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Electronic (e-) Procurement Adoption and Users' Experience in the Nigerian Construction Sector

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ABSTRACT

The adoption of e-Procurement in construction is gaining global acceptability, but in a developing country like Nigeria, there is a paucity of studies on the e-Procurement tools/applications used by construction industry stakeholders and their experiences with this technology. This study investigated e-Procurement adoption and users' experience with it in the Nigerian construction industry using a questionnaire survey of 759 users of e-Procurement. The data were analyzed using descriptive statistics and factor analysis and the results show that whereas relatively high usage of e-Procurement tools in sending and receiving information on tender opportunities, tendering, and making and receiving payments for construction procurement transactions was observed, the use of this technology in monitoring the progress of work on construction sites or tracking the movement of materials was very low. It was also observed that users' experience with e-Procurement in Nigeria was influenced by the adequacy and reliability of Internet infrastructure and ease of use of the technology, operational environment, change management issues, benefits of the technology, and the availability, accessibility, and interoperability of e-Procurement systems. The study implies that in order to ensure sustained use of e-Procurement in Nigeria's construction sector, adequate attention should be given to these factors that influence users' experience.

KEYWORDS

Adoption; construction industry; e-Procurement; Nigeria; survey; users' experience

Introduction

The adoption of e-Procurement in supply chain management is no longer new in the different industrial sectors across the world. The construction sector is considered a late adopter of e-Procurement when compared to its counterparts such as manufacturing and retail business (Laryea & Ibem, 2014), but the literature (Daud, Mohammad, Azmi, & Mohamed, 2013; Eadie, Perera, & Heaney, 2010, 2011; Eadie, Perera, Heaney, & Carlisle, 2007; Ibem & Laryea, 2015; Issa, Flood, & Caglasin, 2003; Rankin, Chen, & Christian, 2006; Zuo & Seo, 2006) has copious evidence indicating that the construction industry has been making steady progress in e-Procurement adoption. e-Procurement is an aspect of e-Commerce that involves the use of Internet-supported information and communication technologies and processes to carry out procurement activities such as sending/receiving information on tender opportunities, submission of tenders/bids, award of contracts,

sourcing for materials/equipment and payment for goods and services (e-Payment) and others (Farzin & Nezhad, 2010; Gunasekaran & Ngai, 2008; Ibem & Laryea, 2015). Put succinctly, it is the use of the Internet to support the execution of procurement tasks (Farzin & Nezhad, 2010; Hashim, Said, & Idris, 2014; Nawi, Deraman, Bamgbade, Zulhumadi, & Riazi, 2017; Teo, Lin, & Lai, 2009).

Aranda-Mena (2004) observed that several authors have examined a wide range of issues related to the use of e-Procurement in the formation and execution of construction contracts in the different countries. For examples, studies have been conducted in the USA (Issa et al., 2003), Australia (Zuo & Seo, 2006), Canada (Rankin et al., 2006), the UK (Eadie et al., 2010, 2011, 2007), South Africa (Ibem & Laryea, 2015) and Malaysia (Hashim et al., 2014; Nawi et al., 2017) on the levels of adoption of e-Procurement in construction. Yet other studies have explored the benefits (Eadie et al., 2010, 2007; Farzin & Nezhad, 2010; Nawi et al., 2017) and barriers to the uptake of e-Procurement in construction in the different countries (Eadie et al., 2010; Isikdag, 2019; Isikdag, Underwood, Ezcan, & Arslan, 2011; Nawi et al., 2017; Zunk, Marchner, Uitz, Lerch, & Schiele, 2014). Aggregate findings of these studies have contributed to improving understanding of the level of adoption of e-Procurement, its benefits, and the barriers associated with the uptake of e-Procurement outside the Nigerian construction environment. However, in Nigeria, Oyediran and Akintola (2011) investigated e-Tendering; Bello and Iyagba (2013) and Aduwo, Ibem, Tunji-Olayeni, Uwakonye, and Ayo-Vaughan (2016) examined the barriers to the adoption of e-Procurement; Ibem, Aduwo, Tunji-Olayeni, Uwakonye, and Ayo-Vaughan (2016) investigated the factors that influenced the adoption, while Aduwo, Ibem, Ayo-Vaughan, Uwakonye, and Owolabi (2017) assessed the level of use of e-Procurement in the Nigerian building industry, respectively. Recently, Afolabi, Ibem, Aduwo, Tunji-Olayeni, and Oluwunmi (2019) uncovered the factors that facilitate the adoption of e-Procurement in the Nigerian construction industry. It is however observed that apart from the studies by Oyediran and Akintola (2011) and Afolabi et al. (2019) that focused on the Nigerian construction industry as a whole, the other published works on e-Procurement in Nigeria are on the building industry, which is a sub-set of the construction sector. Furthermore, to the best of our knowledge, none of the existing studies have examined the various dimensions of users' experience with e-Procurement in construction, particularly in Nigeria, the largest economy in Africa. Consequently, our knowledge of the various e-Procurement tools/applications and processes used by construction industry stakeholders and their experiences with this technology in the Nigerian construction environment is very limited.

In view of the foregoing, the current study sought to investigate e-Procurement adoption and users' experience with this in the Nigerian construction industry. Two basic objectives were pursued in this study. They are 1) to identify the various e-Procurement technologies and tools stakeholders in the Nigeria construction sector use to execute some specific construction procurement activities and 2) to examine the various dimensions of users' experience with e-Procurement in construction in the study area. The current study is based on a cross-sectional survey of 759 users of e-Procurement technology in the Nigerian construction industry. Hence, the study makes contribution to knowledge by improving understanding of the various e-Procurement tools and applications stakeholders in the Nigerian construction environment use and their experiences with these tools and applications in the procurement of construction projects. It also adds to the existing body of knowledge on the specific areas that need more attention to ensure sustained and industry-wide use of e-Procurement in construction business leading to the

maximization of its benefits in the procurement of construction projects in Nigeria and other developing countries who share the same experience with Nigeria in the use of e-Procurement in construction.

