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MEASURING THE EFFECTS OF MOBILE TECHNOLOGY BARRIERS AND ENABLERS ON ACCEPTANCE AND PROFICIENCY IN THE NIGERIAN CONSTRUCTION INDUSTRY

RESEARCH ARTICLE[1]

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ABSTRACT

The impact of mobile technology (MT) barriers and enablers on MT acceptance and proficiency is poorly understood on construction sites in Nigeria. As a result, this article investigated MT acceptance and proficiency levels, as well as MT barriers and enablers, to find out how they affect MT acceptance and proficiency. The research employs a quantitative research design with a structured questionnaire survey. Mean score analysis, exploratory factor analysis (EFA), and paired two sample t-test were among the statistical analyses performed. The research centred on construction site managers in Lagos State, Nigeria. The barriers and enablers of MT have a significant impact on MT acceptance and proficiency. Mobile devices, mobile apps, site documentation, site organisation, and site communication all benefit significantly from task smoothening. Complicated interfaces have a strong effect on site documentation; security concerns have a high impact on mobile devices and site

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communication, and network outages have a greater impact on mobile services, mobile apps, site documentation, site programming, and site administration. The study suggests that the academic programme be updated, in order to produce digitally compliant future construction professionals and accelerate the advancement of MT-based innovative solutions in the Nigerian construction industry.

ABSTRAK

Die impak van mobiele tegnologie (MT) hindernisse en instaatstellers op MT aanvaarding en vaardigheid word nie goed verstaan op konstruksieterreine in Nigerië nie. Gevolglik het hierdie artikel MT-aanvaarding en -vaardigheidsvlakke, sowel as MT-hindernisse en -instaatstellers ondersoek om te sien hoe dit MT-aanvaarding en -vaardigheid beïnvloed het. Die navorsing gebruik 'n kwantitatiewe navorsingsontwerp met 'n gestruktureerde vraelysopname. Gemiddelde telling analise, verkennende faktor analise (EFA), en gepaarde twee monster t-toets was van die statistiese ontledings wat gedoen is. Die navorsing het gesentreer op konstruksieterreinbestuurders in Lagos-staat, Nigerië. Die hindernisse en bemagtigers van MT het 'n beduidende impak op MT-aanvaarding en -vaardigheid. Mobiele toestelle, mobiele toepassings, terreindokumentasie, terreinorganisasie en terreinkommunikasie baat almal aansienlik by taakverligting. Ingewikkelde koppelvlakke het 'n sterk uitwerking op terreindokumentasie; sekuriteitsbekommernisse het 'n groot impak op mobiele toestelle en terreinkommunikasie, en netwerkonderbrekings het 'n groter impak op mobiele dienste, mobiele toepassings, terreindokumentasie, terreinprogrammering en terreinadministrasie. Die studie stel voor dat die akademiese program opgedateer word om toekomstige konstruksie professionele persone wat aan digitaalstandaarde voldoen te produseer en om die bevordering van MT-gebaseerde innoverende oplossings in die Nigeriese konstruksiebedryf te versnel.

1. INTRODUCTION

The construction industry is information-intensive, due to various bits of significant information that need to be transferred and exchanged throughout the construction project's life cycle (El Jazzar, Piskernik & Nassereddine, 2020: 504). The efficiency of the industry depends, partially, on the productivity with which right and timely information is exchanged between the various project stages and among the participants involved in a project (Ghodrati, Yiu & Wilkinson, 2018: 107). Because the actual construction processes and activities are carried out on site, construction sites become an information-intensive environment that requires a more elevated level of expert knowledge. Various construction personnel in the field need large amounts of information ranging from project design drawings to personal diaries to support their ongoing works and to settle on choices about the process of construction. On construction sites, information that people need to support their works include requests for information; materials management; equipment management; cost management; schedule, means and methods; jobsite record-keeping; submittals; safety; quality control and assurance, as well as future trends (El Jazzar *et al*., 2020: 505; Ahmed, 2018: 108).

To manage the information intensity in the construction industry, the utilisation of Information Technology (IT) has been broadly proposed and applied (Yury & Dmytro, 2019: 49). Notwithstanding, the implementation of construction projects takes place on construction sites, where personnel experience issues in accessing conventional computer systems for their information requirements. Managers, builders, engineers, and other key personnel spend more of their time moving from one site to another and to site offices. Accordingly, mobile technologies (MT) were proposed as a method of utilising IT on construction sites.

