Jurnal Teknologi

Environment Variables on IT Adoption: A Case of Nigerian Construction Organizations

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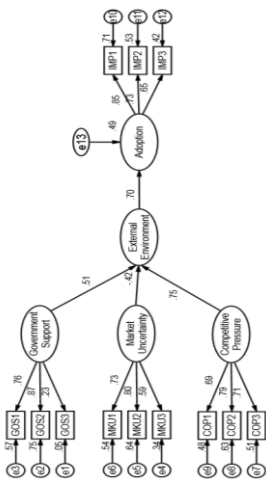*Corresponding author: aywaziri@gmail.com

Graphical abstract

Abstract

Firm's external environment combines many attributes and plays a vital role in IT adoption. Technological innovations are adopted as organizational reactions to change and for influencing the business environment. This study examined the effect of external environment on IT adoption in construction organizations. Specifically, the study empirically explores the external variables, assessed their effects and determined how they can optimally be combined to enable IT acceptance. The data collected was analysed using structural equation modelling analytical approach. Results of the analysis revealed that external environment strongly influence firm's IT adoption with a path coefficient of 0.70 and a z-value of 10.5. Furthermore, a confirmatory factor analysis conducted confirmed competitive pressure, government support and market uncertainty as the most significant variables of firm's external environment in relation to IT implementation with a standardized parameter estimates of 0.75, 0.51 and -0.41 respectively. Precisely, competitive pressure and government support were strongly and positively related to IT adoption while market uncertainty exhibited a strong but negative relationship. It was recommended that managers of construction organizations should, strategically, overcome the pressures they exert from their competitors for improved market share and general organizational performance. Furthermore, government should strive to provide adequate IT infrastructures and enablers within its responsibilities such as adequate electricity, incentives and clear IT policy.

Keywords: IT adoption; construction organizations; organizations; structural equation modelling; external environment

∎1.0 INTRODUCTION

Today's construction business organizations operate in a rapidly changing and unpredictable environment. The environment plays a significant role in organizations' decisions and abilities to adopt advanced technologies [1]. The external environment composed of various variables that affect the operations and determine what can possibly be achieved by business organizations.

Firms have little or no control and manipulation of their external environment. Every decision to be taken should be projected in light of the possibilities of external turbulences. The effects of these external turbulences are more pronounced in developing countries where basic amenities for IT implementation are grossly lacking.

Studies in organizational information technology (IT) adoption have found external environment as the major determinant of implementation [2-4]. These studies recommended a broader assessment of firm's external environment when technology adoption is considered. According to [5], firm's external environment consists of peer influence, competitive pressure and government pressure such as regulatory concern. The authors' findings show significance of these variables in e-business implementation and use.

Research in IT implementation and use in Nigerian construction industry have examined the level of computer application [6, 7] and general IT implementation [8-12]. However, none of these studies have precisely addressed the effect of external environment on IT adoption among construction

organizations. Additionally, none of the studies have examined IT adoption in all the professional organizations in the industry. Furthermore, these studies were mostly conducted from the southern part the country.

There is, therefore, the need for a thorough study on the effect of external environment on IT adoption among the construction organizations combining all the professional business firms in the industry. Specifically, the study should explore the external variables, assess their effects and determine how they can be best combined to enable IT adoption.

■2.0 LITERATURE REVIEW

Level of customer demand or intelligent client brief, intensity of competition, government support, market uncertainty and influence of trading partners have all been found to exert some significant influence in firm's decision to use e-business. Earlier, [13] proposed a model of technology adoption in SMEs. Their result shows that 35% of IT adoption was explained or caused by organizational readiness, national readiness and environmental pressure. The study defined national readiness as the ability of the infrastructure to support IT use by organization. Perceived government support and perceived supporting services was the two dimensions of national readiness. Another significant factor described by [13] was firms' industry readiness with three dimensions: perceived industry standard of IT; perceived trading partners' readiness on IT and perceived level of trust among industry players. The study did not show the individual effect of every variable to determine its contribution in firms' intention to use. How each variable can be used to enhance IT adoption was also not evident in the study. Construction managers need a clear guide in terms of how best to organize the variables for enhanced adoption.