Review of literature

e-Procurement in construction activities

Although there are several definitions of e-Procurement in the published literature as noted by Vitkauskaite and Gatautis (2008) and Aduwo et al. (2017), in the context of this study, e-Procurement refers to the use of Internet-supported or web-based/tools/applications and processes to support the execution of construction procurement activities, including the acquisition of construction works, services, materials, and equipment. Gunasekaran and Ngai (2008) have described e-Procurement technology as consisting of tools that facilitate the acquisition of goods or services over the Internet. On their part, Oyediran and Akintola (2011) described e-Procurement technologies as e-tools that can be used at the different stages of construction projects to execute different tasks such as obtaining design brief from clients, sending/receiving tender notification, preparation of tenders, production of contract drawings, contract formulation, tendering, distribution of contract drawings, interaction with professionals and making/receiving payments. It was on this premise that some authors (Grilo & Jardim-Goncalves, 2011; Ibem & Laryea, 2015) concluded that e-Procurement technologies are web/Internet-enabled/supported tools, software packages/applications or processes that aid in data generation, storage, handling, display, and transmission as well as engender interaction, integration, and collaboration amongst people, equipment, and processes in construction procurement activities. The specific examples of e-Procurement tools and technologies as identified in previous studies (Gunasekaran & Ngai, 2008; Ibem & Laryea, 2015) include e-mail, website, web portals, intranet, extranet, Electronic Data Interchange (EDI), Videoconference, web-supported software applications (e.g., BIM, CAD) and customized e-Procurement software packages and systems and several others.

The review of published literature reveals that a number of studies on e-Procurement in construction business have been carried out both in the developed and developing countries. For example, in the developed countries, a study on the level of use of e-Business in construction project management activities amongst 91 contractors in the US was conducted by Issa et al. (2003). That study reported that whereas around 80.0% of the contractors used e-Mails and fax, 70.0% used project management software applications, 65.0% used Extranet/Intranet, 60% used the Internet, while others used electronic data interchange (EDI) to support the exchange of construction project information and data. In Australia, Zuo and Seo (2006) reported that (100.0%), 37.0% and 30.0% of the 127 respondents sampled in a survey used e-Mail, Intranet and Extranet, respectively, to carry out activities such as online searching and ordering of construction materials/equipment, exchange construction drawings, project management, and sending/receiving tenders. Eadie et al. (2011) also found that amongst government and private sector organizations in the UK construction sector, most construction procurement tasks were executed electronically on write-once CD and that private organizations were at that time lagging behind government institutions in the use of e-Procurement in that country. In Austria,

Zunk et al. (2014) revealed that most of the 100 construction firms sampled were not using e-Procurement frequently and that the potential benefits in cost reduction had not been fully realized in that country. Notably, the studies by Issa et al. (2003), Zuo and Seo (2006) and Zunk et al. (2014) were focused on contracting firms and excluded other categories of construction industry stakeholders in those countries, and thus the findings cannot be generalized.

In the developing countries, Ibem and Laryea (2015) carried out an online survey of 603 stakeholders in the South African construction sector and found e-Mail, static websites, Web 2.0 technologies and portals as the main e-Procurement tools and applications used. The authors reported that around 12.0% of the respondents used e-Procurement to send or receive information on tender opportunities, 83.0%, 22.0%, 20.0%, and 11.0% used e-Mails, Web 2.0-based systems, websites, and cloud-based applications, respectively, to exchange construction project information and data. In southwestern part of Nigeria, Oyediran and Akintola (2011) examined the use of e-Tendering among 66 respondents, including architects, contractors, engineers, quantity surveyors, and contractors. The authors found that many of the respondents used e-Mails, websites, and portals to exchange contract documents, receive or send information on tender opportunities, prepare contract documents and tenders, while the use of e-payment systems was very low. That study was based on a small sample of construction industry stakeholders in Nigeria and only e-Tendering-an aspect of e-Procurement was investigated and as such the findings cannot be considered as a true reflection of e-Procurement use in the Nigerian construction industry. In another study, Ibem et al. (2016) investigated the factors that influenced the adoption of e-Procurement in building projects delivery and reported that the characteristics of e-Procurement technology, size of firms, and the influence of firms outside the building industry were among the key factors that influenced the use of e-Procurement in the delivery of building projects. Aduwo et al. (2017) also revealed that most of the 213 respondents sampled in the building construction sub-sector of Nigeria were using e-Mail to announce or receive information on call for tenders/request for quotations and exchange project briefs/specifications as well as in submitting/receiving tenders/proposals/expression of interest. They also reported the use of static websites and e-Catalogs in sourcing and placing orders for building materials and equipment and wide spread of e-Payment systems in making or receiving payments for building procurement-related transactions. Notably, the studies by Ibem et al. (2016) and Aduwo et al. (2017) were limited to e-Procurement use in the delivery of building projects and did not consider other forms of construction projects. Moreover, they did not investigate users' experience with e-Procurement in building projects delivery in Nigeria. Although a most recent study by Afolabi et al. (2019) focused on the critical success factors for e-Procurement adoption in the Nigerian construction industry, it did not investigate the specific e-Procurement tools used to support the execution of construction procurement activities and users' experience with this technology in the Nigerian construction environment.

From the foregoing review, it is evident that a number of studies have investigated several issues related to e-Procurement technologies, tools, and applications outside the Nigerian construction environment. Worthy of note is the finding on massive use of e-mails, web portals, and websites in construction procurement activities in the different countries. However, in Nigeria, few of the existing studies are focused on e-Procurement use and the factors influencing its adoption in the building industry, and thus their findings are considered inconclusive as they are limited to a sub-sector of the construction

industry. It is observed that except the studies by Oyediran and Akintola (2011) and Afolabi et al. (2019), research on e-Procurement use in the entire construction sector of Nigeria is very limited; hence, there is a need for a study that captures all the sub-sectors of the Nigerian construction industry.