The contentions for the utilisation of MT on construction sites have hinged on the need to gain access to information; embrace productive information sharing and transfer; improve work interpretation, and accomplish real-time information flow (Hu, Laxman & Lee, 2020: 4616; Sepasgozaar, Shirowzhan & Wang, 2017: 1239). With MT, the workers in the field can see plans, models, and punch lists and relay information to others through mobile devices. This eliminates paper-based communication and resolves the ignoring of significant issues that require speedy reaction and regularly makes on-site decisions be conceded. MT has settled the issue of deciphering field entries for different areas of a project, by empowering workers to gather data in a more structured format instead of on paper that lead to high possibilities of human mistake (Hasan *et al*., 2019: 401; Hasan *et al*., 2018: 5). MT on construction sites has the capacity to expand the limit of information systems from site offices to actual work sites and guarantee real-time data flow to and from work sites (Rivera *et al*., 2020: 45).

MT represents small, portable, and wireless technologies that are rapidly evolving from a simple phone and messaging device to a multi-tasking, instant messaging, geographic position services (GPS) navigation, and internet-enabled device. These technologies are designed to be slender and lightweight, compact, relatively cheap, high performing, and user friendly, making them usable on a construction site. Applications in MT incorporate viewing, editing, and submitting data online using the built-in web browser application. Their ability to link to the Internet empowers project stakeholders to access and share information right away. In particular, the increase in wireless network transfer speeds and improvements in mobile application performance give MT a strong potential to improve on-site construction information management and productivity.

The use of MT on Nigerian construction sites would help resolve issues such as quality and productivity concerns (Okafor, Ani & Ugwu, 2022). However, studies on MT in the Nigerian construction industry have only investigated the barriers to information and communication technologies (Amusan *et al*., 2018); augmented reality application areas (Oke & Arowoiya, 2021); barriers to the adoption of the Internet of Things (Oke *et al*., 2022); cyber-physical

system usage for construction projects (Adeosun & Oke, 2022), and mobile technological advancement strategies (Alaba, 2020). Generally, research on MT and the construction industry has been restricted to the acceptance of MT (Sepasgozaar *et al*., 2017; Hasan *et al*., 2021; Hu *et al*., 2020; Hasan *et al*., 2019); the benefits of MT (Hasan *et al*., 2018; Rivera *et al*., 2020; Mandičák *et al*., 2021; Ulhaq *et al*., 2020); systems and frameworks for applying MT (Khelifi & Hyari, 2016; Núñez *et al*., 2018), and MT education (Huang *et al*., 2020; Leveaux & Ornate, 2019). MT is evolving in terms of form and functionality, with an increase in its use on construction sites. However, if the site stakeholders are unfamiliar with MT, it will be difficult to reap its benefits. To ensure widespread MT proficiency on construction sites, however, an understanding of the relationship between MT barriers, enablers, acceptance, and proficiency is required. As a result, the purpose of this study is to investigate MT acceptance, proficiency, barriers, and enablers, in order to determine the impact of MT barriers and enablers on MT acceptance and proficiency on Nigerian construction sites.

2. LITERATURE REVIEW

2.1 Mobile technologies usage acceptance

Several studies have been conducted to investigate the use of MT in the construction industry. For example, in a study that presented Scanner Technology Acceptance Model (STAM), Sepasgozaar *et al*. (2017: 1237) utilised 'usefulness' and 'ease of use' to measure acceptance of scanner technologies. The study used scanners to collect raw 3D point clouds and transfer them into compact, semantically rich models aiding in updating construction drawings. The study asserted that STAM enables technology suppliers to predict the technology diffusion rate and helps the users make decisions on picking the right technology in construction projects. Underpinned by the extended Unified Theory of Acceptance and Use of Technology (UTAUT2) model, Hu *et al*. (2020: 4615) explored the acceptance, preparedness, and adoption of MT in China. The study zeroed in on behavioural intentions, use of MT, and variations between different demographic groups. Findings from the study suggested that the most significant factors affecting behavioural intention and behaviours of use were their performance expectancy, facilitating conditions, hedonic motivation, and habit. The research provides further verification of the effectiveness of the UTAUT2 model in the higher education context and the field of new technologies implementation.

Okoro, Nnaji and Adediran (2022) tested a conceptual model regarding the acceptance of immersive technology (ImT) at the individual level in the construction industry. Results indicated that attitude significantly influenced

the intention to use ImTs. Perceived usefulness positively and significantly predicted the intention to use ImTs and usage attitude. Further, the effects of perceived enjoyment on usage attitude, and social norms and perceived behavioural control on intention to use were positive and significant. Perceived ease of use had negative and non-significant effects on the intention to use and usage attitude. By explaining 82% of the variance, the study established that the proposed model successfully evaluates how management-level professionals in the construction industry accept ImTs. Abdalrahman *et al*. (2020) used the Technology Acceptance Model 3 (TAM3) to investigate the acceptance of Building Information Modeling (BIM) and Augmented Reality (AR) integration in the construction industry. The developed TAM3 demonstrated that users' control over BIM-AR and perception of ease of use have the greatest influence on their perception of the system's usefulness, which influences their intention to use the system. Furthermore, unlike the original TAM3, three variables of image, perception of external control, and voluntariness show new relationships that can be considered a novel outcome.