Another model of organizational IT adoption proposed [14] was a meta-theoretical framework expanding the constructs of TAM (technology acceptance model) and TOE (technology, organization and environment). Firm's external environment, according to the authors is a combination of customer readiness or demand, pressure from competitors, trading partners' readiness (peer influence) and perceived trust. Customer readiness deals with potential market volume, consumer understanding and appreciation of ecommerce application adoption and its profitability. Competitive pressure is the pressure placed on firm to implement a technology innovation so as to remain in business. Trading partners such as customers, dealers and suppliers also influence firm's willingness to digitize their businesses. The external environment variables are now briefly discussed below.

2.1 Government Support

Government support exerts a significant influence on organizational IT adoption. Some of the support arises from the provision of adequate infrastructure suitable for IT implementation in organizations. Additionally, government supports IT adoption by serving as a role model to firms and provision of incentives. Business organizations are therefore motivated in IT adoption through support they received from the regulating state. According to [15] rapid and massive progress in IT adoption by some Asian economics (Korea, Japan, Singapore, Malaysia etc) was attributable to the role played by government.

A survey [16] involving 150 South African managing directors of organizations to develop a conceptual model of eCommerce adoption in developing countries was conducted. It was found that government eReadiness strongly affects eCommerce adoption and institutionalization. Similarly, [17]

empirically analysed ICT usage on logistics activities of manufacturing companies in south-western Nigeria. Their findings showed that ICT has a significant effect on logistics and manufacturing firms recognize its contribution and influence. The authors further identified low ICT utilization due to lack of support from government in areas such as poor ICT policy initiatives and lack of adequate ICT basic amenities.

Researchers have enumerated various barriers to ICT adoption in business organizations. Examining ICT Utilization in Administrative Tasks in Iranian Construction Organizations, [18] conducted 12 semi-structured interviews with construction practitioners and software developers within the industry. They found that low internet connection, high cost of internet charges, lack of construction ICT standards and high cost of hardware are the major impediments to an effective ICT utilization by firms. While some of these are purely governmental responsibilities, it is not clear in the study how these problems can be tackled.

ICT adoption in developing countries suffers setback primarily due to inability of the state to provide adequate electricity supply and support organizations with incentives. The study by [19] confirmed that poor electricity supply, lack of infrastructure, poor service from ISP providers, and lack of general support from Gov't and banks were found to be the major factors hindering ICT adoption among SMEs in Nigeria. It is evident, therefore, that provision of basic ICT infrastructure empowers the organizational readiness to adopt and utilize IT applications. As [20] argues, national e-readiness contributes positively to the organisational readiness for emerging technologies. National eReadiness according to the authors comprises of internet connectivity, business environment, legal environment and government policy and vision.

2.2 Market Uncertainty

Market uncertainty plays a key role in organization's ability to implement advanced ICT applications since business success is essentially concerned with product acceptance. Market uncertainty basically concerns the risks of negative reactions from customers. According to [21] in Nigeria, government is the largest client of the construction industry, accounting for more than 60% of the entire construction output and about 95% of all civil engineering projects. This heavy dependence of construction organizations on the government for contracts leads to corruption from government officials. For instance, an earlier study [21] to empirically investigate the problems of the Nigerian construction industry reveals that construction firms face a multiple of challenges such as delays in receiving payments for completed works, government emphasis on foreign firms and political instability. Such an economic environment is not healthy to firms to invest in IT.

Recent studies on ICT adoption in Nigeria focused on the current state of its utilization. In a survey to examine the current usage of ICT in professional practice in the Nigerian construction industry, [22] administered survey questionnaires directed to architects, engineers and quantity surveying firms. The author found that professional fees and job sizes are not enough for ICT implementation. In a similar study, [23] evaluated the impact of IT on Quantity Surveying service delivery in Nigeria. Their finding revealed that inadequate job order, high cost of engaging a computer literate staff and low professional fees discourages firms from investing in ICT.

2.3 Competitive Pressure

The intensity of competition among firms significantly brings about fast-paced technological change and improved firm

performance. Competition arises from rivalry among firms for customer attention [24] to increased market share and profit margin. This led firms to introduce change into their businesses in order to remain, atleast, relevant. For instance [25] empirically examined the determinants of ICT adoption among Swiss business sector. The author found that pressure from competitors significantly affects firms' intention to adopt ICT. In a similar study, [26] examined the impact of ICT on firm's competitiveness from six European countries. Their findings suggest that ICT implementation for e-business utilization has an influence on firm's e-business competitiveness and performance.

