ITU A|Z • Vol 18 No 3 • November 2021 • 673-689

Critical success factors(CSFs) for e-Business technologies adoption in architectural practice in Nigeria

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Received: June 2020 • Final Acceptance: December 2020

Abstract

Although digital technology has rapidly changed the way professionals in the construction sector render services to their clients, the factors architectural firms must consider to ensure a successful e-Business technologies adoption in their professional practice are not very clear. This research investigated the critical success factors (CSFs) for e-Business technologies adoption in architectural practice in Nigeria. A questionnaire survey involving 243 architectural firms was conducted and the data from196 firms that have adopted e-Business technologies were analysed using descriptive statistics, Spearman's ranked correlation tests, relative importance index and principal components analysis. Significant relationships were found between the duration of use of e-Business technologies and the firms' age, staff strength, number and location of offices, while the top three CSFs for e-Business technologies adoption were availability and access to reliable, affordable and fast Internet services; availability of skilled manpower and knowledge of the benefits of e-Business technologies adoption. In addition, the underlying dimensions of the CSFs were found to be human, technology, management and environment-related. The study is instructive in highlighting the factors architectural practices should give priority attention to for a successful e-Business technologies adoption in improving professional service delivery efficiency and gain competitive advantage.

Keywords

Architectural firms, Critical success factors, e-Business, Technologies adoption, Professional practice.

doi: 10.5505/itujfa.2021.93764

1. Introduction

As construction organisations continue to embrace information and communication technologies (ICTs) with the overall aim of improving their productivity and competitiveness in the global market, the architecture profession is not left out in this move. Evidence in the literature (Ibem, Akinola, Erebor, Tolani & Nwa-uwa, 2018; Ogunmakinde et al., 2014; Tepavcevic et al., 2012; NBS Research, 2018) shows that digital technology has changed the way professionals in the construction industry practice their professions. Architecture as a service-oriented and creative profession renders unique services in the construction sector (Oluwatayo et al., 2014). Hence, there is a growing need for the profession to adopt transformational technologies such as 3D computer-aided design, Building Information Modelling (BIM) and the Internet that will enable its practitioners deliver better services towards creating a better and sustainable built environment.

Notably, architectural practice involves collaboration with other professionals and stakeholders in the course of professional service delivery (McDonald & Madhavaram, 2007; Penttilä, 2009).This makes intra-and inter-firm communication, collaboration and coordination inevitable for a successful architectural practice (Ibem, Aduwo & Ayo-Vaughan, 2017; Oyedele & Tham, 2007; Shen et al., 2010). Some authors (Hussin et al., 2013; Cherian & Kumaran, 2016) have alluded that construction entities that rely on the traditional manual methods and processes in their business operations usually experience poor communication and difficulties in information sharing and teamwork management leading to time and cost overruns and low productivity. In a bid to address these challenges, Eadie and Perera (2016) have noted that ICTs play key roles in all aspects of construction project delivery from design, tendering, project programming to project completion. Ashworth and Perera (2015) argued that one aspect of ICTs adoption that comes with lots of benefits to professionals in the construction sector, including architects is e-Business. In construction, e-Business has been defined as doing business using the Internet (Ruikar & Anumba, 2008; Schneider, 2003). The existing studies have also shown that e-Business technologies adoption offers huge benefits as it engenders efficient work flow and faster communication (Ashworth & Perera, 2015), reduces time and cost of project delivery (Cherian & Kumaran, 2016), improves quality of projects (Dossick & Neff, 2010; Fadeyi, 2017) and promotes effective integration of people, tasks and processes involved in construction project delivery (LaValle et al., 2011). In view of these benefits, research has shown that e-Business technologies and practices were increasingly becoming indispensable in successful professional practice in the construction industry (Eadie & Perera, 2016; Oladapo, 2006).

From the review of published literature, it was observed that certain factors and conditions can facilitate or inhibit a successful adoption of e-Business technologies by firms and organisations (Dubelaar et al., 2005; Eadie, Perera, & Heaney, 2010). However, the specific activities, factors and situations that are considered crucial for a successful adoption and implementation of e-Business technologies and practices by firms or organisations have been described as critical success factors (CSFs) (Mathenge & Wausi, 2018; Perera et al., 2012; Rockart, 1982). Previous studies (Afolabi, Ibem, Aduwo, Tunji-Olayeni, & Oluwunmi, 2019; Butler, 2000; Dubelaar et al., 2005, Kolakota & Robinson, 1999) made attempt to identify the success factors for e-Business model adoption by organisations, but none of them specifically examined this in the context of architectural practice. In addition, although the existing studies provide insight into the adoption of ICTs in professional practice (Arif & Karam, 2001; Oladapo, 2006), impact of ICTs in architectural practice (Abdulkadir & Kamara, 2013; Ogunmakinde et al., 2014), the use of e-Procurement technologies in building project delivery (Ibem, Aduwo & Ayo-Vaughan, 2017), digital technologies (Ibem, Uwakonye, Akpoiroro, Somtochukwu, 2018; NBS Research 2018) and Building Information Modelling (BIM) (Ibem, Uwakonye, Akpoiroro,

Somtochukwu, 2018) adoption in architectural practice, they failed to identify the critical success factors (CSFs) for the adoption of e-Business technologies in architectural practice, especially in developing countries in sub-Saharan Africa, including Nigeria. As a result, there is a gap in knowledge on the specific situations that can enhance a successful adoption of e-Business technologies by architecture firms, especially, in Nigeria- the largest economy in Africa.

