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Research Article

Impact of Internet of Things (IoT) Factors from the Perspective of Nigeria Construction Professionals

Alao Mohammed Kaseem[1, *], **Bella-Omunagbe Cyprian**[2]

[1]Department Building Technology, School of Environmental Studies, Auchi Polytechnic, Auchi, Nigeria
[2]Tet-Fund Centre of Excellence in Creative Innovation and Entrepreneurship, Auchi Polytechnic, Auchi, Nigeria

Abstract

The Nigerian construction industry is bedeviled with poor project performance and outcomes which internet of things (IoT) could address if applied. The application of IoT on Nigerian construction site is very minimal due to certain obstacles, namely, lack of adequate technology, inadequate cyber security, organizational policy and environmental factor, etc., which hinders the implementation in Nigerian's construction industry. Therefore, this study aim at examines the impacts of internet of things (IoT) from the perspective of Nigerian construction professionals. Using a questionnaire survey that was duly validated by experts. Data was collected form 150 construction professionals involving Quantity Surveyors, Architects, Builders and Civil Engineers, Cronbach Alpha reliability technique was used to determine the internal consistency of the questionnaire items at 0.84. Data collected were analyzed through Confirmatory factor Analysis (CFA) using Statistics Package for Social Sciences (SPSS) and Analysis Moment of statistics (AMOS). After a preliminary analysis (descriptive), data from respondents were found to be appropriate for inclusion in Confirmatory factor analysis (CFA). The CFA was achieved and the outcomes of the analysis support the one-factor model of the internet of things having significance impacts on the performance of professionals in built environment. The findings show that the professionals generally agree that internet of things (IoT) factors can bring about better-quality building projects and, increase construction project performance. This paper derives its significance from the need to increase construction project performance and effective building production management.

Keywords

Internet of Things, Construction Industry, Professionals, Confirmatory Factor Analysis

1. Introduction

Nigeria is one of the growing emerging countries in Africa with the need of infrastructures to meet the requirement of the people. Nigeria has a housing shortfall of about 17 million and other many infrastructural shortfalls [2]. Infrastructure that is important to the growth of any country's economy demands massive capital expense which interprets into considerable static costs of any organization [1], and the wish to invest capital into infrastructure is a function of better and quality output.

Therefore, maximizing output from capital project investments calls for tools and techniques such as IoT application that helps in achieving better and greater output. IoT is an

*Corresponding author: kaseemalao@yahoo.com (Alao Mohammed Kaseem)

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incorporation of devices, software, sensors, and networks to work jointly to extract important and working data or information made from it [3]. Internet of things (IoT) profits the organization in many ways from enhancing the efficiency of the organization to increase customer satisfaction but the major benefit of IoT that will influence every business is communication, control, and automation, cost savings [4]. IoT assistances communicate between the humans and the systems and decreases personnel as well as equipment failure cost.

Internet of things (IoT) assistances in reducing maintenance costs of the plant facilities and increasing output in a construction firm with the convenience real-time data. Transportation and shipping companies are also able to reduce maintenance costs and improve delivery service using IoT [6]. However, IoT contains more necessary sensors, acceptable computing competence and desirable wireless networks that permit the distribution of IoT application across numerous sectors of the organization including construction, manufacturing, telecommunication, agriculture, power and energy, health care, supply chain, logistics, data filtering, security and defense industries. The most commonly used IoT applications are inter-connected security systems, regulators, cars, electronic machines, electric lights used in houses and commercial places, alarm clocks, speaker systems, vending machines, Since the beginning 20th century, the ICT had received wide acceptance in the construction industry of many developed nations [7, 5]

Therefore, ICT signified competence in eliminating unnecessary capital and operation costs associated with construction projects. The problem of stakeholder dissatisfaction had also been mitigated through the application of IoT [8]. This implies that the IoT applications on construction projects give both tangible and intangible benefits [9]. The cost saved on construction projects represents the tangible benefit, while better-quality relationship, better understanding of client's requirements and communication among project stakeholders represent the intangible benefits [10]. The intangible benefits also reflect in workshop and project outcomes such as project satisfaction, full participation, high commitment, among others [11]. Therefore, the application of Io contributes to the general achievement of construction projects in both perceptible and imperceptible forms. To this end, countries like Malaysia, Hong Kong, UK and USA have helped very from the application of IoT on many constructions works [12].