Various IT technologies are being implemented by organizations depending on their needs at a particular point in time. Adoption of each IT technology may exhibit a different scale of pressure for a firm. In their case study, [27] used evidences from ten organizations in Hong Kong to identify the most significant factors influencing the adoption of Web-Based Technologies. They discovered that seven of the ten organizations interviewed felt under intense pressure from their competitors or similar organizations to adopt web-based technology

Competition among construction firms in developing countries takes a wider dimension with the recent invasion of Chinese firms. The entry of Chinese firms into the Nigerian construction industry, according to [28] has resulted in strong competition on speed of project delivery, supply-chain management as well as overall service quality. This is not possible on the part of the local firms without implementing some changes into their organizational and operational structure.

2.4 Peer Influence

Organizations inclination or tendency to innovate is affected by threats and opportunities presented by its environment. The nature of actions by peer organizations affects the way an organization behaves. Effects of peers in influencing adoption of innovation were evident in many studies. When organizations learn of a positive norms and values from sources such as media, trade partners and business and professional associations concerning a certain business practice, they experience normative pressures to adopt such business practice [29]. Earlier organizational IT adoption studies [30] have confirmed peer influence as an important external environment variable in IT adoption. Son and Benbasat [30] identified two groups of factors (efficiency and legitimacy-oriented factors) influencing organizational participation in business to business (B2B) e-marketplaces. They argued that intent to adopt B2B e-marketplace by firms is strongly affected by rate of adoption among peers.

Subsequent IT adoption studies in organizations [30-32] have found an organizations' intention to adopt technological innovation is primarily influenced by normative pressures. Specifically, [32] conducted an empirical study to find out why organizations are slow in the adoption of virtual world. Perceived memetic pressures from competitors and perceived normative pressures from trading partners, professional and trade associations were found to be positively related to organizations' intent to adopt virtual worlds. This study shows the extent to which external environment variables of peer influence strongly affects firm's decision to adopt any technological innovation.

The study of [33] further confirms the influence of normative pressure on firm's intention to adopt IT innovation. The authors developed, operationalized and empirically tested a model that depicts brokerage firms' intention to adopt electronic trading systems. They found that external normative pressure such as general level of adoption of a specific IT innovation by network and internet service providers, firms in other industries and ICT applications adopted by government departments significantly influence brokerage firms' intention to adopt Electronic Trading Systems (ETS).

2.5 Customer Demand

Customer demand for a product is the most significant factor fuelling business growth. Construction activities in developing countries, like it's developed counterpart, is affected by the level of demand of construction output by both public and private clients. Researchers [34-36] have observed that as the major client of construction firms, government spending, in form of infrastructural development, is the major contributor to the industry. This fuels corruption in the entire system since government officials choose, not by merit, who wins a given construction contract. Most of the indigenous firms are inexperienced and deficient in financial effectiveness and innovations [37] thereby losing most of the construction contracts to the expatriates multi-national firms [38]. This trend implies that local firms do not have adequate job order or frequent construction contract to guarantee any investment in manpower, massive capitalization and IT implementation.

The study by [34] to examine the business development strategies of firms in the Nigerian construction industry reveals that the most frequently used strategies by contracting organization for survival include market penetration and organization/internal development. The author recommended a partnership between local firms and financial institution for enhancement of firms' share of the market. Firms, as further recommended by the authors, should expand their scope of business to multi-dimensional.

The organizational structure, strategy and vision of a contracting firm are very essential in its survival in an environment dominated by well-equipped foreign companies. Prior to the above study, [39] studied the business structure in terms of performance and output of the contracting firms in Nigeria. The study discovered that firm's annual turnover, staff strength and equipment capacity are significant to the business structure of a local firm. The study further reveals that most of the indigenous firms surveyed specialized in building works leaving heavy engineering contracts from government in the hands of the foreign firms. These are cases of poor financial status.

■3.0 METHODOLOGY

This study examined the effect of external environment on IT adoption abilities by construction organizations. A hypothesized linear relationship was proposed and tested using structural equation modelling analytic approach.