It was in an attempt to bridge this gap that the current study sought to investigate the critical success factors (CSFs) for e-Business technologies adoption in architectural practice in Nigeria. The four basic research objectives pursued in the study were to:

- identify the categories of architectural firms that have adopted e-Business technologies in Nigeria,
- examine the relationship between the characteristics of architectural firms and their duration of use of e-Business technologies in the study area,
- identify the factors with the highest influence on successful adoption of e-Business technologies by architectural firms, and
- investigate the underlying dimensions of the CSFs for e-Business technologies adoption in professional practice by the architectural firms in Nigeria.

In view of the risk associated with the transition from the traditional methods to digital business model by firms/organisations, the current research makes contribution to knowledge by revealing the specific factors and situations architectural firms must give priority attention in the acquisition and use of e-Business technologies and processes. The study also provides a guide for categorising architectural firms with respect to their capacity to adopt e-Business technologies and possibly the Internet of Things (IoT) in the nearest future. It is therefore envisaged that the findings of this study will inform architectural practice, especially on the strategies for leveraging e-Business technologies to improve their professional service delivery efficiency and gain competitive advantage locally and globally.

2.Review of literature

2.1 Concept of electronic (e-) Business

Historical facts show that the term 'e-Business' originated from the International Business Machine (IBM, 2001). Since then, the term has been defined in various ways in the literature. For examples, e-Business has been defined as the use of digital or electronic tools and computer networks to carry out business activities and financial transactions (Schneider, 2003; Zwass 2003). It has also been described as the practice or process of remodelling traditional business process using electronic tools (Cherian & Kumaran, 2016). In construction, Ruikar and Anumba (2008) described e-Business as doing construction business using Internet technology. Based on the foregoing, e-Business as used in this research, refers to the use of Internet or web-based technologies, tools and processes in architectural practice.

Emerging from the definitions of e-Business presented here is the understanding that e-Business involves the use of digital/electronic tools and computer networks collectively known as e-Business technologies in business operations as explained by previous authors (Devaraj & Wei, 2007; Issa et al., 2003). IBM (2001) specifically described e-Business as leveraging the Web/Internet services such as electronic data interchange (EDI), e-Mail, software packages, communication networks and other electronic tools in business operations. For construction entities, authors (Issa et al., 2003; Perera et al., 2012; Bowmaster et al., 2017) have identified cloud computing, BIM and Internet-supported project management software packages and communication networks as some of the key e-Business technologies found useful to the industry.

Several authors (Bowmaster et al., 2017; Costa & Tavares, 2014; Ruikar & Anumba, 2008) have noted that the adoption of e-Business technologies goes beyond the replacement of paper-based or manual practices with digital technologies and tools but involves a transition from manual to digital processes and practices in business operations as well as intelligent use of

digital media and electronic (e-)Tools to create a virtual environment that facilitates intra-and inter-organisational/ firm interactions, communication and exchange of information. This means that for construction entities, e-Business technologies use encompass the adoption of various digital media and electronic tools, applications and processes in facilitating information and data generation and exchange, which is referred to as electronic (e-)Procurement) and the deployment of electronic means and processes in financial transactions associated with construction project delivery, otherwise known as electronic (e-) Commerce).

2.2. Intersection of e-Business technologies and architectural practice

Architectural practice involves the use of tools, information and creative knowledge to provide a wide range of professional services related to building and construction projects. According to the International Standard Organisation (ISO) 10845(2010), there are six main areas of professional service delivery in building and engineering projects. These are 1) establishment of what is to be procured 2) selection of procurement strategies to be used 3) call for tender offers 4) tender evaluation 5) award of contract and 6) contract administration. As it relates to architecture, professional practice involves the provision of services starting from the brief taking, designing, planning, construction, maintenance, operation to demolition stages of building projects (Grilo & Jardim-Goncalves, 2011; McDonald & Madhavaram, 2007). Following from these, the Architects Registration Council of Nigeria (ARCON, 2011) has delineated the scope of core architectural services delivery stages in building and related projects in Nigeria to include design stages (I and II), tendering and award, construction and post construction stages as shown in columns 1 and 2 of Table 1.

Relating these services delivery stages to the six areas of construction procurement service delivery identified by ISO 10845(2010), it is evident that the five services delivery stages identified by the ARCON cover the six key construction procurement activities shown in Table I. This means that architectural practice involves the provision of a wide range of services in the formation, management and fulfilment of building and engineering contracts.

Table 1. *Architectural Services Delivery Stages (ASDS) in Nigeria (Source: ARCON (2011) & ISO 10845(2010)).*

Table 1

Stage	Scope of services	Construction procurement activities
Design Stage 1	Commences from the date of receipt of instructions to the submission of the final concept design and include the preliminary estimated total cost for client's approval.	Establishment of what is to be procured
Design Stage 2	Begins from the date of client's approval of final concept design and ends with the submission of the tender documents for client's approval.	Deciding on procurement strategies to be used
Tendering and Award Stage	Starts from call for tender offers and ends with the awarding of the contract.	Soliciting for tender offers evaluating tender offers and awarding contracts
Construction Stage	Commences from handing-over site to the contractor, issuing of Architects Payment Certificates, completion and acceptance of the works by the client, Defects Liability Period, issuing of the Practical Completion Certificate and ends with the issuing of Final Payment Certificate.	Contract administration to ensure compliant with project requirements.
Post Construction Stage	Project hand over to client through the defects liability period up to final account.	Contract administration to ensure compliant with project requirements.

