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RESEARCH ARTICLE

Exploring anti-corruption capabilities of e-procurement in construction project delivery in Nigeria

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Abstract

The use of electronic (e-) procurement to support the execution of supply chain management activities in the different industrial sectors is permeating all regions of the world. However, in countries in sub-Saharan Africa where there is a significant level of corruption and unethical practices in the procurement process, there is a need for a better understanding of how e-Procurement can help to check the incidence of corrupt and unethical practices in construction project delivery. This study relied on a cross-sectional survey of 759 respondents, including architects, builders, engineers, estate/facilities managers, contractors, construction/project managers, quantity surveyors, supply chain managers and others to identify and analyse the anti-corruption capabilities of e-Procurement in construction project delivery in Nigeria. The results of the descriptive statistics, relative importance index and principal components analysis identified 18 anti-corruption capabilities in e-Procurement in construction project delivery with the three most important ones being the capability of e-Procurement to ensure good inventory management/record keeping; accountability by providing audit services trail

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and minimise direct human contacts during bidding. The key underlying dimensions of these capabilities include the advantage of e-Procurement over the traditional paper-based method; transparent bidding process and increase in competition in construction project delivery process. The findings of this study have implications, especially, on the use of e-Procurement to curb corruption in construction procurement activities.

Keywords:

Anti-corruption capabilities, Procurement, Construction project delivery, e-Procurement, Nigeria.

Introduction

One of the challenges confronting the construction industry globally is the growing incidence of corruption in the delivery of projects. In fact, Hardoon and Heinrich (2011) observed that the Transparency International classifies the procurement of public works and construction projects among the activities where the payment of bribes is very common. Although corruption is generally described as the abuse or misuse of entrusted power for private gains or benefits (Transparency International, 2013), in the context of construction, it is the abuse of assigned authority or engagement in unethical practices for personal gains at the expense of projects (Le et al., 2014). The existing studies have shown that corruption in the construction industry, manifests in different forms such as embezzlement, kickbacks, and fraud (Sohail and Cavill, 2008; Ameh and Odusanmi, 2010), collusion, nepotism, and extortion (Osei-Tutu, Badu and Owusu-Manu, 2010; Chan and Owusu, 2017) and others. These have been attributed to the lack of transparency in the acquisition of construction works, services, materials and equipment (Boyd and Padilla, 2009).

Several existing studies (Kenny, 2007; Krishnan, 2009; Inuwa, Usman and Dantong, 2015; Kasimu and Kolawole, 2015; Henry, 2017) have identified the adverse social, economic and ecological effects of corruption in the construction industry. These effects are particularly evident in the developing countries where corruption has become a cultural issue and assumed an alarming dimension (Kenny, 2007; Sohail and Cavill, 2008; Krishnan, 2009; Owusu et al., 2019). As a result, several measures for reducing corruption in construction project delivery have been identified by previous authors (see for examples Zou, 2006; Ameyaw and Mensah, 2013; Chan and Owusu, 2017; Owusu et al., 2019). However, electronic (e-) Procurement, which is the use of the Internet to acquire works, goods and services (Vitkauskaite and Gatautis, 2008; Ibem and Laryea, 2015, Aduwo et al., 2017), has been recognized as a powerful tool for improving transparency and reducing the incidences of corrupt practices in all forms of procurement activities (Neupane, Soar and Vaidya, 2012; Zakaria, et al., 2014; World Economic Forum, 2016; OECD, 2016).

Research on the various aspects e-Procurement in construction abounds in the literature. For examples, there are several studies on the extent of use of e-Procurement (Eadie et al., 2007; Eadie, Perera and Heaney, 2011; Hashim, Said and Idris, 2014; Ibem and Laryea, 2015; Aduwo et al., 2017), its benefits (Eadie et al., 2007; 2010; Nawi et al., 2017) and barriers to its adoption (Zunk et al., 2014; Nawi et al., 2017; Isikdag, 2019) and other related issues. From the findings of previous studies (Sohail and Cavill, 2008; Zakaria, et al., 2014) we understand that e-Procurement use can check the incidence of corrupt practices by reducing face-to-face contacts in the procurement of public goods, works and services. In spite of this knowledge,

studies on the capabilities of e-Procurement in curbing corruption in construction project delivery, especially in developing countries in sub-Saharan Africa are very scarce. This study, therefore, investigated the anti-corruption capabilities in e-Procurement in construction project delivery in Nigeria so as to suggest how this technology can be effectively used to reduce the growing incidence of corruption in the procurement of construction works, services, materials and equipment in developing countries. This study was guided by two key research questions. These are:

- What are the anti-corruption capabilities of e-Procurement in the delivery of construction projects in Nigeria?
- What are the key components of these capabilities that must be enhanced to maximise the benefits of e-Procurement in checking corruption in the delivery of construction projects in the study area?