In Nigeria, there are few research work and application of IoTs in diverse areas, however a lot of studies and application of IoTs have been conducted in many areas like educational institutions, smart homes, smart cities, public relations firms and agencies [18], revealed that Africa has a slow rate in the adoption of IoT compared to other continents, but that Nigeria which has the largest population and economy in Africa has large prospects in IoT if it is effectively implemented. Nevertheless, in the light of preceding research carried out on the IoT; this research work focuses on the impact of IoT on the performance of built environment professionals in Nigeria. This research will be significant to academic researchers and practitioners/professionals in the construction industry. It will help professionals to understand the large potential benefits of IoT to the construction industry and. IoT will make the construction world more interesting and technological, enhance productivity and improve the standard of living. Hence, the following objectives were considered in the study.

1) To examine the Perception of Construction Professionals on the level of Impact factor of IoT on the Performance.
2) Significant relationship between IoT Impactful factors on the performance of construction professional in Nigeria.

The above objectives would provide an answer to the research questions namely:

1) What is the significant relationship that exist among IoT factors that enhances performance in construction site?
2) What is the perception of construction professionals on the factors that influences performance on construction site?

Literature Review

The construction industry has been described as such that is lagging in embracing novelty when compared to other industry [16]. This was validated by [17] that the construction industry has failed to accept innovation through benchmarking with other sectors. [18] ascribed the slow acceptance of innovation in the construction industry to disintegration of the industry, poor investment in research and development amongst several other factors. This slow step in the acceptance of innovation donates to the poor performance of construction projects. Hence, the need to devise a plan for the acceptance of innovative strategy like IoT becomes imperative. Internet of Things is a model in which computing and networking abilities are inserted into any sort of possible object [18]).

Internet of things (IoT) process is often described in light of the techniques and process for achieving greater performance and better-quality building production for Nigerian construction industry money [17]. Therefore, the systems for the application of IoT is considered important [11]. The adoption of IoT into the construction industry of many nations has attracted tremendous benefits [2]. Application or adoption of IoT contributes to sustainability and overall quality improvement of construction projects [12]. In countries like Singapore, IoT is apply in the construction of so many government projects above a certain threshold of amount [13]. This had led to cost-saving of millions of dollars for government projects [14]. The importance of IoT to the performance of construction projects activated many nations to ensure the implementation of IoT to suite their construction practices.

The need for application of IoT technology in the Nigerian construction industry is appropriate to better the poor performance of construction projects. (ITU) as a global infrastructure for the information society, enabling progressive service by connecting physical and virtual things based on existing and evolving interoperable information and communication technologies. [15]. Indeed, IoT is known as a system of 'Things' by means of the Internet to connect and communicate with one another [17].

Specifically, 'Things' are postulated as 'smart devices' connected to a network and communicate among each other with minimum human engagement [2]. The main objective is that activities of day-to-day life can be equipped with the detection, sensing, networking, and processing capabilities that permit them to communicate over the Internet with each other and with other devices and services to attain a common goal [15]. In such context, the IoT permits people and Things to be connected anytime, anyplace, with everything and anyone, preferably using any network and any service [18]. The system enables getting, processing, and reacting to real-world data in real-time [6].

2. Methodology

This research adopted a survey research approach. As revealed by Qureshi, (205), a survey research design is a descriptive study that uses a sample of a study to the document which define and explain what did not -existent on the actual status of phenomena being examined. The population for the study consisted of 150 built environments professional from the seven (7) North-Central states of Nigeria. The research questions were established to guide the study. A structured questionnaire was used to collect data from the respondents which was duly authenticated by experts. Cronbach alpha reliability method was used to determine the internal consistency of the questionnaire items at 0.84. Data collected were analyzed through Confirmatory factor Analysis (CFA) using Statistics Package for Social Sciences (SPSS) and Analysis Moment of statistics (AMOS). The survey research design is appropriate for this study since data were collected through a questionnaire on the impact of IoT technology on built environment professional in the Nigerian construction industry.