Source: ARCON (2011) & ISO 10845(2010)

Further evidence in the literature (McDonald & Madhavaram, 2007; Penttilä, 2009; Rivard, 2000) also indicates that architectural practice involves the gathering, processing, displaying and exchanging of various kinds of data related to building and construction projects. As a result, architectural practices are confronted with challenges of ineffective and inefficient communication process (Ibem, Aduwo & Ayo-Vaughan, 2017; Oluwatayo & Amole, 2014; Oyedele & Tham, 2007), poor data management and exchange (Johnson & Clayton, 1998; Penttilä, 2009; Ogunmakinde et al., 2014; Shen et al., 2010). To address these challenges, Gajendran and Perera (2017) explained that e-Business technologies have become an integral part of professional practice in architecture. This is because they help to achieve effective communication and information exchange among the design, engineering and construction teams, prompt access to key information and reduction in cost and turnaround time of projects (Worst, 2009). In addition, they facilitate automation of information flow via the Internet and optimises business processes (Issa et al., 2003) resulting in overall improvement in the

quality of service and firms' productivity (Abdulkadir & Kamara, 2013; Ibem, Akinola, Erebor, Tolani & Nwa-uwa, 2018).

In the light of the foregoing, several studies have highlighted the levels of penetration of ICTs in architectural practice. For examples, the extant study by Arif and Karam (2001) revealed that architectural practices in Western Cape Province, South Africa, had deployed information technology (IT) to support their work processes, while the review by Abdulkadir and Kamara (2013) reported that in architectural practice, ICTs have been extensively used in the design process resulting in enhanced productivity, performance and the competitiveness of firms and improved transparency in business processes and the quality products. The findings by authors (Arif & Karam, 2001; Abdulkadir & Kamara, 2013) were also corroborated by Oladapo (2006) who reported that in architectural practices in southwest Nigeria, core architectural functions such as preparation of drawings have been largely digitised, but the use of the Internet was limited to e-Mails and its potentials in other vital areas such as e-Business and electronic data exchange were yet to be explored. Ogunmakinde et al. (2014) also revealed that ICTs were impacting architectural practice in Nigeria as the core architectural business activities such as communication, architectural design, word processing and presentations have largely been computerized with the use of different architectural design software and word processing packages. They identified changing trends, level of competition, and industry demands as the determinants of ICTs use in architectural practice in this country. In contrast to the findings by Oladapo (2006) on the limited use of Internet services, other studies (Ibem, Aduwo & Ayo-Vaughan, 2017; Ibem, Akinola, Erebor, Tolani & Nwa-uwa, 2018) provide copious evidence indicating that architectural firms in Nigeria were using different digital media and electronic tools to support their core business operations. However, these studies are silent on the success factors for e-Business technologies adoption by architectural firms in Nigeria.

2.3. Critical success factors (CSFs) for e-Business technologies adoption

Evidence in the published literature (Li et al., 2005; Rockart, 1982) has shown that Rockart and the Sloan School of Management were the first to introduce critical success factors (CSFs) as a business concept. In fact, Rockart (1982) first defined CSFs as 'those key areas of activity where favourable results are very necessary for the achievement of goals by managers. This definition suggests that CSFs can be described as factors, features, situations or changes required to achieve a substantial success in any business endeavour (Mathenge & Wausi, 2018). Therefore, as used in this research, CSFs are those factors, situation and elements that are significantly important in ensuring that firms or organizations achieve success in the adoption of e-Business technologies and process. This is consistent with the submission by Boynton and Zmud (1984) as cited in Li et al. (2005) indicating that CSFs are key areas that influence business and management success.

As it relates to e-Business technologies, the literature highlights a variety of factors that can lead to a successful adoption of these technologies by firms/organisations. For instance, Kalakota and Robinson (1999) identified the existence of effective change management, appropriate technology and skilled personnel, while Butler (2000) insisted that a sound knowledge of the capabilities and value of e-Business technologies by executives are top among the success factors for e-Business technologies and processes adoption. Further, the study by Dubelaar et al. (2005) classified the success factors of e-Business technologies adoption into three main categories: strategic, structural, and management factors. The authors explained that the strategic factors are related to the following: 1) Internet and related technologies 2) understanding the competitive advantages of e-Business technologies over traditional system 3) availability of new competitors and large markets 4) adoption of web-based marketing approach 5) organisation's/firm's strategic position in the market 6) buyer and customer behaviour 7) first-mover advantage and quick time to market 8) quality of products and services offered by the

firm 9) readiness of firm to innovate, and 10) expectations of customers and business partners. The structural factors include 1) availability of the appropriate digital infrastructure 2) good e-Business education and training to employees, management, and customers 3) extension of e-Business model to cover entire supply chain, and 4) effective and efficient cost control measures, while the management factors are 1) existence of e-Business leadership in the firm 2) top management support for e-Business 3) knowledge of the capabilities of e-Business technologies by to executives, and 4) ability and willingness of top management to communicate the values of e-Business model in the organization (Dubelaar et al., 2005).

For construction entities, the study by Perera et al (2012) identified enabling technologies as the perquisite for successful e-Business activities in this sector, while Afolabi, Ibem, Aduwo, Tunji-Olayeni, & Oluwunmi (2019) reported that the CSFs for e-Procurement adoption in the Nigerian construction business environment were mainly management, human and technology in nature, and that access to reliable and fast Internet services at affordable cost was top on the list of CSFs for the adoption of this aspect of e-Business in this industry. From the studies reviewed here, it can be inferred that the CSFs for e-Business technologies adoption in organisations differ but can be generally described as social, technical and economic factors. In spite of this understanding, very little is known about the CSFs for e-Business technologies adoption among architectural organisations, especially in a developing nation like Nigeria. This forms part of the knowledge gap the current study attempted to fill.