As used in this study, anti-corruption capabilities refer to the features or characteristics of e-Procurement technology that enable it to check or eliminate the incidence of corrupt or unethical practices when used in the procurement of construction works, services, materials/equipment. The specific aspects of e-Procurement in construction project delivery investigated in this study are: 1) dissemination of information on tender opportunities or request for quotation (RFQ) (e-Notification/Informing/Announcing) 2) submission of tenders/bids or proposals (e-Submission/ e-Tendering) 3) award of contracts (e-Awarding) 4) sourcing of materials and equipment (e-Sourcing) 5) placement of orders for materials and equipment (e-Ordering) 6) payment for services, materials/equipment (e-Payment) and 7) tracking of the movement of materials and progress of work on construction sites. This means that the scope of this study is limited to construction procurement activities relating to the exchange of project information, tendering, award of contracts, ordering of materials and equipment, payment for works, materials/equipment, and services and tracking the movement of materials and progress of construction works.

Nigeria was chosen for this research because of the growing level of corruption in her public procurement process in general and in her construction sector in particular as previously reported in the literature (see for examples Ameh and Odusami, 2010; Agwor, 2015; Adeyemo and Amade, 2016; Transparency International, 2019). Therefore, this study is considered valuable as it makes contribution to knowledge by firstly, uncovering the specific features of e-Procurement with great potentials of checking or eliminating the use of corruption or unethical practices in the formation and execution of construction contracts. Secondly, it improves understanding of how e-Procurement technology can be more effectively used to fight corruption in the delivery of construction projects in Nigeria and other developing countries.

The remaining part of the paper is divided into the following key sections: literature review, research methods, findings of the research, discussion of the results as well as conclusions and implications of the findings.

Literature review

CORRUPTION IN CONSTRUCTION PROJECT DELIVERY

The published literature is replete with different definitions of corruption (see for examples Krishnan, 2009; Transparency International, 2013; Chartered Institute of Builders (CIOB),

2013). However, as used in this research, corruption refers to any act that violates established guidelines and procedures involved in construction project delivery for private benefits or personal gains. It is also used to describe unethical practices involved in the procurement of construction works, services, materials and equipment.

The review of the published literature reveals that corruption occurs at different stages of construction project delivery (Stansbury, 2005; Ameyaw and Mensah, 2013; CIOB, 2013). It was also found in the existing literature (Sohail and Cavill, 2008; CIOB 2013; Legae and Adeyemi, 2017; Owusu et al., 2019) that corrupt practices in construction project delivery manifest in different forms such as 1) payments of bribes to gain advantage over others 2) theft through misrepresentation of facts (fraud) 3) misappropriation of project funds (embezzlement) 4) sweeteners or rewards for favourable decisions (kickbacks) 5) unauthorized alteration of written documents or falsification of information with the intent of promoting personal interests and causing harm to other person (s) (forgery), and 6) obtaining material benefits or money from somebody using illegal methods, force or persuasion or under false pretence (extortion).

In the two largest economies in Africa, a previous study by Bowen, et al. (2007) reported that the South African construction industry has been associated with unethical conducts such as collusion, bribery, negligence, fraud, dishonesty and unfair practices as well as bribery in the form of payments and gifts, while fraud appeared not to be as serious a problem in that country. Another study in South Africa (Bowen, Edwards and Cattell, 2012) also revealed that corruption was most prevalent during the bid evaluation and tendering phases of projects and that this manifested in the forms of conflicts of interest, tender rigging (collusion), fronting and kickbacks and were perpetrated by government officials (as clients), contractors, and sub-contractors. In Nigeria, Oyewobi, et al. (2011) reported the formation of cartel and submission of several bids by the same contractor using different names, while other authors (Kasimu and Kolawole, 2015; Adeyemo and Amande, 2016) observed that the use of bribes (e.g. cash and materials gifts or kind) to win contracts, overbidding and collusion between contractors and professionals to deliver poor quality work were very common in this country. In fact, an earlier study by Ameh and Odusami (2010) revealed that the most common form of bribery in the industry was financial inducement and that quantity surveyors were perceived to be the most susceptible to bribery among professionals in the Nigerian construction industry.