Users' experience with e-Procurement in construction

In the literature, user experience generally refers to peoples' perception of a product, service, or process in terms of its value, ease of use and efficiency in meeting their needs and expectations. It is a subjective assessment of an individual's perception and thought about a product, service, and process that he/she engages with in the course of performing a task. Sandler (2015) explained that users of products and services would always demand and expect ease of use and functionality of products and services they have acquired, and if they realize that a product or service is not helping them achieve their goal, they may become frustrated and look for alternatives. This suggests that among several factors, it is user experience that makes people to prefer one product or service to another. Hence, specialists in human interactions with technologies and tools have concluded that the most important factor that makes people use a particular technology, tool, application, or process is user experience.

Although no published research article on users' experience with e-Procurement in construction was identified by the authors, it can be inferred from the existing studies that users' experience with e-Procurement in construction can be viewed from the perspectives of the benefits associated with its use and barriers that inhibit its widespread adoption in the delivery of construction projects. As it relates to benefits, authors (Eadie et al., 2010; Ibem & Laryea, 2015) have reported that users of e-Procurement in the UK and South Africa, respectively, have, on the one hand, experienced a reduction in transaction cost and time, improvement in the efficiency of procurement process and elimination of geographic barriers in participation in construction procurement business. Other studies (Aduwo et al., 2017; Ibem & Laryea, 2015) have also reported a significant reduction in paperwork and manual human efforts in the use of e-Procurement in construction. On the other hand, the barriers to critical mass uptake of e-Procurement have been linked to resistance to change (Aranda-Mena, 2004; Bello & Iyagba, 2013; Ibem & Laryea, 2015; Rankin et al., 2006), low level of awareness and knowledge of the technology (Aranda-Mena, 2004; Ibem & Laryea, 2015) and the lack of confidence in the technology by people in the construction industry (Aduwo et al., 2016; Eadie et al., 2010). Others are lack of flexibility, high cost of Internet services and exclusion of firms that do not have access to Internet services (Aduwo et al., 2016; Ibem & Laryea, 2015), noninteroperability of e-Procurement software packages and systems (Aduwo et al., 2016; Eadie et al., 2007; Ibem & Laryea, 2015), insecurity of data and lack of confidentiality of information in electronic transactions (Eadie et al., 2007; Ibem & Laryea, 2015; Rankin et al., 2006) and others.

From the foregoing, it is evident that previous studies have examined both the benefits of using e-Procurement and the barriers (i.e. factors or situations) that prevent its adoption by stakeholders in the construction sectors of the different countries. However, none of the existing studies specifically investigated the various dimensions of users' experience with e-Procurement in construction, particularly, in a developing economy like Nigeria. As a result, there is little understanding of the various aspects of users' experience that need attention to ensure sustainability in the use of e-Procurement in construction. This is part of the gap the current study attempted to fill.

Research methodology

The research design used in this study was a cross-sectional survey involving construction industry stakeholders, including architects, builders, engineers, quantity surveyors, construction/project managers, estate/facilities managers) and nonprofessionals like contractors, supply chain managers/procurement officers, construction materials/equipment vendors, and others (e.g., ICT officers) in Nigeria. The data gathering instrument used was a structured questionnaire designed by the researchers. The questionnaire had three sections A, B, and C. Section A had questions on the profiles of participants in the research, while Section B had questions on the predominant e-Procurement tools/applications they use to perform specific construction procurement activities. In order to identify the actual users of e-Procurement, the participants in the survey were asked to indicate if they have been involved in construction projects that required the use of any form of e-Procurement by ticking Yes or No options. Those who indicated that they were users were further asked the pick from several options the main e-Procurement tools and applications they have used to support the execution of specific construction procurement activities. Section C of the questionnaire helped the researchers to collect data on the experiences of users of e-Procurement in the Nigerian construction environment. In measuring users experience, the participants were asked to show the extent to which they agree or disagree with 20 statements related to the benefits and challenges of e-Procurement in construction as reported in the literature (Aduwo et al., 2016; Eadie et al., 2010, 2007; Ibem & Laryea, 2015). The scale of measurement used was 5-point Likert type scale of starting with 1 = Strongly Disagree and ending with 5 = Strongly Agree and 0 = No Response. Reliability of the scale of measurement used for the 20 items was investigated using Cronbach alpha reliability test, which gave a value of 0.8. This is greater than the acceptable value of 0.7 as recommend in research literature (see Pallant, 2011).

In view of the fact the population of stakeholders in the Nigerian construction sector is large and the actual number of users of e-Procurement in this sector is not known, the researchers assumed a maximum variability of the user population in the country. Therefore, in order to determine the minimum sample size for the survey, an extant formula developed by Cochran (1963) presented in Equation 1 was used.

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

In using the formula, the $p = .5$, i.e., the maximum variability at 95.0% confidence level and q represented by $(1 - p)$. Therefore, the minimum sample size was 385 construction stakeholders. The following main urban centers in each of the six geopolitical zones of Nigeria, namely, Kaduna (Northwest), Abuja (Northcentral), Lagos and Ibadan (Southwest), Port-Harcourt and Uyo (Southsouth) and Owerri and Enugu (Southeast) (Northcentral, Northeast, Northwest, Southeast, Southsouth and Southeast) were purposively selected for the physical administration of the questionnaire. For the Northeast, where there are security challenges and other cities that the researchers and recruited research assistants could not visit, e-mail was used in the administration and retrieval of the questionnaires.

In selecting participants, a multi-stage sampling technique was applied. First, purposive sampling method was used in selecting only those involved in the procurement of works,

services, and materials/equipment in the Nigerian construction sector. Second, random sampling method was used to select participants in firms/organizations involved in construction procurement activities in the selected cities. The survey was conducted in Nigeria between November 2017 and August 2018. Although 1750 hard copies of the questionnaire were administered to construction stakeholders in the aforementioned cities by hand and 250 copies via e-mail attachments, a total of 1100 questionnaires administered were retrieved. However, 1092 representing around 55.0% of the total questionnaires sent out by the researchers and recruited researcher assistants were found to have been correctly filled and were subsequently included in the analysis.