3. Instrument Reliability

From Table 1, the professionals in Nigerian construction industry used for this pilot survey were 8 in number. Henceforward, the questionnaire for the pilot survey were totally filled and returned. 5% of a total of 150 expected participants was used for the pilot survey. [13], declared that, if a problem exists with 5% likelihood in a potential study respondent, then the problem most likely for sure be identified with 95% confidence. Furthermore, Table 2 shows the reliability of the instruments. According to [11, 5], Cronbach's alpha normally measures for scale reliability of 0.7 as a cut-off value. [12], opinion that a value ≥ 0.7 indicates high reliability as well. Hence, from the Table 2, the Cronbach's alpha coefficients for the instrument used is highly reliable at 0.84 value which is above the acceptable value of 0.7.

Table 1. *Case processing summary.*

Case valid	N	%
Case valid	08	100
Exclude	0	0
Total	08	100

Table 2. *Reliability Statistic.*

Cronbach alpha	No of Item
0.84	5

4. Data analysis and Discussion

Table 3 shows the number of registered construction professionals that form the participants in this survey. From the Table 3 the following were the numbers of each professional and their affiliation: Builder (56), Quantity Surveyor (43), Architects (26) and Civil Engineers (25). These are the representation of the sample for the population of this study.

Table 3. *professional affiliation of the participant.*

	PROFFESSIONAL AFFILIATION				TOTAL
	CORBOB	COREN	ARCON	NIQS	
Builder	56				56
Quantity Surveyor		25	26	43	43
Architects					26

	PROFFESSIONAL AFFILIATION				TOTAL
	CORBOB	COREN	ARCON	NIQS	
Engineers					25
Total					150

Table 4. *Participant's years of experience in the building industry.*

Professional affiliation	Years in the construction industry					Total
	5-10 years	11-15 years	16-20 years	21-25 years	26 and above	
Builders	15	09	13	14	05	56
Architects	06	07	06	04	03	26
Quantity Surveyors	12	08	09	08	06	43
Civil engineers	06	04	08	03	04	25
Total	39	28	30	29	18	150
	26%	18.6%	20%	19%	12%	100%

Table 4 is a presentation of the years of experience of the participants in this study. From the table, the following are the percentages of respondents' years of experience captured in this study: 5-10 years (26%), 11-15 years (11%), 16-20 years (20%), 21-25 years (19%) and 26 years and above years (12%).

Table 5. *Showing the level of impact of IoT factors on the performance of construction professionals.*

Level of Impact factors on the performance		Statistics				
		N	Means	STD Dev	Ranking	Status
1	Technology	150	4.03	0.964	3rd	Impactful
2	Cyber security	150	4.31	0.846	1st	impactful
3	Organizational policy	150	4.21	0.872	2rd	impactful
4	Environmental factors	150	3.97	0.674	4th	impactful
5	Availability of experts	150	3.84	0.843	5th	impactful
6	Government policy	150	2.04	0.743	6th	Non -impactful
7	Power supply	150	1.54	0.872	7th	Non-impactful
8	Limited consumer demand	150	2.02	0.832	8th	Non-impactful

The results from the Table 5 shown the level of IoT impact factor on the performance of construction professional in the Nigerian construction industry. In the findings, participants ranked the means based on the perception of the participants, meanwhile, means and ranking were based on the overall retrieved and analyzed 150 questionnaires. Consequently, the

overall response given by the participants range from impactful and non- impactful The respondents ranked the Cyber security grade one, with a mean of 0.846 and organizational policy rank grade two with a means of 0.872, while Technology rank grade three with a mean of 0.873, environmental factor rank grade four with a mean of 0.674, availability of experts rank grade five with a mean of 0.843, Government policy rank grade six with a mean of 0.743, power supply rank grade seven with a mean of 0.872 and limited consumer demand rank grade eight with a mean of 0.832 respectively. which indicates that five of the factors are highly impactful in enhance the performance of the professionals, while other three are not very impactful.