Several reasons have been put forward on why construction projects are vulnerable to corruption. For examples, Stansbury (2005) argued that the complex technical requirements, uniqueness, and large sizes of construction projects; competitive nature of construction contracts and the large number of participants, make control measures hard and ineffective in tracing monetary transactions in such projects. The author further explained that the complicated nature of contractual processes and fragmented nature of construction project implementation structures as well as concealment of the quality of work make it possible for corruption to thrive in the procurement of construction projects. In addition, Boyd and Padilla (2009) noted that corrupt practices in construction project delivery are principally due to poor documentation/record keeping, the lack of sufficient transparency and poor professional ethical standards. Similarly, Hardoon and Heinrich (2011) argued that political involvement and the use of different codes of conduct and practices in any single project are responsible for the high incidences of corrupt practices in the delivery of construction projects. Again, that study by Bowen, Edwards and Cattell (2012) also identified the facilitating factors of corruption in the South African construction industry to include a lack of transparency in the awarding of contracts and the operating environment of the industry. In the Nigerian

construction environment, Ayodele, et al. (2011) reported that construction procurement activities were prone to corruption due to the high level of poverty and greed amongst the participants and entrenched culture of political interference, favouritism and nepotism in the award of contracts, professional misconduct and quackery.

From the foregoing, it can be inferred that corruption in construction project delivery occurs in various forms under different names and can be perpetrated by clients, professional consultants, government officials, contractors, building material manufactures and vendors as well as workers on construction sites. It is also evident in the studies reviewed here that construction projects are generally vulnerable to corruption due to the characteristics of the industry, construction projects as well as the legal, political, and social milieu in which construction works take place.

ANTI-CORRUPTION CAPABILITIES OF E-PROCUREMENT IN PROCUREMENT ACTIVITIES

In the context of this research, anti-corruption capabilities refer to the features or measures in e-Procurement that help to check or reduce the incidence of corrupt practices in the procurement of construction works, services and materials/equipment. Although several measures for checking corruption in construction project delivery have been documented in the literature (see for examples Osie-Tutu, Badu and Owusu-Manu, 2010; Ameyaw and Mensah, 2013; Chan and Owusu, 2017, Owusu, Shan and Chau, 2017; Owusu et al., 2019), the World Economic Forum (2016) and OECD (2016) had argued that the use of digital technology stands out as one of the most effective ways for checking and reducing the incidences of corrupt practices in public procurement. Laryea and Ibem (2014) had observed that in most recent times, one aspect of digital technology that has become very useful in the acquisition of works, goods, and services in the different sectors is electronic (e-)Procurement. The study by Aduwo, et al. (2017) provides evidence on the extent of use of e-Procurement in the delivery of building projects in Nigeria. Other studies have also been done in the UK (Eadie et al., 2010; Eadie, Perera and Heaney, 2011), Malaysia (Hashim, Said and Idris, 2014), and South Africa (Ibem and Laryea, 2015) on the use of e-Procurement in the construction industry. In addition, other authors (Sohail and Cavill, 2008; Neupane, Soar and Vaidya, 2012) have noted that the use e-Procurement has great potentials to reduce the level of corruption in the acquisition of goods, services, and works by governments, while evidence from Malaysia shows that the use of online tendering system had helped to reduce the level of corruption in construction project delivery in that country (Zakaria, et al., 2014).

From the review of the existing literature, some anti-corruption capabilities of e-Procurement in public procurement in the developing countries were identified and summarized in Table 1.

Table 1 Anti-corruption capabilities of e-Procurement in public procurement

S/N	Anti-corruption factors	Sources
1	Prevents maverick buying/ unnecessary projects	Neupane, Soar and Vaidya 2012
2	Access to procurement information on real time basis or real time bidding	Adebiyi, Ayo and Adebiyi, 2010; Neupane, Soar and Vaidya 2012; Ibem and Laryea, 2015

Table 1 continued

S/N	Anti-corruption factors	Sources
3	Automation of procurement process	Sohail and Cavill, 2008; OECD, 2016; Neupane, Soar and Vaidya 2012;
4	Increase competition among the bidders/suppliers /vendors	Hanna, 2010 ; OECD, 2016
5	Reduction in the levels of human interactions in the bidding process	Sohail and Cavill, 2008; OECD, 2016; World Economic Forum , 2016;
6	Standardization of procurement information	Neupane, Soar and Vaidya 2012
7	Monitoring and tracking audit trail	Vaidya, 2007; Aman and Kasimin, 2011; World Economic Forum , 2016;
8	Efficient and secured online exchange of procurement information	Hanna, 2010; Adebisi, Ayo and Adebisi, 2010; Neupane, Soar and Vaidya 2012
9	Managerial control and collaboration	Neupane, Soar and Vaidya 2012;
10	Transparency and accountability	Sohail and Cavill, 2008; Pathak et al., 2009; Neupane, Soar and Vaidya 2012;
11	Easier and faster procurement process	Hanna, 2010, Ibem and Laryea, 2015
12	Obtain the best quality services/ product at competitive price	World Economic Forum
13	Better online interactions between suppliers/ vendors	Adebisi, Ayo and Adebisi, 2010
14	Reduction of cartel formation, collusion and bid riggings	Pathak et al., 2009;
15	Improvement of audit and analysis	Gupta, Jha and Gupta, 2009
16	It involves less paperwork	Neupane, Soar and Vaidya 2012
17	Good inventory management/ record keeping	Sohail and Cavill 2008; Aman and Kasimin, 2011
18	Easy and efficient monitoring of contract execution	Ibem and Laryea, 2015

Compiled by the authors

It can be seen from Table 1 that there are several anti-corruption capabilities of e-Procurement in the acquisition of works, goods and services. Generally speaking, evidence in Table 1 shows that the anti-corruption capabilities of e-Procurement are linked to the automation of procurement process and activities, which results to transparency and accountability, prompt access to information and reduction in the level of face-to-face interactions in the procurement of goods, works and services.