The data were subjected to descriptive statistics and factor analyses. The former was used to compute the frequencies and percentages to show the distribution of the participations according to their profiles and the different e-Procurement tools and applications they use. In addition, mean and standard deviations of the participants' responses on the 20 statements used to assess their experiences with e-Procurement were also computed. Several authors (Aduwo et al., 2016; Eadie et al., 2010; Ibem & Laryea, 2015; Isikdag, 2019; Nawi et al., 2017) had used the mean and standard deviations of participants' responses in a survey of similar nature to describe the data collected. The exploratory factor analysis with the Principal Component Analysis (PCA) and Varimax Rotation was used to extract the different dimensions the users of e-Procurement encountered in this survey understood and expressed their experience with it. The results of the analyses are presented using charts, mean scores, and tables.

Results

Profile of e-Procurement users' in the Nigerian construction environment

Participants in the survey were first asked to indicate if they have participated in construction projects that involved the use of any e-Procurement tools/applications/systems. The results reveal that although 1092 persons participated in the survey, 759 representing around 69.5% of them indicated that they have taken part in construction projects that involved the use of e-Procurement. This suggests that the remaining number are not users of e-Procurement, meaning that they are still using the traditional manual method of construction procurement. Those who indicated that they have used e-Procurement were also asked to indicate their role in the industry, type of firms/organizations, years of experience in the industry and the main areas of their firms'/organizations' construction procurement experience. [Table 1](#) shows the results for each aspect of the respondents' profile as captured in the survey.

From [Table 1](#), it can be seen that the highest percentage of those who use e-Procurement in the Nigerian construction industry encountered in the survey are quantity surveyors with 26.4% followed by architects (25.2%) and engineers (15.8%) and others. The results also show that the highest proportion (34.9%) of those who use e-Procurement in construction in the survey are employed in consulting firms, followed by those in contracting firms (31.9%) and government ministries/parastatals/institutions (22.5%) and many of them (52.8%) have more than 5 years of experience in the construction industry and most (87.1%) are involved in the procurement of building projects. These results suggest that the participants in the survey are eminently qualified to provide reliable data for the current study.

Table 1. Profiles of the participants.

Profile category	Frequency	Percent
Role in the Industry		
Quantity Surveyor	200	26.4
Architect	191	25.2
Engineer	120	15.8
Builder	69	9.1
Estate/Facilities Manager	55	7.2
Contractor	52	6.9
Construction/Project Manager	37	4.9
Supply Chain Manager/Procurement Officer	20	2.6
Others	10	1.3
Construction Materials/Equipment Vendor	5	0.5
Categories of organization employed		
Contracting firm	265	34.9
Consulting firm	242	31.9
Government Ministries/Parasatals/Institutions	171	22.5
Client Organization	58	7.6
No Response	20	2.6
Building Materials Manufacturer/Vendors	3	0.4
Length experience in the industry in years		
6-10	239	31.5
Less than 5	166	21.9
11-15	162	21.3
16-20	95	12.5
21 +	91	12.0
No Response	6	0.8
Areas construction procurement experience		
Residential Buildings	474	62.5
Nonresidential Buildings	187	24.6
No Response	36	4.7
Transportation	26	3.4
Energy	16	2.1
Telecommunication	12	1.6
Sanitation	5	0.7
Water Supply	3	0.4

E-procurement technologies and tools used in construction procurement

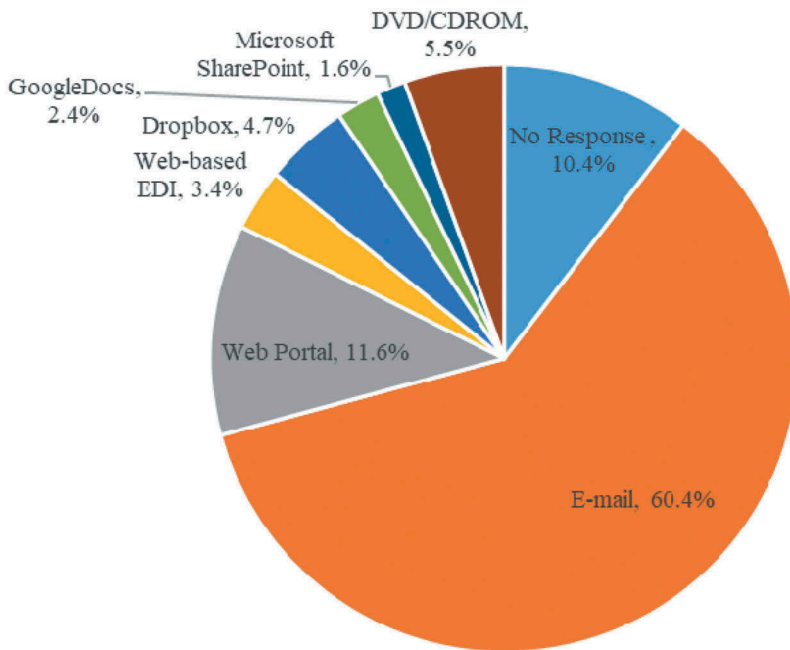
In view of the fact that organizations or individuals can use more than one e-Procurement technologies/tools/applications to support the execution of a particular construction procurement activity, the participants were also asked to indicate the predominant e-Procurement technologies/tools or applications used to send or receive information-related call for tenders/request for quotations (RFQs) at the design stage of construction projects. The results are presented in [Table 2](#).

A careful examination of the results in [Table 2](#) shows that around 40.6%, 17.8%, and 7.0% of the participants indicated that they used e-Mail, Web Portal, and Instant Messaging, respectively, to receive or send information related to call for tenders/RFQs. Regarding the predominant tools, they used to exchange construction projects information and data, the results in [Figure 1](#) also reveal that around 60.0%, 12.0%, and 5.0% of the participants indicated that they used e-Mail, web portal, and Dropbox for this purpose.

On the predominant e-Procurement tools/applications used to submit or receive bids/tenders or project proposals, the results in [Table 3](#) show that around 51.0%, 9.7%, and 3.6% of the respondents indicated that they used e-Mail, web portal, and dropbox, respectively, for this purpose.