3. Research methods

This research is part of a bigger study that investigated Internet/web-based technologies, tools and applications adoption by firms and organisations in the Nigerian construction sector. The data used in this paper were derived from a cross-sectional survey of architectural firms accredited by the Architects Registration Council of Nigeria (ARCON) to provide professional services in Nigeria. From the register of architectural firms published by ARCON in April 2017, a total of 1,079 architectural firms were identified with contacts details of their principals in Nigeria. In order to have a sample size that is representative of the total population of firms identified, the formula for estimating sample size for a finite population first developed by Yamane (1967) and presented in equation 1 was adopted.

$$n = \frac{N}{1+N(e)^2} \quad \ldots\ldots \text{Equation 1}$$

Where n is the estimated sample size, N = is the research population, e is allowable error in statistical estimation, which for this research is ±5% margin of error at 95% confidence level. Substituting these parameters as shown in Equation 2, a minimum of 292 firms were obtained.

$$n = \frac{1079}{1+1079(0.05)^2} \quad \ldots\ldots \text{Equation 2}$$

$$n = 291.8 \text{ firms}$$

To accommodate possible low response rate, 10% of 292 was added to the calculated sample size. This translated to a total of 321 architectural firms.

A structured questionnaire designed by the authors was used to generate the primary data. The review of literature helped in the identification of the variables investigated and these were framed into questions in the questionnaire. Although the questionnaire for the larger research project was structured into five distinct sections, the data for this papers were drawn from sections A, B and C of the questionnaire. These sections dwelt on the basic information related to the respondents and their respective firms, e-Business technologies adoption, the length of use of these technologies to facilitate professional practice and the CSFs for e-Business technologies adoption, respectively. In order to identify those who have adopted e-Business technologies, participants in the research were requested to indicate if their firms have used e-Business technologies in professional practice using two options- *'No'* and *'Yes'*. In addition, they were also asked to indicate how long their firms have been using e-Business technologies by choosing any of these

options: 1 for *Not Sure*, 2 for *less than 1 year*, 3 for *1-5years*, 4 for *6-10years*, and 5 for *Over 10years*. Section C of the questionnaire had questions on the factors they considered to be of high influence in the successful adoption of e-Business technologies in architectural practice. A total of 21 factors identified from the review of previous works (e.g. Dubelaar et al., 2005, Perera et al., 2012; Afolabi, Ibem, Aduwo, Tunji-Olayeni, & Oluwunmi, 2019) were included in the questionnaire and the participants were asked to rate each of them according to their influence in the successful adoption of e-Business technologies in their respective firms using 1 for *"No Influence"*; 2 for *"Very Low Influence"*; 3 for *"Not Sure"* 4 for *"High Influence"* and 5 for *"Very High Influence"*. On the one hand the validity of the questionnaire was examined by subjecting it to review by experts and also pre-testing it among architectural firms in Lagos metropolis, southwest Nigeria. The reliability of the questionnaire was on the other hand examined by subjecting the 21 CSFs to Cronbach's Alpha test and the result produced 0.945, which is more than 0.6 minimum value recommended in the research literature (see Pallant, 2011)

The surveys were carried out by the researchers and trained research assistants between the second week of November 2017 and last week of August 2018.The surveys involved the distribution by hand and e-Mail attachment a total of 321 copies of the questionnaires to randomly selected principals of architectural firms or their representatives across major cities and urban areas in Nigeria. The choice of administration of questionnaire as the data collection method was based on the nature of the research objectives and the geographic coverage of the survey. Moreover, previous studies on critical success factors cited in this paper had adopted similar method (see for examples Li, Akintoye, Edwards & Hardcastle, 2005; Mathenge & Wausi, 2018; Ibem, Akinola, Erebor, Tolani & Nwa-uwa, 2018). Similarly, random sampling technique was used in the selection of participants because of the need to give every firm equal chances of being included in the surveys, and thus eliminating bias associated with non-probability sampling technique in the survey. Of the 321 copies of questionnaires administered, 243 representing about 76% of the number administered to architectural firms were retrieved. Preliminary analysis of the data however revealed that 196 copies of the questionnaire representing around 81% of the retrieved questionnaire were found to have been filled by participants who indicated that their firms have deployed e-Business technologies and processes in professional practice. In view of the fact that the main interest of this study was on firms that have been using e-Business technologies, only data from the 196 participants who indicated that their firms have been using e-Business technologies to facilitate professional practice were further subjected to statistical analyses.