5. Significant Relationship Between IoT Impact Factors on the Performance of Construction Professional in Nigeria

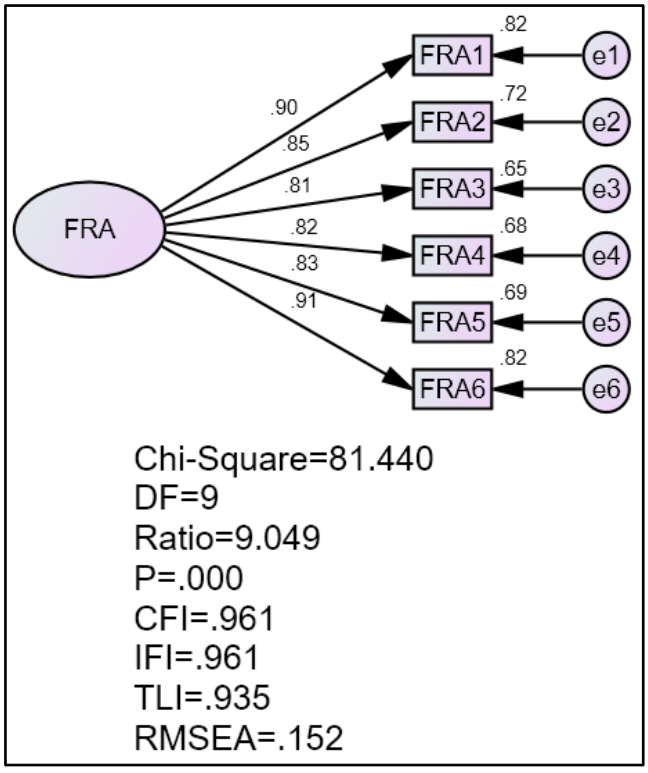

Figure 1. *Final CFA of Internet of things (IoT) Factors.*

Significant relationship between internet of things (IoT) factors on the performance of construction professionals in Nigerian. The initial confirmatory factor analysis (CFA) of IoT (FRA) towards increasing performance of construction professionals is shown in Figure 1 shows that the CFA of internet of things did not attain the standards for goodness model fit due to RMSEA which stood at .152, contrary to the specified threshold of .080 or less. The values gotten are: Chi-square= 81.440, DF=9, Ratio=9.049, P=.000, CFI=.961, IFI=.961, and TLI=.935, the CFA model for IoT impact factor comprises of 6 (six) variables. The result in Figure 1 confirms the distinguished factor loadings within the acceptable threshold but showing the misfit of the model with RMSEA value of .152 which indicate there is a need for Chi-square improvement. The modified CFA IoT factor (FRA) towards increasing performance of construction professionals is shown in Figure 2. The covariance of items FRA2 and FRA5, enhanced the modification indices criteria. Therefore, the obtained values are: Chi-Square= 10.826, DF=4, Ratio= 2.707, P=.0.29, CFI=.995, IFI=.995, TLI=.988 and RMSEA .070. Consequently, the model is considered suitable are: Chi-Square= 10.826, DF=4, Ratio= 2.707, P=.0.29, CFI=.995, IFI=.995, TLI=.988 and RMSEA .070. Consequently, the model is considered suitable. Ratio= 2.707, P=.0.29, CFI=.995, IFI=.995, TLI=.988 and RMSEA .070. Consequently, the model is considered suitable.