Table 2. E-Procurement technologies and tools used for e-notification/announcing/informing.

Technologies/Tools/Applications	Frequency	Percent
E-Mail	308	40.6
Web Portal	135	17.8
Instant Messaging	53	7.0
Internet-supported Fax	45	6.0
Voice on Internet Protocol (VOIP)	36	4.7
YouTube/Facebook/Twitter	29	3.8
Web Blogs	26	3.4
Web-Based EDI	20	2.6
Webcasting	11	1.5
Online Newsletters	4	0.5
Brochure-ware Website	3	0.4
No Response	89	11.7
Total	759	100.0

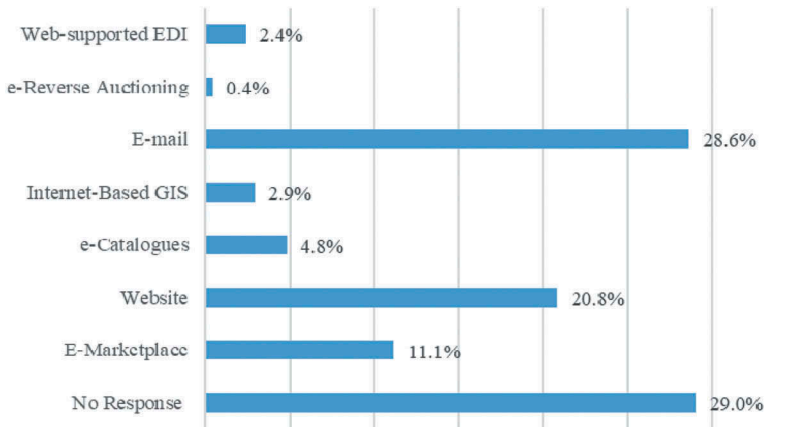
**Figure 1.** Tools and applications used to exchange project information/data.

Again, regarding the predominant e-Procurement tools/applications used to search and place orders for construction materials and/or equipment, the results are shown in [Figure 2](#).

The results in [Figure 2](#) reveal that around 29.0% of the participants were not actually involved in placing orders for construction materials or equipment electronically, but around 28.6%, 20.8%, and 11.1% of those who were involved indicated that they mainly used e-Mail, websites, and e-Marketplaces, respectively, for this purpose. Related to this are the results in [Figure 3](#), which show that the predominant e-Payment systems used to make or receive payments for construction works, services materials, or equipment by 52.8% of the participants in the survey was electronic fund transfer (EFT).

Table 3. E-tendering technologies/tools/applications used.

Tools and Applications/System	Frequency	Percent
E-mail	387	51.0
Web Portal	74	9.7
Dropbox	27	3.6
Web-based EDI	14	1.8
Micro-Soft SharePoint	10	1.3
Oracle	5	0.7
SAP B2B 2.0	5	0.7
Ariba	4	0.5
Alibaba	4	0.5
IBM Emptoris	2	0.3
No Response	227	29.9
Total	759	100.0

**Figure 2.** Technologies/tools/applications for e-ordering.

The last set of e-Procurement tools/applications investigated in the survey are those used to monitor or track the movement of materials or progress of work on construction sites. The responses to the question on the predominant e-Procurement tools/applications used in executing this aspect of construction procurement activities are presented in Table 4. The results in Table 4 reveal that around 20.2%, 10.9%, and 8.6% of the respondents indicated that they use web-based project management software, web-based BIM technology, and Internet-supported project camera, respectively, for this purpose. These suggest that around one-half of the users of e-Procurement in the Nigerian construction sector are not really tracking or monitoring the progress of work in construction sites electronically.

Users' experience with e-Procurement in construction

In addressing the second objective of the study, the participants were also asked to indicate their level of agreement/disagreement with 20 statements describing their possible experience with the use of e-Procurement in the Nigerian construction environment. The results as presented in Table 5 reveal that all the 20 items investigated except the 'adequacy of construction industry stakeholders' level of knowledge of e-Procurement' have a Mean Score (MS) of less than 3.0. This means that the participants are in agreement with the

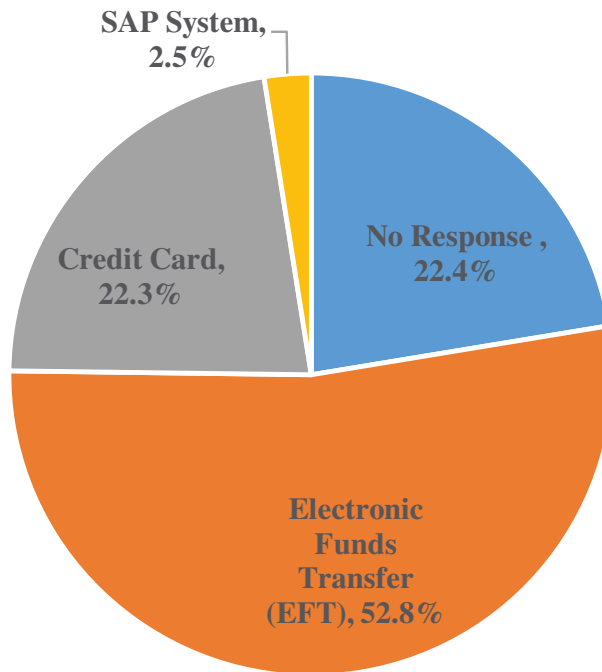


Figure 3. E-Payment technologies/tools/applications used.

Table 4. Tools and applications used to monitor the progress of work in construction sites.