Research methods

The data used in this paper are part of a larger survey of consulting and contracting firms, private and public sectors clients' organisations and building materials suppliers/vendors involved in the different aspects of construction project delivery in Nigeria. The research design was survey and the quantity research approach was adopted. The choice of survey and quantitative research approach was based on the research questions that guided the study and the fact that most of the previous studies reviewed here and cited in Table 1 adopted a similar approach.

To ensure adequate coverage of the study area, the research drew participants from all the six geopolitical zones: Northcentral, Northeast, Northwest, Southeast, Southsouth, and Southeast in Nigeria. Going by the fact that the population of construction industry stakeholders is huge and there is no accurate record on the users of e-Procurement technology in this sector of the Nigerian economy, a maximum variability of users was assumed. Therefore, Cochran (1963) formula for infinite population stated in equation 1 was used to determine the minimum sample size for the survey.

$$n_0 = \frac{Z^2 pq}{e^2} \quad \text{equation (1)}$$

Where n_0 represents the minimum sample size, Z is the critical value for 95% confidence level, which in this case is 1.96; $p=0.5$; $q = 1 - p$ and e is the desired level of precision in the estimate. Based on the above parameters, the minimum sample size obtained for the survey was 385 construction stakeholders.

The research process involved literature search, identification and the review of relevant and current literature on the subject. These helped in identifying the gap this research attempted to fill and in designing the questionnaire used in the survey. The questions in the questionnaire were grouped into five distinct sections A to E. However, based on the research questions stated in this paper, the data used were derived from questions in sections A and E of the questionnaire. Specifically, questions in Section A were mainly used to extract data from the participants who indicated that they have used and are still using e-Procurement technology to execute the identified construction project delivery activities. Specifically, the key e-Procurement technologies, tools, applications investigated in this research are e-mail, dropbox, building information modelling (BIM), e-Markets, electronic data exchange (EDI), geographic information system (GIS), radio-frequency identification (RFID); project management software packages and e-Tendering systems.

To identify the actual users of e-Procurement technology, the participants were firstly requested to indicate whether or not their firms/organisations have been involved in construction project(s) where any of the identified tools, technologies, packages was used using *Yes* or *No* options. They were also asked to indicate how long their organizations have been using the identified e-Procurement technologies/tools/applications in the procurement of construction works, services, materials/equipment. Questions in section E of the questionnaire were used to assess the anti-corruption capabilities in e-Procurement in construction project delivery. Specifically, the respondents were asked to rate 18 capabilities identified in the published literature (Sohail and Cavill, 2008; Neupane, Soar and Vaidya 2012; OECD, 2016) and presented in Table 3 in order of their importance in preventing or reducing corruption in construction project delivery based on 5-point Likert type scale ranging from 1= No Significant Importance, 2= Very Little Importance, 3= Undecided, 4= Significant Importance

to 5=Most Significant Importance. Cronbach alpha reliability test was used to examine the reliability of this scale of measurement and the test returned 0.854 for the 18 items, which is more than the recommended 0.70 in the literature (see Pallant, 2011). Therefore, the scale of measurement used to assess the anti-corruption capabilities of e-Procurement in the current research was considered reliable.

A number of steps were taken to ensure the validity of the research. First, internal validity was achieved through a nationwide survey of construction industry stakeholders in Nigeria and by subjecting the survey data to factor analysis. Second, external validity was achieved firstly, by drawing sample from the actual users of e-Procurement technology in construction project delivery in the study area and secondly, by distributing 2000 copies of the questionnaire instead of the calculated sample size of 385. These was done to avoid the effect of low response rate and to ensure that the sample is representative of the population of actual users of e-Procurement so that the findings of this research can be generalised within the context of the Nigerian construction environment. Thirdly, before the main survey, the questionnaire was pre-tested in architectural, building construction and quantity surveying firms in the city of Lagos southwest Nigeria and the feedback was used to refine the final version of questionnaire.