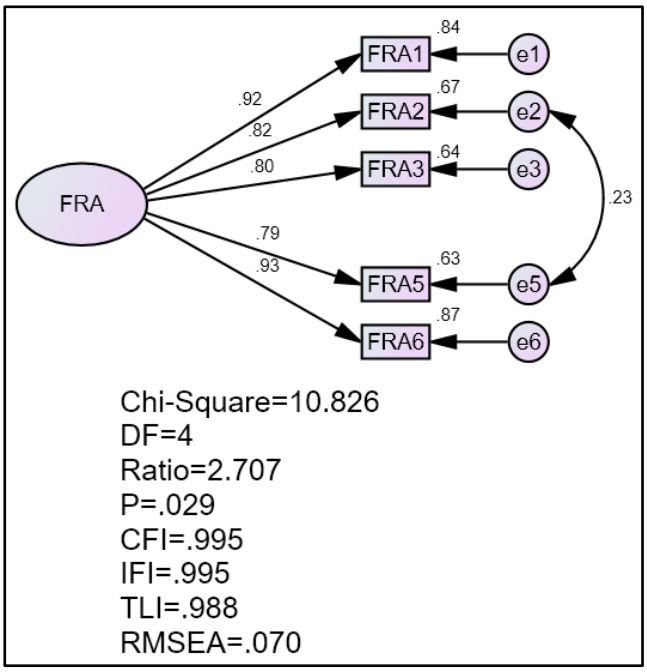

Figure 2. *Final CFA of Internet of things (IoT) Factors.*

6. Discussion of Findings

Findings from this study shown the application of impactful IoT factor that increases the performance of construction professionals in construction site. The findings revealed that mean scores ranged between 2.02 and 4.31, and the grand mean stood at 4.31, which implies that five (5) of the internet of things (IoT) factor under investigation are required by the professional in the building industry for effective site administration and management. The findings of this study are in alignment with the results of a study by [15], who established that the professional in construction industry needed implementation of IoT technology for performance enhancement.

This finding is also in agreement with the opinion of [13], who found that effective utilization equipment will inspire students and cause enhanced interest. Confirmatory factor analysis (CFA) as used in this study, is a statistical method used to confirm the factor structure of set of perceived variables. It allowed the researcher to determine the relationship between observed variables and their important latent constructs. This study presents both the initial and the final CFA Models of each of the constructs. For a model is considered fit, there are criteria to be met which encompass that all the factor loadings must be equal to or above 0.5. Likewise, the modification indices such as CFI, IFI, TLI must be above 0.90, the Ratio of the Chi-square and the degree of freedom (df) recommendations which range from as high as 5.0 [3]) to as low as [14], RMSEA<0.08. The Confirmatory Factor Analysis (CFA) conducted to validate the findings shows that items FRA1 (Technology), FRA2 (Cyber security), FRA3 (Organizational policy), FRA4 (Environmental factor), FRA5 (Availability of experts5) were confirmed impactful and effective for enhances construction professional. The final model revealed CFA of internet of thing (IoT) and each item shows an acceptable factor loading of more than 0.5 as required and the model exhibited satisfactory goodness-of-fit which implies that the model developed was suitable to be used to study the internet of things (IoT) for construction professional performance. The study is in line with the specifications of [7]. However, the findings of these various authors support the justification of the findings of this study for internet of things (IoT) technology for the purpose of performance improvement in the Nigerian construction in industry.

7. Conclusion and Recommendation

1) This study examines the impact of Internet of things (IoT) factors on the performance of the construction professionals in the Nigerian construction industry, with a specific objective of determine the most influential factors of IoT that enhances performance of construction professional and significant relationship of impactful factors of IoT that influences performance of construction professionals in the Nigeria construction industry.
2) Data was collected from highly educated professionals in the Nigeria building industry and analyzed using SPSS and SEM-Amos an approach that are generally considered by many researchers as an ideal for testing significant relationship of multiple variables and capable of determine the effect of dependence variables on independence variables especially in the case of multiples data. The results of this study provide new insight to understand the significant factors that impact the performance of construction professionals in the Nigerian construction site, and ranked the factors according to their level of impact on the performance of construction professionals.
3) Furthermore, the findings in this study will provide suggestions for Builder, Facility managers, Quantity Surveyor, Architects, and other stakeholders in built environment for the effective implementation of IoT in the construction site. The study focused on data from professionals in the building industry, hence the conclusions may differ for other areas of applicatio.

Conflicts of Interest

The author declares no conflicts of interest.

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