3.1 Instrumentation and Data Collection

The construct (external environment) consists of 5 sub-constructs–government support, market uncertainty, competitive pressure, peer influence and customer demand. Government support and market uncertainty sub-constructs were assessed using 3 custom-designed items each validated by construction professionals from both academic and construction industry. Competitive pressure and customer demand sub-constructs were measured using items developed by Khalifa and Davidson [33]. Peer influence was measured from items developed and validated by Son and Benbasat [30]. All adapted items were modified where necessary to reflect the study context. Consequently, all items were loaded on a 5-point likert-type scale where respondents' agreement/disagreement with the statements was assessed.

Prior to the administration of the questionnaires, the content validity was assessed by professionals. For pre-test analysis, 95 questionnaires were administered and analysis was carried out on 72 valid questionnaire responses. Item scale reliability were tested using SPSS version 22.0 with Cronbach's alpha values 0.88, 0.75, 0.78, 0.63, and 0.71 for government support, market uncertainty, competitive pressure, peer influence and customer demand respectively.

Stratified random sampling was used to select 6 states from the 18 states of northern Nigeria. A total of 390 questionnaires were administered to practicing professional firms from the construction industry (Quantity Surveyors, Architects, Builders, Estate Managers and Urban and Regional Planners). A total of 317 questionnaires were returned and analysis was conducted on 284 valid responses. Descriptive statistics shows that 72% of the respondents were male and 28% female. Of the respondents, 29%, 36%, 19%, 7% and 9% were Architects, Quantity Surveyors, Builders, Estate Managers and Urban and Regional Planners respectively. Additionally, 12% of the surveyed firms specialized in construction contracting services, 68% construction consultancy services and 20% engage in both.

3.2 Data Analysis and Results

To establish the nature and extent of the effect of external environment variables on organizations' willingness to adopt IT, structural equation modelling using SPSS Amos version 22.0 was used. SEM allows a set of relations between independent and dependent variables to be tested for causal or correlational relationships and modelling [40]. The two-step approach recommended by [41] was adopted in the model development process. The measurement model was first assessed using confirmatory factor analysis before the final structural model.

The data was screened for missing values, outliers and normality of distribution. Furthermore, skewness and kurtosis was assessed using descriptive statistics from SPSS. All values of skewness and kurtosis lie within the range of values ±2 and ±7 respectively which is consistent with [42] recommendation.

The CFA measurement and the structural models were assessed based on model fit indices acceptable cut off values suggested by [43]. Therefore, GFI, AGFI, CFI and NFI were accepted only when their values are up to 0.90. Root Mean Square Error of Approximation (RAMSEA) and Chi-square were acceptable at ≤0.10 and ≤5.0 respectively.
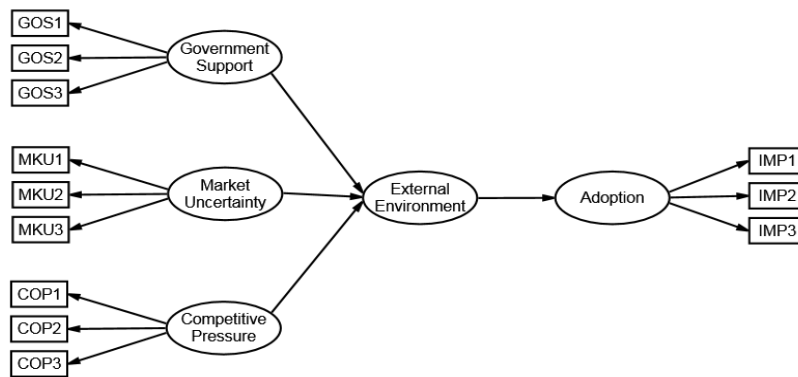

Figure 1 Hypothesized structural model of external environment

The Figure 1 above shows the hypothesized structural model of the study. At the completion of the CFA process, peer influence and customer demand sub-constructs were removed due to poor standardized factor loading less than 0.50 using [44] recommendation. All indicators of government support, market uncertainty and competitive pressure were however, retained after the CFA model process.