Technologies/Tools/Applications	Frequency	Percent
Not Used	392	51.7
Web-supported project management software	153	20.2
Web-based BIM technology	83	10.9
Internet-supported project camera	65	8.6
Web-based multimedia technology	53	7.0
Laser distance and ranging technology (LADAR)	13	1.7
Total	759	100.0

statements describing the speed, reliability, security, lower cost of transaction associated with e-Procurement use as well as the availability, adequacy, the accessibility and reliability of the technology, Internet facilities and good public policies on e-Procurement as well as the acceptability of electronic contracts in Nigeria. In addition, the results also show that they were also in agreement with the statements related to the following issues (i) high cost of Internet services, (ii) lack of flexibility and interoperability of e-Procurement systems, (iii) the difficulties people in the industry face in adapting and switching to e-Procurement systems and tools, (iv) in transitioning from paper-based procurement method to e-Procurement system, (v) authenticating of documents submitted, and (vi) signing of construction contracts electronically.

To identify the various dimensions of the users' experience with e-Procurement in construction, the 20 items investigated were subjected to exploratory factor analysis. Prior to this analysis, the suitability of the data set for factor analysis was investigated using

Table 5. Descriptive statistics of users' experience with e-Procurement in construction.

Users' Experience with e-Procurement in construction	N	Mean	Std. Dev.
We experience greater speed of transaction with e-Procurement	710	4.1	1.0
e-Procurement systems and processes are reliable and secure	707	3.8	2.5
There is lower cost of transaction with e-Procurement	711	3.7	1.1
We find it easy to use e-Procurement systems, tools and processes	713	3.6	1.1
Internet services in this country are expensive	709	3.6	1.2
Consultants, contractors/vendors easily respond to our requirements electronically	706	3.6	1.1
e-Procurement exclude firms that have no access to Internet from participating in construction procurement activities	705	3.6	1.2
We experience that people find it difficult to adapt and are not willing to switch over to e- Procurement systems and tools	703	3.5	1.1
We notice that the available technology and Internet facilities are adequate and reliable to support e-Procurement use in construction	716	3.4	1.2
We find it easy to integrate e-Procurement systems and tools with the existing construction procurement process in my organization	704	3.4	1.0
We find it easy to engage consultants and contractors onto e-Procurement	710	3.3	1.1
We observe that e-Procurement tools and applications are readily available and accessible in the country	702	3.3	1.2
There is no flexibility in the use of e-Procurement in carry out construction procurement tasks	704	3.3	1.1
We experience interoperability issues with e-Procurement systems/applications	689	3.2	1.0
There is a challenge in authenticating documents submitted electronically	704	3.2	1.2
We experienced some level of difficulties trying to change from paper-based procurement method to e-Procurement system in my organization	703	3.2	1.2
Electronic contracts are generally acceptable in the construction industry	699	3.1	1.1
There is good public policies that promote e-Procurement use	710	3.1	1.1
We have difficult in signing electronic contracts in my organization	690	3.1	1.7
Construction industry stakeholders have adequate knowledge of e-Procurement	710	3.0	1.1

Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy test and Bartlett's Test of Sphericity. The KMO was 0.8 which is more than the recommended 0.6 and Bartlett's Test of Sphericity was significant ($p < .05$). Consequently, the survey data were considered suitable for factor analysis.

Figure 4 shows the Scree plot of the 20 items included in the factor analysis. An inspection of the Scree plot in Figure 4 reveals that where the Scree plot produced a departure from linearity coincides with a 6-factor result, meaning that six dimensions (factors) are prominent in explaining users' experience with e-Procurement in the Nigerian construction environment.

The results in Table 6 show that accumulative percentage of variance of 56.9% was accounted for by 6 dimensions (factors) having an Eigenvalue greater than 1. The six factors show how users of e-Procurement sampled understood and interpreted their experience with the technology in construction procurement.

It is evident from the results in Table 6 that the first dimension: "adequacy and reliability of Internet Infrastructure and ease of use of e-Procurement systems/tools" accounted for around 13.3% of the total variance in the 20 items investigated and has four factors loaded on it. This is followed by 1) "cost and penetration of Internet services and lack of flexibility in the use of e-Procurement" which accounted for around 10.1% with another four variables loaded on it, 2) "operational environment of the firms" accounting for about 10.0% of the variance in the 20 variables and with four variables loaded on it and 3) change management issues contributing approximately 9.0% of the variance with three variables loaded on it. The remaining two dimensions are the "benefits

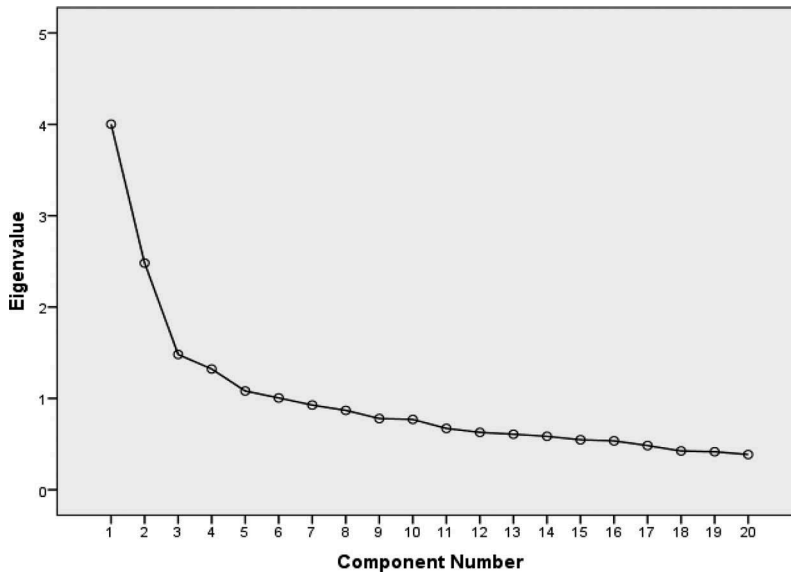


Figure 4. Scree plot of the 20 items included in the factor analysis.

of e-Procurement” responsible for about 7.7% of the variance and with three variables loaded on it, and “availability, accessibility and interoperability of e-Procurement systems and applications” accounting for around 6.8% of the variance and having two variables loaded on it.