A cross-sectional survey involving the distribution of 1750 hard copies of questionnaire to randomly selected participants in the different categories of firms/organizations identified in the Nigerian construction environment in main urban centers of Kaduna (Northwest), Abuja (Northcentral), Lagos and Ibadan (Southwest), Port-Harcourt and Uyo (Southsouth) and Owerri and Enugu (Southeast) was used. However, due to the security challenges in the Northeast zone of the country and the inability of the researchers so visit all the urban centers in the study area, additional 250 copies of the questionnaire were sent out as e-Mail attachments to randomly selected participants. The random sampling technique was used in the selection of respondents in the survey. This selection method ensured that every member of the study population had equal opportunity to be selected to participate in the survey. The surveys began in November 2017 and ended in August 2018 and a copy of the questionnaire was given to one respondent in each of the firms and organizations sampled. In all, 2000 copies of questionnaires were distributed, but 1100 were retrieved, and 1092 of them representing around 55% of the total number of questionnaires administered were found to have been correctly filled by the respondents.

The data analysis was done using the Statistical Package for the Social Sciences (SPSS). This software was chosen because of its user-friendliness and the fact that it has all the most commonly used statistical tests in social science research of this nature. The three basic types of analyses the data were subjected to were descriptive statistics, relative importance index (RII) and categorical principal components analysis (CATPCA). Specifically, frequency distribution and percentages were used to examine the characteristics of users of the technology in construction project delivery, while mean scores, standard deviation, relative importance index (RII) and mean scores ranking were used to assess the respondents' rating of the level of importance of each of the 18 anti-corruption capabilities in construction project delivery investigated. Specifically, relative importance index (RII) was considered and used in this study because it helped in the identification and prioritization of the most important features of e-Procurement that make it an effective tool for checking or reducing the incidence of corrupt and unethical practices in construction project delivery from the perspective of users who participants in the survey. The relative importance index (RII) for each of the anti-corruption capabilities was determined using equation 2.

$$RII = \frac{\sum W}{A \times N}; \quad (0 \leq RII \leq 1) \quad \text{Equation 2}$$

Where W is the score given to each of the 18 items by all the participants in the survey, $\sum W$ is the sum of scores ($W_1 + W_2 + W_3 + \dots + W_{18}$), A is the highest possible score on the 5-point Likert type scale, which in this case is 5.0 and N is the total number of persons who participated in rating each of the 18 anti-corruption capabilities investigated in the survey. In interpreting the result, the closer the calculated value (i.e. RII) for each measure (item) is to 1.00, the more important and contribution it can make in checking or reducing corruption in the procurement of construction projects. The CATPCA was used to investigate the underlying dimensions in the 18 anti-corruption capabilities investigated in this research. The CATPCA was preferred to the traditional principal component analysis (PCA) for two reasons. First, the CATPCA does not assume linear relationships amongst the variables, and second, the benefits of using optimal scaling in the Statistical Package for the Social Sciences (SPSS) to specify the level of measurement the researchers wanted to have during the CATPCA. The results are presented using texts, charts, and tables in the next section of the paper.

Study findings

RESPONDENTS IN THE SURVEY

From the survey data, it was found that of the 1092 valid questionnaires retrieved, 759 representing around 69.5% of the valid questionnaires were filled by those who use e-Procurement technology in construction project delivery in the study area. Table 2 is a summary of the background information of users of e-Procurement technology in construction project delivery in Nigeria identified in the survey.

Table 2 Background information of respondents and their organisations

Variables	Categories	Frequency N=759	Percent
Role in the construction industry	Architect	191	25.2
	Builder	69	9.1
	Engineer	120	15.8
	Contractor	52	6.9
	Construction/Project Manager	37	4.9
	Quantity Surveyor	200	26.4
	Estate/ Facilities Manager	55	7.2
	Supply Chain Manager/ Procurement Officer	20	2.6
	Construction Materials/ Equipment Vendors	5	0.6
	Others	10	1.3

Table 2 continued

Variables	Categories	Frequency N=759	Percent
Type of organization	Consulting firm	242	31.9
	Contracting firm	265	34.9
	Private sector client organisation	58	7.6
	Government Ministry/Parasatals/ Institution	171	22.5
	Building Materials Manufacturer/Vendors	3	0.4
	Others	20	2.6
Areas of construction procurement experience	Residential buildings	474	62.5
	Non-residential buildings	187	24.6
	Buildings and Transportation	36	4.7
	Energy	16	2.1
	Transportation	26	3.4
	Telecommunication	12	1.6
	Sanitation and Water Supply	5	0.7
	Others	3	0.4
Duration of e-Procurement use in years	Less than 1 year	155	20.4
	Between 1 year and 5 years	363	47.8
	Between 6 and 10 years	112	14.8
	.Over 10 years	40	5.3
	Not Sure	89	11.7

The results in Table 2 show that most of the users of e-Procurement technology in construction project delivery who participated in the surveys were employed in professional consulting and contracting firms with construction procurement experience in building design, construction, and project management and have been using this technology for between 1 year and 10 years. Based on the results in Table 2, it can be inferred that the respondents in the surveys are qualified to provide valid data for this research.