Figure 2 below shows the final structural model of external environment. As seen from the model, all standardized factor loadings were significant ($P < 0.001$). The GFI was 0.93, AGFI = 0.91, RMSEA = 0.098, NFI = 0.90, CFI = 0.90, TLI = 0.90 and the CMIN (x^2/df) = 4.54. Interestingly, the path coefficient is strong (0.70) and statistically significant. In essence, the result of the analysis shows that external environment has a direct and positive relationship with IT adoption by construction organizations. About 50% of the variance in the observed and unobserved variables was accounted for by the model.
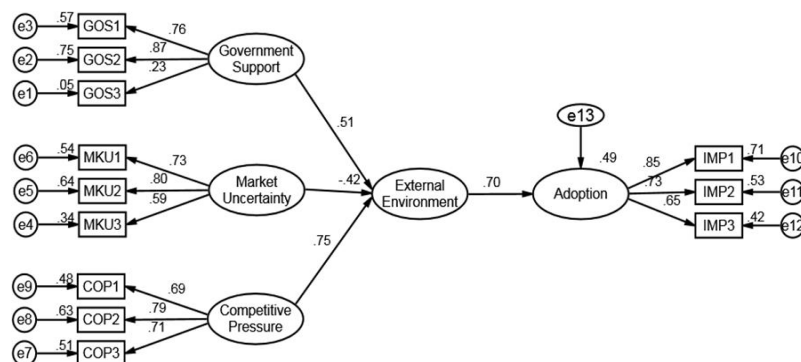

Figure 2 Final structural model of external environment

Considering the values of the standardized parameter estimates, it can be said that a unidimensionality of scales are achieved in the model development process. According to [45], constructs should display estimates of 0.50 or larger. Estimates less than 0.50 indicate that variance due to measurement error is larger than the variance captured by the factor.

The GOS3 indicator, as shown on the final structural model, exhibits a factor loading of 0.23 (less than 0.50). A removal of that indicator rendered the model unidentifiable signifying inability to perform further estimation again. Since no further improvement can be made and a parsimonious model was achieved, indicator GOS3 can be retained as part of the model.

Table 1 below shows the final factor structure of all the constructs in the study. Deleted items were indicators found to be weak in factor loadings (less than 0.50) and subsequently dropped.

Furthermore, the model was assessed for reliability and validity of constructs [46]. For these purposes, the reliability of the constructs was examined with the aid of Cronbach's alpha and construct reliability (CR) as suggested [47-48]. For validity, the convergent and discriminant validities were assessed based on the significance of standardized parameter estimates and correlations among factors [49].

Table 1 Final factor structure of external environment

Original Item	Item Label	Deleted Items
Government Support		
• Government supports ICT adoption by providing adequate incentives to firms	GOS1	
• Government improves infrastructure to support ICT adoption in firms	GOS2	
• Government serves as a role model to firms for ICT implementation	GOS3	
Market Uncertainty		
• Our firm operates in a stable economic environment	MKU1	
• We have adequate job order to encourage investment in ICT applications	MKU2	
• Professional fees are adequately paid to guarantee ICT implementation in our firm	MKU3	
Competitive Pressure		
• Competitors that have implemented ICT in their firms benefited greatly	COP1	
• Competitors that have implemented ICT in their firms are perceived favourably by customers	COP2	
• Competitors that have implemented ICT are more competitive	COP3	
Peer Influence		
• Large pressure is placed on our firm to implement ICT by professional member firms	PEI1	Deleted
• We actively participate in conferences and workshops of our trade profession on ICT implementation	PEI2	Deleted
Customer Demand		
• Customers that matter to us believe that we should use ICT in our services	CDD1	
• We may not retain our important customers without implementing ICT	CDD2	Deleted
• Customers that are crucial to us encourage us to use ICT in serving them	CDD3	
ICT Implementation		Deleted
• Our firm intends to implement ICT for improved service delivery	IMP1	
• It is likely that this firm will take steps to implement ICT	IMP2	Deleted
• We will install all necessary professional and non-professional software in our firm	IMP3	
• ICT will be deployed in all units soon	IMP4	Deleted

The Cronbach's alpha coefficient reliability assessment for all scales exceeded the minimum cut-off mark of 0.70 recommended by [47] and C.R is also ≥ 0.60 as depicted in Table 2. Thus, constructs used in the study are reliable. In the case of validity, the results obtained from goodness-of-fit indices confirm construct validity. Additionally, convergent validity was evident since results have shown that all standardized factor loadings for indicators measuring the same constructs are statistically significant [50-52]. According to [53], the correlation between any given two constructs should not be ≥ 0.85 for evidence of discriminant validity. Results obtained through confirmatory factor analysis support this case.