Discussion

From the findings of this research, some key issues have been identified for further discussion in this section of the paper. First, in support of previous studies (Aduwo et al., 2017; Ibem & Laryea, 2015; Issa et al., 2003; Oyediran & Akintola, 2011; Zuo & Seo, 2006), this research reveals massive use of e-Mails in sending and receiving information on the availability of tender opportunities or RFQs. This suggests that most stakeholders in the Nigerian construction environment have been using e-Mail to send out or receive information on tender opportunities for construction works and services. This is e-Notification/Informing/Announcing aspect of e-Procurement. Similarly, evidence of the use of e-Mail, web portal, and dropbox in intra- and inter-firm exchange of construction projects data was also found (i.e., e-Exchange). This appears to be consistent with the findings of the study on the use e-Mail and web portals in the South African construction industry by Ibem and Laryea (2015) and Aduwo et al. (2017) in the Nigerian building industry. Furthermore, the survey data also reveal that a high majority of the participants (71.0%) were using different e-Procurement systems such as e-Mail and websites in placing order for construction materials/equipment (e-Ordering). This seems to provide support to findings of a previous study in Australia (Zuo & Seo, 2006) that reported extensive use of the Internet to support the acquisition of construction materials and equipment. It is also similar to the findings of the earlier studies in South Africa (Ibem & Laryea, 2015) and Nigeria (Aduwo et al., 2017; Oyediran & Akintola, 2011) showing massive use of e-Mails in placing orders for construction materials and

Table 6. Dimensions of users' experience with e-Procurement in construction.

Dimensions of Users Experience with e-Procurement in Construction	Factor loading	Eigen Value	% Variance	% Cumulative
Factor 1: Adequacy and reliability of Internet Infrastructure and ease of use of e-Procurement systems, tools		4.0	13.3	13.3
The technological and Internet infrastructure available to support e-Procurement use are adequate and reliable	0.7			
It is easy to use e-Procurement systems, tools and processes	0.8			
We find it easy to integrate e-Procurement systems and tools to the existing construction procurement process in my organization	0.7			
We find it easy to engage consultants and contractors onto e-Procurement	0.6			
Factor 2: Cost and penetration of Internet services and lack of flexibility in the use of e-Procurement		2.5	10.1	23.4
e-Procurement exclude firms that have no access to Internet from participating in construction procurement activities	0.7			
There is a challenge in authenticating documents submitted electronically	0.7			
Internet services in this country are expensive	0.7			
There is a lack of flexibility in the use of e-Procurement in construction	0.7			
Factor 3: Operational environment of the firms		1.5	10.0	33.4
Construction industry stakeholders have adequate knowledge of e-Procurement	0.7			
There is good public policies that promote e-Procurement use	0.7			
Electronic contracts are generally acceptable in the construction industry	0.6			
It is easy for consultants, contractors/vendors to respond electronically to our requirements	0.5			
Factor 4: Change management issues		1.3	9.0	42.4
We experienced difficulty in transitioning from paper-based procurement method to e-Procurement system in my organization	0.8			
We experience challenges of adaptability and willingness of our people to switch to e- Procurement systems and tools	0.8			
We have difficult in signing electronic contracts in my organization	0.6			
Factor 5: Benefits of e-Procurement		1.1	7.7	50.1
There is lower cost of transaction with e-Procurement	0.6			
There is greater speed of transaction with e-Procurement	0.6			
e-Procurement systems and processes are reliable and secure	0.8			
Factor 6: Availability, accessibility and interoperability of e-Procurement systems and applications		1.0	6.8	56.9
We experience interoperability issues with e-Procurement systems/ applications	0.8			
e-Procurement tools and applications are readily available and accessible	0.6			

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

57% of the total variance.

equipment by stakeholders in the construction sectors of these two countries. Emerging from this study is the revelation that e-Mails and websites/web portals that were extensively used in the construction industry in the developed countries in the mid-1990s are currently the predominate electronic tools for searching and placing orders for construction materials and equipment in Nigeria today. This is an indication of the rate of diffusion of e-Procurement from the developed countries into the Nigerian construction industry.

In tendering for construction projects, it was found that many of the participants also used e-Mails, while very few used web portals and dropbox to submit and receive tenders (e-Tendering/Submission). This result seems to be consistent with the findings of similar studies in South Africa (Ibem & Laryea, 2015) and Nigeria (Aduwo et al., 2017) as previously highlighted in the literature review section of this paper. This result, however, appears to be contrary to the situation in the UK, where Eadie et al. (2011) reported massive use of write-once CD for tendering for construction works. Furthermore, also in line with earlier studies in South Africa and Nigeria (Aduwo et al., 2017; Ibem & Laryea,

2015) relating to the use of e-Payment platforms is the finding in the current study indicating that there is significant use of electronic fund transfer (EFT) by the participants in the survey, which is one of the notable e-Payment platforms. Although this particular result contradicts the earlier findings by Oyediran and Akintola (2011) on non-usage of e-Payments in the Nigerian construction industry, this study has shown that there is evidence of use of e-Payment systems in the Nigerian construction industry. Further analysis of the findings reveals that although previous authors (Laryea & Ibem, 2014; Zuo & Seo, 2006) have identified the various e-Procurement systems used in monitoring the progress of work and tracking the movement of materials/equipment on construction sites, the current study clearly shows that these aspects of construction procurement activities were yet to substantially benefit from the use of e-Procurement systems when compared to the other construction procurement activities investigated in this research. This suggests that e-Tracking is not very common amongst stakeholders in the Nigeria construction industry encountered in this survey.