In line with the stated four research objectives, the data were subjected to four types of analyses with the help of Statistical Package for the Social Sciences (SPSS) software package. For the first research objective, simple descriptive statistics, namely, frequency distributions and percentages were used, while Spearman's ranked correlation (Rho) tests were used to address the second research objective. The choice of Spearman's ranked correlation (Rho) tests was based on the fact that the variables involved in this specific analysis are ordinal/interval data and non-parametric in nature. In addressing the third research objective, descriptive statistics, including mean and standard deviation; and relative importance index (RII) and ranking were used. Ranking of the CSFs was based on the relative important index calculated for each of the 21 factors using the formula given in equation 3.

$$RII = \frac{\sum W}{A \times N}; \quad (0 \leq RII \leq 1) \qquad \text{Equation 3}$$

Where W is the score given to each of the 21 factors by all the participants in the survey, ∑W is the sum of scores (W1 + W2 + W3 + ...+ W21), A is the highest possible score on the 5-point Likert type scale, which in this research is 5.0 and N represents the total number of respondents who rated each of the 21 factors investigated. In interpreting the results, the closer the calculated RII for each factor is to 1.00, the more influential the factor is assumed to be in

contributing to a successful e-Business technologies adoption in the firms. The relative importance index was useful in prioritising the factors rated on Likert-type scale by the respondents in the survey. The last research objective was addressed using the Principal Component Analysis (PCA) Varimax with Kaiser Normalization Rotation Method. This analysis was used to extract the key dimensions of the 21 CSFs for e-Business technologies adoption by architectural firms in the survey and it was adopted because the dataset is ordinal and non-parametric in nature.

4.Results

4.1. Users of e-Business technologies

Table 2 is a display of the results on the characteristics of registered architectural firms who have adopted e-Business technologies in professional practice in Nigeria. The results show that the highest proportion of the firms that have adopted e-Business technologies were those that are over 10 years old and had more than one offices located within the southern part of Nigeria (Table 2). The results also revealed that more than one-half of the firms had staff strength of less than 21 persons and their main area of professional practice experience was in residential buildings. It was also observed that the highest percentage of the firms have been using e-Business technologies for less than 6 years as at 2017/2018.

The results in Table 2 generally indicate that architectural firms who used e-Business technologies and processes encountered in the survey

Table 2. *Characteristics of firms who use e-Business technologies.*

Characteristics of firms	Categories	Frequency n=196	Percent
Age of firm	Below 6years	42	21.4
	6-10years	43	21.9
	11years+	103	52.6
	No Response	8	4.1
	1	103	52.6
	2	42	21.4
Number of offices in	More than 2	39	19.9
Nigeria	No Response	12	6.1
	Less than 10 persons	71	36.2
	10-20 persons	54	27.6
Staff Strength	21-30 persons	18	9.2
	31-40persons	3	1.5
	41-50 persons	41	20.9
	No Response	9	4.6
Areas of firm's main	Residential buildings only	127	64.8
professional practice	Non-residential buildings	37	18.9
experience	only		
	Residential and non-residential buildings	25	12.8
	Infrastructure (e.g. energy, transport, telecommunication and water supply)	7	3.5
	South East	18	9.2
Location of office(s)	South-South	53	27.0
(Geo-political zone in	South-West	55	28.1
Nigeria)	North-Central	33	16.8
	North-West	5	2.3
	North-East	2	1.0
	No Response	30	15.3
	Less than 1 year	52	26.0
Duration of use of e-	1 year - 5 years	62	32.0
Business technologies	6 years-10 years	22	11.0
and practices	Over 10 years	11	6.0
	Not Sure	49	25.0

Table 3. *Ranking of CSFs for e-Business technologies adoption in the firms.*

	No. of Responses	Sum	Mean	Std. Deviation	RII	Ranking
Access to reliable, affordable and fast Internet services	183	746.00	4.08	1.05	0.81	1st
Availability of skilled manpower to handle e-Business technologies and processes	180	722.00	4.01	1.05	0.80	2nd
Having adequate knowledge of the benefits of e-Business	175	690.00	3.94	0.97	0.79	3rd
Access to reliable ICT Infrastructure	184	721.00	3.92	1.07	0.78	
Top management commitment and support to adoption of e-Business tools and practices	179	699.00	3.91	1.04	0.78	
Having an efficient change management plan and training of all the stakeholders	175	681.00	3.89	0.97	0.78	4th
High level of computer literacy in the industry	174	676.00	3.89	1.01	0.78	
Access to affordable e-Business technologies and applications	184	712.00	3.87	1.10	0.77	
Security and authenticity of e-Business processes	173	669.00	3.87	1.08	0.77	5th
Availability of regular power supply	184	711.00	3.86	1.37	0.77	
Confidentially in e-Business processes	177	677.00	3.83	1.16	0.76	6th
High level of awareness of e-Business model in the architecture industry	176	659.00	3.74	1.11	0.75	
High level of trust on e-Business technologies amongst people in the industry	176	657.00	3.73	1.17	0.75	7th
Interoperability of e-Business software packages, applications and systems	175	652.00	3.73	0.97	0.75	
User-friendliness of e-Business technologies, practices and processes	177	654.00	3.70	1.13	0.74	8th
Compatibility of e-Business model with the existing work processes in the firm	168	616.00	3.67	1.08	0.73	9th
Acceptability of the legality of electronic contracts	173	623.00	3.60	1.18	0.72	
Employees' commitment to successful adoption of e-Business operations	172	618.00	3.59	1.01	0.72	10th
Existence of pro e-Business policies and legislation	171	609.00	3.56	1.19	0.71	
Existence of a uniform standard for describing, displaying and specifying construction materials, works and services	175	621.00	3.55	1.11	0.71	11th
Government support for the adoption of e-Business technologies in the industry	174	608.00	3.49	1.22	0.70	12th

are more than 10 years old with professional practice experience in residential developments and had their offices in southern part of Nigeria. These results suggest that a majority the architectural firms included in the survey started using e-Business technologies around 2011 and 2012.