ANTI-CORRUPTION CAPABILITIES OF E-PROCUREMENT IN CONSTRUCTION PROJECT DELIVERY

Table 3 is the result of the levels of importance of each of the 18 capabilities in preventing or reducing the incidence of corrupt and unethical practices in construction project delivery in the study area. From the mean scores it can be seen that each of 18 items can play important role in checking corruption in construction project delivery. However, based on their relative importance indices(RII) as shown in Table 3, it can be seen that the first four most important anti-corruption capabilities in the use of e-Procurement in construction project delivery in

the order of importance include, good inventory management/record keeping (RII=0.84), accountability by providing audit services trail (RII=0.833); reduction in direct human physical interaction in the bidding process (RII= 0.831), easier and faster procurement process (RII= 0.827). The least important measure is reduction in the number of unnecessary construction projects (RII =0.650).

Table 3 Anti-corruption capabilities of e-Procurement in construction project delivery

Anti-corruption capabilities in the use of Internet	No of Respondents	Mean	Std. Deviation	RII	Ranking in the order of importance
Good inventory management/record keeping	714	4.20	0.96	0.840	1 st
Accountability by providing audit services trail	714	4.23	1.79	0.833	2 nd
Reduction of direct human interactions in bidding process	713	4.22	0.95	0.831	3 rd
Easier and faster procurement process	715	3.91	1.11	0.827	4 th
Efficient and secure document transmission	712	4.13	0.94	0.826	5 th
Easy and efficient monitoring of contract execution	710	4.12	0.96	0.826	5 th
Reduction of paperwork	713	4.03	1.12	0.814	6 th
Better interactions among stakeholders through online system	707	4.10	0.98	0.813	7 th
Better status monitoring and tracking of applications	712	4.06	0.92	0.812	8 th
Transparency in the procurement of construction works and services	713	4.00	1.06	0.803	9 th
Automation of construction procurement process	710	3.93	0.95	0.790	10 th

Table 3 continued

Anti-corruption capabilities in the use of Internet	No of Respondents	Mean	Std. Deviation	RII	Ranking in the order of importance
Managerial control and collaboration	713	3.89	0.97	0.778	11 th
Standardization of project requirements	713	3.85	1.11	0.771	12 th
Access to construction project information on real time basis	712	3.90	1.49	0.770	13 th
Reduction in cartel formation, collusion and riggings in online bidding	712	3.78	1.17	0.757	14 th
Disclosure of procurement information	708	3.71	1.15	0.743	15 th
Increased competition among bidders or suppliers	709	3.70	2.13	0.730	16 th
Reduction in the number of unnecessary construction projects	710	3.32	2.04	0.650	17 th

DIMENSIONS OF ANTI-CORRUPTION CAPABILITIES OF E-PROCUREMENT IN CONSTRUCTION PROJECT DELIVERY

In examining the dimensions of anti-corruption capabilities investigated, the 18 capabilities were further subjected to CATPCA- a variant of factor analysis. However, before conducting this analysis the survey data were examined for suitability for CATPCA using Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity. The result produced KMO value of 0.92, which is more than the recommended 0.70 and the Bartlett's Test of Sphericity ($\chi^2 = 4161.659$; $df = 153$) was significant at $p = 0.000$; meaning that the dataset is suitable for CATPCA. The results identified five (1-5) dimensions accounting for around 70.32% of the variance in the 18 capabilities investigated. The model summary of the result is as presented in Table 4.

Table 4 Model Summary of CATPCA

Dimension	Cronbach's Alpha	Variance Accounted For	
		Total (Eigenvalue)	% of Variance
1	0.889	6.220	34.56
2	0.708	3.016	16.75
3	0.305	1.405	7.81

Table 4 continued

Dimension	Cronbach's Alpha	Variance Accounted For	
		Total (Eigenvalue)	% of Variance
4	0.095	1.099	6.11
5	-0.096	.917	5.10
Total	0.975 ^a	12.657	70.32

a. Total Cronbach's Alpha is based on the total Eigenvalue.

Table 5 shows the names of the five dimensions identified and the factors loading on each of them. From the results in Tables (4 and 5), it can be seen that the first dimension, which is *the advantage of e-procurement technology has over the traditional paper-based method* has 12 of the 18 capabilities/items loaded on it and counts for around 34.56% of the variance in all the items investigated. The second is *transparent bidding process*, which accounts for 16.75% of the variance and has three items loaded on it, while the third dimension, which is *improvement of competition among bidders and reduction in the number of unnecessary construction projects* has two items loaded on it and accounts for around 7.81% of the variance in the 18 items. The last two dimensions are *disclosure of procurement information* accounting for around 6.11% of the variance and having one factor loaded on it and *reduction in the levels of human physical interactions in bidding process*, which also has one item loaded on it and accounts for around 5.10 % variance in all the 18 items investigated in this study.

