt e-Procurement systems are those construction firms whose senior management supports the use of e-Procurement systems and have an encouraging attitude towards aligning with the current global trend on e-Procurement use in construction works. It is important to note that for the success of e-Procurement adoption in the construction industry, all the infrastructure to ensure seamless operation must be reliable and affordable. The imperceptible aspect of this factor is the need to still increase awareness of e-Procurement use and benefits in the construction industry. Even though there may be resistance to

change, the top-to-bottom approach can be adopted, whereby increased management support can filter down to other construction staff.

The second component, human factors, explained 6.6% variance. In this component, several issues that revolve around the users of e-Procurement technologies and character of the users are highlighted. The major variable that explains the other components is the knowledge of the benefits of e-Procurement use in the construction industry. This can be related to the Technology Acceptance Model (TAM) theory which describes how employees believe the innovative tool will improve their productivity on the job. This theory places emphasis on the importance of the fact that how users feel (human behavior) towards a particular tool will determine if they adopt a technology or not.

Studies from [31,32] showed the underlying significance of considering professional's attitude and self-efficacy in the adoption of ICT tools. Another important human factor is the skill possessed by the professional to handle the ICT tool, this was shown in the study by [33]. The users' characteristics explained in this section will ensure that the items in component 1 are successful. These users' behavioral components include knowledge, literacy, trust, commitment, uniform standard, change management, and training. Notable among the variables loaded under this second factor is the existence of a uniform standard for describing, displaying and specifying construction materials, works, and services. The emergence of this under human factor is understandable because standards are created by human beings based on the existing cultural, social, economic, and technological norms locally and globally. Consequently, the essence of standards is to have a unified and generally accepted criteria or parameters for describing the characteristics of tangible and intangible entities amongst people. The implication of this finding is that in order to increase the adoption of e-Procurement systems in the construction industry, there is a need for entrenched understanding of common parameters for describing, displaying, and specifying construction materials, works, and services as well as the benefits of e-Procurement systems. Driving up the adoption of e-Procurement systems means that the users of e-Procurement systems must be computer literate and able to operate the e-Procurement environment. Users should develop high trust for the system that it is able to deliver on the benefits attached to them. Once a construction company accepts the adoption of e-Procurement systems, there should be adequate commitment from the employees to use the new system. However, there may be some resistance to the new technology, therefore, construction firms must put in place an effective change management plan and training of all the stakeholders involved in the procurement process.

The third component, characteristics of the technology, explained 5.5% variance in the critical success factors for the adoption of e-Procurement systems investigated in this study. This component explain that users of e-Procurement technologies are concerned with characteristics such as security, ease of use, legality, supportive systems, confidentiality, and compatibility of e-Procurement systems. This finding is also supported by the Rogers' Diffusion of Innovation (DOI) theory of 1995. Specifically [34], DOI theory noted that there are perceived attributes of an innovative tool or technology that would encourage or discourage its adoption by firms/individuals. Moreover, [25] emphasized three attributes of relative advantage, compatibility and simplicity as major contributors to the adoption of e-Procurement tools and technologies. Developers of e-Procurement technologies should ensure that these characteristics are of the highest standard while ensuring user friendliness of the system.

5. Conclusions and Recommendations

The study evaluated the CSFs for successful adoption of e-Procurement systems in the Nigerian construction sector. The study revealed the distribution of the actual users of e-Procurement technologies in the Nigerian construction industry. Further analysis showed the organizational proponents in the use of e-Procurement systems with a low participation of the public sector in the innovative tool. An assessment of the duration of e-Procurement use revealed that most Quantity Surveyors have been exposed to the use of e-Procurement technologies for over 10 years. A large

proportion of the construction stakeholders picked up the use of the technology mostly within the last 5 years. The study revealed that construction stakeholders perceive the availability of reliable, affordable and fast Internet services as the most critical success factor for the adoption of e-Procurement technologies. The critical success factors (CSFs) were further classified into management support for physical infrastructure, human factors, and characteristics of the technology. The study showed that these critical success factors (CSFs) are crucial for the adoption of e-Procurement systems in the Nigerian construction industry. For technological sustainability within construction firms, the identified CSFs in this study should be considered. The study recommendations are as follows:

- For e-Procurement technologies to adequately permeate the fabrics of the Nigerian construction industry, there is still the need for increased awareness of the e-Procurement tools and technologies and the benefits that are accrued from its use. This is mostly essential among government departments, agencies, and ministries. This can be achieved through continuous professional trainings via the professional bodies, construction trade fairs, and public enlightenment through seminars.
- Having highlighted the critical success factors (CSFs), construction firms should put in place mechanisms that can help measure the metrics of physical ICT infrastructure provision. This will in turn result in generating company policies that guide the adoption of innovative tools in the construction process.
- Since e-Procurement systems are heavily dependent on Internet services, adequate internet infrastructure needs to be attracted to the country for the successful integration of e-Procurement technologies.
- Government needs to play a crucial role in providing the necessary ICT infrastructure and providing the leadership role in using e-Procurement technologies in their public procurement process.

This study's contribution to knowledge is manifested in identifying the actual users of e-Procurement in the Nigerian construction industry. It also uncovers specific areas where attention is needed to ensure heightened uptake of e-Procurement in the Nigerian construction industry, leading to maximizing its benefits in the procurement of construction materials, works, and services in this country. Findings of this study are therefore expected to add to the growing literature on e-Procurement in construction from the perspective of a developing country.

Author Contributions: The professional background of each author contributed to the data collection from each sector being part of the Building Informatics Research Cluster. E.I. conceived the idea, while A.A. put together the article. E.A. and O.O. were involved in the data coding. A.A., E.I. and P.T.-O. performed the data analysis. E.I. reviewed the article for final submission.

Funding: This research was funded by Covenant University Centre for Research, Innovation and Discovery (CUCRID), Covenant University through the grant number CUCRID RG14.12.14/FS to the Building Informatics Research Cluster, which made this research possible and the APC.

Conflicts of Interest: The authors declare no conflict of interest.

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