4.2. Relationship between firms' characteristics and duration of use of e-Business technologies

Results of the Spearman's ranked correlation (Rho) tests revealed that whereas positive significant relationship existed between the firms' duration of use of e-Business technologies and their age (ρ =0.309, p=0.000), staff strength (ρ =0.205, p=0.015), number of offices in Nigeria (ρ = 0.286, p = 0.001), a negative significant relationship was found between the duration of use of e-Business technologies and location of the firms' office(s) (ρ = -0.221, p=0.007). However, no significant relationship was found between the duration of e-Business technologies use and the main area of firms' professional practice experience (ρ = 0.097, p=0.270). These results mean that the older a firm is, the larger its staff strength and the more the number of offices, the longer the time it has been using e-Business technologies in professional practice. In addition, the result also means that the duration of use of e-Business technologies is not a function of the main area of professional service delivery experience of the firms sampled.

4.3. CSFs for e-Business technologies adoption

Table 3 shows the results of CSFs for e-Business technologies adoption in the architectural firms sampled. The results reveal that all the 21 factors investigated have mean values of between 3.49 and 4.08 (see Table 3), suggesting that they all have potentials in ensuring a successful e-Business technologies adoption in architectural practice in Nigeria. Based on the relative importance index of each of the factors investigated, it is obvious that the top three CSFs with the highest influence on successful adoption of e-Business technologies in professional practice identified in the survey are 1) access to reliable, affordable and fast Internet services (RII = 0.81), 2) availability of skilled manpower to handle e-Business technologies and processes (RII= 0.80), and 3) having adequate knowledge of the benefits of e-Business (0.79), while the least factor is government support for the adoption of e-Business technologies in the industry (RII=0.70). The closeness of the RII of the three top factors is a measure of their relative contribution to a successful e-Business technology and processes adoption in architectural practices. It is also an indication that these three factors require the same level of attention for a successful adoption of e-Business technologies and process by in the firms.

4.4. Underlying dimensions of CSFs for e-Business technologies adoption

Before subjecting the dataset to principal component analysis (PCA), its suitability for this analysis was investigated using Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity. The test results produced KMO value of 0.897, which is greater than 0.70 and the Bartlett's Test of Sphericity ($\chi 2$ = 1673.709; df = 210) was significant at p=0.000; meaning that the dataset is suitable for the analysis. The PCA yielded four underlying dimensions (i.e. components 1-4) each with Eigenvalue greater than 1.0 and all accounting for around 62.1% of the variance in the 21 factors investigated as shown in Table 4. The suggested name and the factors loading on each of the components identified in Table 4 are shown in Table 5.

From the results in Tables (4 and 5), it can be seen that the first dimension, which is *'availability of skill manpower, electricity, affordable and reliable e-Business infrastructure*' has six factors loaded on it and counts for around 17.31% of the variance in all the 21 factors investigated. The second is *'existence of favourable operational environment for e-Business adoption*' which also has six factors loaded on it but accounts for about 16.91% of the variance in the 21 factors, while the third dimension, which is 'characteristics of e-Business technologies and processes' has five items loaded on it and accounts for around 13.99% of the variance in all the items include in the PCA. The last dimension is 'e-Business readiness of top management and employees' with four items loaded on it and accounts for around 13.86% of the variance in the 21 factors investigated.

5. Discussion

As stated earlier, this study investigated the critical success factors (CSFs) for e-Business technologies adoption in architectural practice in Nigeria. Arising from the findings are four key issues considered important for further discussion. First, the results revealed that a majority of the adopters of e-Business technologies among the architectural firms were those that had existed for over 10 years, had at most two offices located in southern part of Nigeria and residential developments as their main area of professional practice experience.

Table 4. *Model summary of the PCA.*

Table 4

Component	Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total(Eigenvalue)	% of Variance	Cumulative %
1	8.378	39.894	39.894	3.636	17.313	17.313
2	2.082	9.916	49.810	3.550	16.907	34.220
3	1.429	6.803	56.613	2.939	13.994	48.214
4	1.147	5.460	62.074	2.911	13.860	62.074

Extraction Method: Principal Component Analysis.

Table 5. *Underlying dimensions of CSFs for e-Business technologies adoption.*

Dimension names	Critical Success Factors (CSFs)	Factor loadings
1. Availability of skill manpower, electricity and affordable and reliable e-Business infrastructure	Access to affordable e-Business technologies and applications	0.718
	Access to reliable, affordable and fast Internet services	0.785
	Access to reliable ICT Infrastructure	0.836
	Availability of regular power supply	0.760
	High level of computer literacy in the industry	0.703
	Availability of skilled manpower to handle e-Business technologies and processes	0.575
	High level of awareness of e-Business model in the architecture industry	0.682
2. Existence of favourable operational environment for e-Business adoption	High level of trust on e-Business technologies amongst people in the industry	0.542
	Acceptability of the legality of electronic contracts	0.737
	Government support for the adoption of e-Business technologies in the industry	0.849
	Existence of pro e-Business policies and legislation	0.854
	Existence of a uniform standard for describing, displaying and specifying construction materials, works and services	0.610
3. Characteristics of e-Business technologies and processes	Interoperability of e-Business software packages, applications and systems	0.633
	Security and authenticity of e-Business processes	0.503
	Compatibility of e-Business model with the existing work processes	0.607
	User-friendliness of e-Business technologies, practices and processes in the firms	0.771
	Confidentially in e-Business processes	0. 458
	Employees' commitment to successful adoption of e-Business operations	0.674
4. e-Business readiness of top management and employees	Top management commitment and support to adoption of e-Business tools and practices	0.459
	Having adequate knowledge of the benefits of e-Business	0.755
	Having an efficient change management plan and training of all the stakeholders	0.676