Table 5 Dimensions of anti-corruption capabilities of e-Procurement in construction project delivery

Dimensions/ components	Component Loadings					
	Dimension					
	1	2	3	4	5	
1. Advantage of e Procurement technology over the traditional paper-based method	Real time access to construction project information	.678				
	Automation of construction procurement process	.711				
	Transparency in the procurement of construction works and services	.647				
	Reduction of paperwork	.615				

Table 5 continued

Dimensions/ components	Component Loadings					
	Good inventory management/ record keeping	.748				
	Accountability by providing audit services trail	.732				
	Easy and efficient monitoring of contract execution	.680				
	Easier and faster procurement process	.705				
	Efficient and secure document transmission	.704				
	Standardization of project requirements	.611				
	Managerial control and collaboration	.618				
2. Transparent bidding process	Reduction in cartel formation, collusion and riggings in online bidding		.999			
	Better status monitoring and tracking of applications		.999			
	Better interactions among stakeholders through online system		.999			

Dimensions/ components	Component Loadings				
3. Improvement of competition among bidders and reduction in the number of unnecessary projects	Increased competition among bidders or suppliers			.561	
	Reduction in the number of unnecessary projects			.530	
4. Disclosure of procurement information	Disclosure of procurement related information			.635	
5. Reduction in physical human interactions in bidding process	Reduction of direct human interactions in bidding process				.628
Variable Principal Normalization.					

Discussion

From this research, it was found that all the 18 items investigated are among the capabilities of e-Procurement in checking corruption in construction project delivery, which seems to provide support to the findings of previous studies on the anti-corruption capabilities of e-Procurement in public procurement (Sohail and Cavill, 2008; Neupane, Soar and Vaidya 2012; OECD, 2016). Analysis of the results of the relative importance index for each of the capabilities investigated reveals that the most important anti-corruption capability of e-Procurement is good inventory management/record keeping. This result did not come as a surprise because the existing studies (Eadie, et al., 2007; Ibem and Laryea, 2015; Nawi, et al., 2017) have shown that one of the reasons why e-Procurement was increasingly gaining acceptance in construction project delivery is that it has several advantages over the manual and paper-based method of acquiring goods, works and services as it engenders effective and efficient record keeping, data storage, retrieval and dissemination. Others are lower transaction cost, shorter procurement turnaround time, easier storage, faster retrieval and exchange of project information, involvement of less paperwork, automation of project delivery activities and processes, transparency and accountability, less involvement of face-to-face human contacts and reduction of errors in information management. This probably explains why the first of the five underlying dimensions of the capabilities of e-Procurement that reduce the incidences of corruption, identified in Table 5 is also related to the advantage of e-Procurement over the traditional paper-based method of construction procurement. These features, according to Zunk, et al. (2014) can help to check the incidences of corrupt practices such as fraud, forgery, embezzlement, formation of cartels by bidders in construction project delivery. This suggests that e-Procurement use can help to address issues of poor documentation, record keeping and inability to trace payments which previous authors (Stansbury, 2005; Boyd and Padilla, 2009; Hardoon and Heinrich, 2011) had identified as

some of the issues that promote corruption in construction project delivery. In this regard, it can be inferred that e-Procurement can help to reduce fraud and unauthorized alteration of written documents (forgery) in construction project delivery.

The next most important anti-corruption capability of e-Procurement identified is linked to the benefits of accountability through the provision of audit services trail in transactions associated with construction project delivery. Notably, previous authors (Sohail, and Cahill, 2008; Hardoon and Heinrich, 2011) had observed that corruption thrives in construction because of the lack of sufficient transparency and accountability. According to Boyd and Padilla (2009), audit services trail helps to address the issue of lack of transparency and accountability, while Neupane, Soar and Vaidya (2012) explained that it reduces the level of secrecy and information asymmetry, alteration or falsification of project information. These might help to explain why the second most important anti-corruption capabilities of e-Procurement identified in this study is transparent bidding process. Previous studies have also established that transparent bidding/tendering process can be achieved through adequate monitoring and tracking of online transactions (Aman and Kasimin, 2011), better interactions among stakeholders through online systems (Adebisi, Ayo and Adebisi, 2010) and reduction in cartel formation, collusion, and rigging of bids (Tindsley and Stephenson, 2008; Pathak, et al., 2009). It was on this premise that the World Economic Forum (2016) and OECD (2016) argued that by providing audit trail services, e-Procurement can help to check incidence of fraud, forgery, and embezzlement in the procurement of works, goods and services by engendering constant monitoring/tracking and trailing of communications and transactions done electronically.