As it relates to participants' experience with e-Procurement in construction, this study identified six main ways users of e-Procurement in the Nigerian construction environment understood and interpreted their experiences with this technology. The first and most influential way or dimension of users' experience relates to the adequacy and reliability of Internet infrastructure and ease of use of e-Procurement systems and tools. This dimension has the highest number of factors that are related to the ease of use of e-Procurement (see Table 6). Therefore, its emergence as the first dimension did not come as a surprise. Moreover, from the diffusion of innovation theory, it is understood that one of the factors that determine the extent of diffusion and adoption of a new technology is the degree to which the adopting unit finds it easier or complex to understand and use (Rogers, 2003). Furthermore, the existing studies by Daud et al. (2013) and Ibem et al. (2016) have specifically identified ease of use as one of the factors that influenced e-Procurement use by contractors in the Malaysian construction and stakeholders in the Nigerian building industry, respectively. The second most important dimension of users' experience is related to cost, penetration of Internet services and lack of flexibility in the use of e-Procurement. Based on the factors loaded on this dimension, it is suggestive that users' experience with e-Procurement in the Nigeria construction environment in terms of cost and flexibility of use can be compared to those of their counterparts in the UK, South Africa, Malaysia, and Turkey, as reported in the previous studies (Eadie et al., 2010; Ibem & Laryea, 2015; Isikdag, 2019; Nawi et al., 2017).

The next dimension is the operational environment of the firms/organizations. This deals with the knowledge base of people in the industry on e-Procurement, existence of supportive e-Procurement policies and acceptability of electronic contracts in Nigeria. Notably, previous studies (Ibem et al., 2016; Ibem & Laryea, 2015) have identified the role operational environment of the adopting unit plays in determining the level of e-Procurement use in construction. Based on this finding, it can be inferred that users' experience with e-Procurement in construction is a function of the socio-technical and policy environment in which they carry out construction business activities. Another important dimension of users' experience is related to change management issues. In fact, several authors (Aranda-Mena, 2004; Eadie et al., 2010; Isikdag, 2019; Isikdag et al., 2011; Nawi et al., 2017; Zunk et al., 2014) have reported that the lack of effective change management strategies was responsible for the observed slow and low level of adoption of

e-Procurement in construction in many countries. This means that the nature of existing policies and programs that guide the process of transition from the use of manual method to e-Procurement systems is partly responsible for the difficulties or otherwise experienced when individuals, firms, or organizations make the first attempt to use e-Procurement to support the execution of construction procurement activities.

Again, in support of previous studies (Eadie et al., 2010, 2007; Farzin & Nezhad, 2010; Nawi et al., 2017), users of e-Procurement in the Nigerian construction environment also reported experiencing greater speed, reliability, security, and lower transaction cost. This goes to suggest that the benefits of e-Procurement in construction are not geographically bound but can be experienced by users in the different countries. Lastly, the users also reported experiences linked to issues of availability, accessibility, and interoperability of e-Procurement systems and applications. Specifically, this result is consistent with that of previous studies (Aduwo et al., 2016; Bello & Iyagba, 2013; Eadie et al., 2010; Isikdag, 2019; Nawi et al., 2017) revealing that the availability and levels of interoperability of e-Procurement systems were among the key factors that influenced users' experience with e-Procurement in construction. What this means is that although significant progress has been made in ensuring that e-Procurement systems are available and interoperable as reported by Grilo and Jardim-Goncalves (2011), users' are still experiencing interoperability challenges, with e-Procurement systems, tools/applications, especially those developed by different companies. This implies that significant effort is still needed in addressing this issue, especially, in a developing country like Nigeria.

Conclusions and recommendations

This study investigated e-Procurement adoption and users' experience in the Nigerian construction sector. Based on the findings of this research, the following conclusions are made. The first conclusion is that the predominant e-Procurement applications or tools used to support the execution of construction procurement activities in the Nigerian construction environment are e-Mail, websites, portals, web-supported project management software packages, and electronic funds transfer (EFT). The second one is that users of e-Procurement in the Nigerian construction environment have both pleasant and unpleasant experiences with e-Procurement and they understood these experiences from six main perspectives with the top three being: 1) adequacy and reliability of Internet infrastructure and ease of use of e-Procurement systems, 2) the cost and penetration of Internet services and lack of flexibility in the use of e-Procurement, and 3) the operational environment of the firms and others.

These findings have a number of implications that are noteworthy. First, the study implies that whereas there is increasing use of e-Procurement tools to disseminate and exchange construction projects information and data, place orders and make or receive payments for services, materials, and equipment, the use of e-Procurement to monitor the progress of construction works on sites or track the movement of materials/equipment (e-Tracking) is lagging behind in the Nigerian construction environment. This means that significant barriers exist in the use of these aspects of e-Procurement. Therefore, urgent steps are required to remove the barriers through massive investments in Information Technology infrastructure and skill acquisition by people in the construction industry. The role of construction educators in helping people acquire the requisite knowledge and skill on this aspect of e-Procurement cannot be overemphasized. This does not only apply

to Nigeria but to other countries such as South Africa and Turkey, where the studies reviewed in this paper show that they share similar experience with Nigeria when it comes to the use of e-Tracking systems in construction supply chain management.

Second, the study also implies that the key factors that influence users' experience with e-Procurement in the Nigerian construction industry are the six dimensions they understood and interpreted their experiences. Therefore, to ensure a critical mass uptake of e-Procurement and sustained use of e-Procurement in construction businesses, adequate attention should be given to these factors, especially, those capable of inhibiting initial uptake and sustained usage of e-Procurement. Since the previous studies reviewed in this paper show that some of the unpleasant experiences such as lack of flexibility and interoperability of e-Procurement systems and poor access and high cost of Internet services are not peculiar to Nigeria, there is a need for developers and vendors of e-Procurement systems/applications to come up with systems and tools that would enhance flexibility in the use of e-Procurement in the execution of construction procurement activities and interoperability of different brands of e-Procurement tools/applications/systems. Similarly, for developing countries, including Nigeria, where high cost and low penetration of Internet services are major impediments to initial uptake and sustained use of e-Procurement in the construction sector, policy actions and financial investments are required on the part of government and the private sector in making Internet services readily available at affordable cost to all categories of firms irrespective of their locations.

Lastly, findings of the study are limited to the bias of respondents in the survey and selected construction procurement activities: calling for tender offers/request for quotations (RFQs), submission of tenders; ordering and payment for materials and monitoring/tracking of construction works and materials/equipment. It is therefore suggested that future study can investigate the use of e-Procurement in the execution of other construction procurement activities and aspects of user experience not covered in this research.

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