Table 2 Assessment of reliability and validity of constructs

Constructs	Indicators	Factor Loadings	Cronbach's Alpha	C.R	C.R (z-value)
Government Support	GOS1	.76	.88	.68	4.5
	GOS2	.87			4.5
	GOS3	.23			2.6
Market Uncertainty	MKU1	.73	.75	.75	9.9
	MKU2	.80			9.7
	MKU3	.59			6.8
Competitive Pressure	COP1	.69	.78	.78	11.6
	COP2	.79			11.5
	COP3	.71			9.4
IT Adoption	IMP1	.85	.71	.79	4.3
	IMP2	.73			10.4
	IMP3	.65			10.5

■4.0 DISCUSSION OF RESULTS

This study adds to existing body of knowledge on organizational IT adoption by examining external environment variables and their level of impact on technological innovation in construction firms. Findings from the study reveal some interesting and meaningful implications. The results confirm the critical role of external environment variables in influencing IT implementation. The observed association between external variables (government support, market uncertainty and competitive pressure) and IT adoption is certainly clear. Firstly, the study confirms that competitive pressure is the most significant factor that compels IT adoption in construction organizations. This implies that IT adoption necessitates firm's ability to identify where it fits in the market and tactically draws customers' attention for increased market share. The domination of the Nigerian construction industry by Chinese and other foreign firms has ignited a strong competition in the industry. This finding is consistent with [54] who argued that the intensity of competition among organizations results in faster technological change.

Adequate support from government is ranked second in firm's ability to adopt e-business in Nigerian construction industry. This implies that construction firms require government intervention in the provision of IT adoption amenities such as adequate supply of electricity, support and encouraging of provision of cheaper IS service, establishment and adhering to a sound and adequate IT policy as well as provision of incentives to firms to encourage general IT implementation. This finding supports the works of [17-20].

As expected and reflected in many studies of IT adoption, market uncertainty was found to be negatively related to IT adoption. Uncertain market condition, therefore adversely affects IT adoption. In essence, construction managers decline to invest in IT facilities in uncertain economic settings. This is logical and consistent with [23] who argued that construction managers are reluctant to invest in IT due to uncertainties in job frequency. Where and when job order is inconsistent, fear of expenditure in IT facilities arises since return on investment cannot be guaranteed.

Generally, the findings of this study confirmed that external environment is a significant determinant of IT adoption in the construction industry.

■5.0 CONCLUSION

In sum, this study assessed the effect of external environment variables on IT adoption in organization. External variables supporting IT adoption are competitive pressure, government support and market uncertainty in order of severity. The study makes a theoretical contribution by confirming that external environment strongly and positively influence IT adoption construction organizations. More importantly, the factor-structure of the external environment construct was established through confirmatory factor analysis and SEM was used to assess the contribution of each sub-construct in IT implementation.

The results obtained from this study confirm that external environment is an important variable in IT adoption by construction organizations. Specifically, competitive pressure and support from government are the two most important aspects of firms' externalities.

Firms should act appropriately on the pressures they exert from their competitors. Furthermore, government should strive to provide adequate IT infrastructures and enablers within its responsibilities such as adequate electricity, incentives and clear IT policy.

This study assumes both theoretical and practical implications. In theoretical terms, as the first study of its kind, researchers within the study context can explore further and replicate or extend the study to other industries. Practically, construction managers willing to deploy technological innovations in their organizations could use the findings as guide to successfully embed their organizations within the ecommerce arena.

This study is not vaccinated from certain limitations. Firstly, external environment alone cannot be regarded as the only determinant of IT adoption in organizations. Furthermore, though adequate sample size was used, the study considered only northern Nigeria which may be different from other regions.

Further studies, should therefore consider external environment variables along with others such as employees' resistance to change, readiness for change and commitment to change. Additionally, a large data covering the entire geopolitical zones of Nigeria should be collected and analyzed to warrant generalization of the findings.

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