The results also indicated that the highest proportion of the firms had been using e-Business technologies for less than six years. Notably, the characteristics of firms encountered in this survey seem to be consistent with the findings of previous studies (Ogunmakinde et al., 2014; Oluwatayo et al., 2014) indicating that most architectural practices in Nigeria are small and medium size firms operating in major town and cities in Nigeria. The results also suggest that the use of e-Business technologies in professional practice by the architectural firms in Nigeria is a recent development as most of the firms encountered in the survey started using these technologies and processes between 2011 and 2012, while around 17.0% of them began using them before this time. Based on the evidence from this research, it can be inferred that whereas architectural practices in the developed economies had embraced e-Business technologies and processes in the mid-1990s as indicated by Tepavcevic et al. (2012), most of their counterparts in Nigeria started using these technologies about 25 years later. This may imply that many of the registered architectural practices in Nigeria sampled are late adopters e-Business technologies, which suggests a slow rate of diffusion of e-Business technologies and indeed digital technology as well as Internet penetration in architectural practice in Nigeria.

Second, the study also found significant positive relationships between the duration of use of e-Business technologies and the age, staff strength, number of offices and a negative relationship with location of the office(s) in Nigeria. This means that the differences in the duration of use of e-Business technologies among architectural practices in Nigeria is a function of their age and staff strength as well as the location and number of offices operated. This specific finding appears to be consistent with those of a recent study by Aduwo, Ibem, Ayo-Vaughan, Afolabi, Uwakonye & Oluwunmi (2020) revealing that the

adoption of e-Procurement by construction entities in Nigeria, which is one aspect of e-Business, varied according to their characteristics. Further analysis of the results revealed that the adoption of e-Business by architectural firms seems to increase with their age, staff strength, and number of offices. This is understandable because the older firms with large staff strength and multiple offices are confronted with the greater challenge of management, integration and exchange of information than the younger firms with fewer staff and less number of offices. Similarly, the result showing that there was a strong relationship between the duration of use of e-Business technologies and location of the firms' offices might be explained based on the observation that most of the firms have their offices in big cities in the southern part of Nigeria such as Lagos and Port Harcourt where there appears to be more demand for architectural services and availability of ICT infrastructure. This might suggest that architectural firms in large cities are most likely to adopt e-Business technologies than those in smaller cities where the demand for architectural services are less and the supply of ICT infrastructure is marginal. However, the result showing that there was no significant relationship between the duration of e-Business technologies use and the firms' main area of professional service delivery experience was expected. This is because a majority of the firms have their professional practice experience in residential buildings, which of course is in line with the submissions by several authors (Arif & Karam, 2001; Authors et al., 2018; Ogunmakinde et al., 2014; McDonald & Madhavaram, 2007) indicating that across the world, the core professional area of architectural practices is the provision of building design and construction services to different categories of clients.

Furthermore, in line with the existing studies (Afolabi, Ibem, Aduwo, Tunji-Olayeni, & Oluwunmi, 2019; Dubelaar et al., 2005; Kolakota & Robinson, 1999), all the 21 factors investigated emerged as CSFs for e-Business technologies adoption in professional practice in the firms sampled. However, in order of their contributions to facilitating a successful adoption of e-Business technologies and processes, the top three factors are access to reliable, affordable and fast Internet services; availability of skilled manpower to handle e-Business technologies and processes; and having adequate knowledge of the benefits of e-Business technologies. These results are well expected because evidence in the literature (IBM, 2001; Issa et al., 2003; Ruikar & Anumba, 2008) shows that the e-Business model relies mainly on the use of the Internet or web-based technologies to support the execution of procurement and transaction activities by firms or organisations. Therefore, the emergence of access to reliable, affordable and fast Internet services as the most important CSF for e-Business technologies adoption in professional practice by architectural firms is considered to be order. In fact, this finding agrees with that of a recent study by Afolabi, Ibem, Aduwo, Tunji-Olayeni, & Oluwunmi (2019) which also reported that access to reliable and fast Internet services at affordable cost was the most important CSFs for the adoption of e-Procurement in construction business in Nigeria.

Similarly, the emergence of availability of skilled manpower to handle e-Business technologies and processes as the second most important CSFs for e-Business technologies adoption by architecture firms is also in tandem with the finding by Afolabi, Ibem, Aduwo, Tunji-Olayeni, & Oluwunmi (2019) as previously highlighted. Since the previous authors have shown that the adoption of e-Business technologies involves a transition from the adoption of manual tools and processes to the use of digital media and e-Tools (Bowmaster et al., 2017; Costa & Tavares, 2014) and remodelling traditional work process (Cherian & Kumaran 2016), the need for skilled personnel to oversee the implementation of e-Business technologies and processes for effectiveness and efficiency in professionals service delivery by architectural firms may not be considered to be out of place. In fact, previous studies had reported that the lack of technical expertise was a key impediment to the uptake use of e-Procurement, which is incidentally an aspect

of e-Business by construction organisations in Nigeria (Aduwo, Ibem,Tunji-Olayeni, Uwakonye & Ayo-Vaughan, 2016), the UK (Eadie et al., 2010), and Turkey (Isikdag, 2019). This suggests that the skill set needed to function effectively in e-Business environment is different from those required in the traditional and papered-based business settings; and hence architectural firms need to have adequate number, well-trained and experienced ICT savvy staff to ensure that they can successfully carry out their business operations using e-Business technologies and processes.