Next in order of importance of the anti-corruption capabilities of e-Procurement in construction project delivery is the reduction of direct human interactions in the bidding process. This has a direct link to the fifth dimension of the anti-corruption capabilities identified in this study. As previously highlighted in this paper, copious evidence in the literature (Sohail and Cavill, 2008; Pictet and Bollinger, 2008; World Economic Forum, 2016) shows that carrying out project delivery activities using online platforms among others helps to eliminate opportunities for face-to-face requests and payments of bribes and collusion in the bidding process leading to transparent procurement process. It also helps to prevent the formation of cartel and collusion by bidders identified by Oyewobi et al. (2011) as one of the ways corruption manifest in the Nigerian construction environment. Moreover, the study by Zakaria, et al. (2014) as previously highlighted confirmed that the use e-Tendering, which eliminates direct human physical contacts amongst participants in construction procurement activities, was instrumental to fighting corruption in construction project delivery in Malaysia.

From the foregoing, it can be inferred that the capability of e-Procurement to provide audit services trail and reduce the level of face-to-face human contacts in construction procurement activities can be linked to its automation feature, which Sohail and Cavill (2008) identified as a very important feature of e-Procurement that reduces the incidence of corrupt practices in public procurement process. This is because automation, among other things, facilitates easier and faster procurement process, efficient and secure online exchange of information; easier and effective monitoring of construction project execution, reduction of paperwork and standardization of construction project requirements. According to OECD (2016), these features engender easier access to procurement information and detection of integrity breaches, illegal payments and embezzlement and other unethical practices in the procurement process. Added to these is the benefit of having a large pool of vendors, service providers, suppliers, and contractors that procurers of construction works and services can select from.

This is made possible because previous studies (Ibem and Laryea, 2015; Aduwo, et al., 2017) have shown that e-Procurement helps to eliminate geographic barrier associated with the traditional paper-based method of construction procurement. This, according to the OECD (2016), encourages the use of standard and uniform information and healthy competition in procurement activities as well as limits the use of bribes and favouritism in the selection of service providers and suppliers.

Conclusions and implications of the study

In this study, the anti-corruption capabilities of e-Procurement in construction project delivery were examined using empirical data obtained from industry-wide survey in Nigeria. Based on the results two key conclusions are made. The first conclusion is that there are at least 18 capabilities in the use of e-Procurement technology to reduce corruption in construction project delivery in Nigeria. However, the three most important ones are the capabilities in good inventory management/record keeping; accountability by providing audit services trail and reduction of direct human interactions in bidding process. The second conclusion is that the five underlying dimensions of the 18 anti-corruption capabilities in the order of their importance are 1) the advantage of e-Procurement over the traditional paper-based method, 2) transparent bidding process 3) increasing competition among bidders and reducing the number of unnecessary projects 4) disclosure of procurement information, and 5) reducing the level of physical human contacts in the bidding process.

Findings of this research have some implications that are noteworthy. Firstly, the study implies that as is true with public procurement generally, the use of e-Procurement technology has a number of features capable of reducing the incidences of corrupt and unethical practices in construction project delivery in both public and private sectors entities in Nigeria and other countries in the global South. However, the capabilities identified in this study that seem to contribute more in reducing corruption than the others, and thus should be given preference to by current and intending users of e-Procurement in construction project delivery are the capabilities related to good inventory management/record keeping, availability of audit services trail and reduction in direct physical human contacts in bidding process.

Secondly, the study also implies that the use of e-Procurement technology to carry out construction project delivery activities such as the acquisition of works, services and materials/equipment reduces the incidence of corrupt practices, by circumventing the various challenges associated with the traditional paper-based procurement method, promoting transparent bidding process, increasing competition among bidders and reducing the acquisition of unnecessary projects and facilitating easier and prompt disclosure of vital information, and reducing the level of human face-to-face interactions. Therefore, intending and current users of this technology are advised to given adequate consideration to these aspects if they hope to use e-Procurement technology as a tool for reducing corruption in construction project delivery. Based on the foregoing, this study is considered relevant to construction industry stakeholders and this journal in revealing the specific aspects of e-Procurement that can help in reducing or curbing the incidences of corrupt and unethical practices in the procurement of public works and construction projects. It also adds to the growing literature on the strategies for improving the efficiency and corruption rating of the construction industry.

Since the data used in this research were sourced from a questionnaire survey and 18 anti-corruption capabilities of e-Procurement technology were investigated, the findings of this study cannot be separated from the biases of those who took part in the survey. Of course,

this is one of the limitations of a questionnaire survey of this nature. In the light of this, it is suggested that further studies be conducted using mixed methods of data collection such as questionnaire and interview with the inclusion of more anti-corruption capabilities. The study is also limited to the e-Procurement technologies/tools/applications and project delivery activities investigated; hence other study should also consider other e-Procurement systems used in construction project delivery not included in the current study.

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