Last, it was also found that four underlying dimensions of CSFs for e-Business technologies in architectural practice were identified in this research. These dimensions are related to technology, organisational and environmental factors. For example, the first dimension- availability of skill manpower, electricity, affordable and reliable e-Business infrastructure comprises human, technology and economic factors required for the adoption and use of the e-Business model, while the second deals with the operational environment that favours the adoption of e-Business technologies and processes by the firms. Furthermore, the third dimension deals with the characteristics of e-Business technologies and processes (i.e. technology), while the last dimension is e-Business readiness of top management of the firms. Although, the current study identified 'existence of favourable operational environment for e-Business adoption' as one of the dimensions, the other three dimensions identified in this research seem to be in line with the strategic, structural, and management factors identified by Dubelaar et al. (2005) as well as the human, technology and management factors reported by Afolabi, Ibem, Aduwo, Tunji-Olayeni, and Oluwunmi (2019). Notably, the identification of the characteristics of e-Business technologies and processes as one of the dimensions of the CSFs in this study appears to be in line with the tenets of diffusion innovation theory, which identified the characteristics of innovation (technology) as one of the factors that determines the extent of its adoption by individuals and organisations (Rogers, 2003). These are also in line with the technology, organisation and environment factors identified by Tornatzky and Fleischer (1990) as capable of determining the extent of the adoption of innovation by organizations or firms. In all, these findings are pointing to the fact that these four dimensions are the main factors and situations that can influence the uptake and sustain use of e-Business technologies and process among architectural firms in Nigeria.

6. Conclusions, study implications and recommendations

In this study, the critical success factors(CSFs) for e-Business technologies adoption in professional practice by architectural firms in Nigeria were investigated. From the findings, the following conclusions were made. First, it can be concluded that the categories of architectural firms that use e-Business technologies in Nigeria are those that are over 10 years old, have at most two offices in areas where there are huge markets and involved in residential developments. The implication of this findings is that for clients who desire to engage the services of e-Business-compliant architectural firms, they should beam their searchlight on those that have existed for over a decade and have offices in large cities. The study also implies that architectural practices in Nigeria involved in residential developments have access ICT infrastructure and skilled manpower; hence they are able to adopt e-Business technologies and processes in their operations in line with the current trend in the global architecture markets.

Second, there are relationships between the duration of e-Business technologies use and architectural firms' age, staff strength, number and location of offices. From these findings, it can be inferred that differences in the duration of e-Business technologies adoption in professional practice by architectural firms in Nigeria, can be explained based on variations in their age, staff strength, number and location of offices. This implies that organizational characteristics can be used as parameters for identifying architectural practices that are most likely to adopt e-Business technologies and processes, and may most likely em-

brace emerging digital concepts and practices such as the Internet of Things (IoT) in Nigeria and other countries in sub-Saharan Africa and beyond.

Third, it can also be concluded that the top three CSFs for e-Business technologies adoption in professional practice by architectural firms in Nigeria that require priority attention by their principals are the availability and access to reliable, affordable and fast Internet services; availability of IT skilled manpower; and having adequate knowledge of the benefits of e-Business. The implication of this is that for architectural firms in Nigeria, other countries in sub-Saharan Africa and beyond who are yet to embrace e-Business technologies and process in their operations, they must invest in the acquisition of Internet technology and information technology savvy human resource base to ensure that their adoption of e-Business model will be successful. In addition, the principals and top management staff of architectural firms must have adequate understanding of the capabilities and full benefits of e-Business technologies and processes in professional practice. This is to ensure that firms acquire the right set of ICT infrastructure capability suitable for their e-Business operational requirements and derive optimal benefits from their adoption in the delivery of quality services to their clients. This will no doubt require financial investments in knowledge acquisition by top management staff of the firms and their employees.

Further, the fourth conclusion is that the key dimensions of the CSFs for e-Business technologies adoption in architectural practice are availability of skill manpower, electricity, affordable and reliable e-Business infrastructure; existence of favourable operational environment for e-Business adoption; characteristics of e-Business technologies and processes; and e-Business readiness of top management and employees. This means that these are the four key aspects principals of firms or stakeholders understand and interpret the 21 CSFs for e-Business technologies and processes adoption in the architecture industry investigated in this research. The implication of this is that for architectural practices in Nigeria and possibly other countries in sub-Saharan Africa and beyond to successful adopt and use e-Business technologies and processes and other emerging digital technologies and practices, they must adequately evaluate and give priority attention to these four groups of factors and conditions before embracing the e-Business model in their operations.

Last, although this research has achieved its goal by identifying the specific factors and conditions that must be given priority attention for a successful adoption of e-Business technologies and processes by architectural firms in Nigeria, it is not without some limitations. First, since the data used were derived mainly from the administration of structured questionnaire to participants, the findings are limited to the biases of the respondents. In view of this, future study is suggested and such study should consider combining the administration of questionnaires and interviews in the data collection process. Second, the research sampled only registered architectural firms in Nigeria; and thus the findings are limited to this category of firms and cannot be extended to unregistered architectural and other professional firms in the Nigerian construction industry. Based on this, it is recommended that other study should be conducted to explore the situation among other professional groups in the construction sector, including engineers, quantity surveyors, facilities and project managers and builders among others. Last, the current study is on Nigeria, and thus its findings may have limited implication for other countries, except those in the developing countries in sub-Saharan Africa and other parts of the world that share similar experience with Nigeria when it comes to architectural practice and ICT infrastructure development and adoption.

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