Using the Technology Acceptance Model (TAM), Sorce and Issa (2021) attempted to understand what factors improve the use and adoption of ICT in the US construction industry. The findings revealed that the US construction industry follows the TAM model, which states that, if a technology is perceived to be useful, it will be adopted. Yassin and Al Naqbi (2022) investigated the barriers to mobile technology adoption in the Abu Dhabi Emirate, by identifying 52 factors that motivate users to adopt mobile technology across a wide range of applications. These factors were classified into six groups: perceived ease of use; perceived user experience; attitude; customer satisfaction excellence; perceived usefulness, and intention to use. According to the study, the three most common categories considered by respondents when using any technology are perceived ease of use, user experience, and attitude. User experience is the second most important factor driving respondents' use of technology. This is followed by the user's attitude, which is what drives technology adoption.

Hewavitharana *et al*. (2021) investigated human behaviours that influence the digital transformation of the construction industry, using the widely accepted model of the unified theory of technology acceptance and use (UTAUT). The findings of the study examined the changing demands for human beings in digitally transformed environments such as Industry 4.0.

These studies assessed MT acceptance in the context of the construction industry and provided data for new technology providers to better understand MT acceptance patterns. The studies, however, revealed a lack of understanding of the dimensions of MT and its specific application on construction sites. To address the shortcomings of previous studies, the

researchers classified MT into three categories: mobile devices (portable and small computing and communication devices), mobile services (mobile networks to which these mobile devices are connected), and mobile apps (application software to support mobile services and devices). Mobile devices are an important component of MT. They are designed to provide utility in a way that is user friendly, and through various features built into the devices as well as numerous applications that can be added to the devices.

2.2 Mobile technologies proficiency

In the construction industry, there is growing concern about MT proficiency. Hasan *et al*. (2021) reported on findings from semi-structured interviews conducted to examine the use of MT in the Australian construction industry. The interview focused on mobile information, communication, and technology (mICT) and how construction project managers manage boundaries between work and life in the use of mICT. The findings of the study showed that there is an absence of consensus among construction project managers with respect to how to view informal work prompted by mICT. The study likewise discovered that, without relevant organisational policies and guidelines, work-life boundary management approaches taken by individual managers shift substantially and largely determine the degree of their mICT usage for work during non-work hours and its implications for their work and life. In addition, the study clarified variability in the permeability of work-life boundaries based on three factors: individual behavioural characteristics, work attitude, and job factors. Sattineni and Schmidt (2015) interviewed end-users of MT to discover how they are utilising MT on construction sites. The study uncovered that MT is progressively effective in empowering site personnel in a myriad of ways such as communication and productivity enhancement. Bilal *et al*., (2016: 503) undertook a review of the present status, opportunities, and future trends of Big Data that demarcated the concepts of Big Data Engineering and Big Data Analytics. Likewise, it depicted the works such as building information modelling optimisation, construction litigation, and structural damage detection, utilising these technologies across various subdomains of the construction industry.

Rivera *et al*. (2020) studied the usability and performance of mobile manipulators as displaceable 3D printing machinery on construction sites, with accentuation on the three main different existing mobile platforms: the car-like, the unicycle, and the omnidirectional, with a UR5 manipulator on them. The study proposed the printing of the following building elements: helical, square, circular, and mesh, with different sizes using the printing machinery. The results of the study showed that the omnidirectional platform presents the lowest tracking error and lowest control effort for circular, helicoidal, and mesh building elements, while the car-like platform presents

the best results for square-like building elements. Ulhaq *et al*. (2020) led a contextual investigation of mobile messaging applications as a tool for managing construction project stakeholders in Vietnam. The study showed that mobile messaging platforms are prime channels to manage project site work together with advantages including real-time collaboration, seamless knowledge sharing, quick feedback, and consensus development.

This article conceptualised the domains and areas of proficiencies that are attainable in MT, in order to adequately address the MT proficiency concern. In accordance with this concept, there are five areas of proficiency in MT, including site administration, documentation, programming, organisation, and communication. Site administration skills include site security, surveillance, money and payment transactions, site supervision and control, site office management, site meetings, site team management and control, as well as document and material management. Site documentation skills include the ability to use MT for work and information documentation, as well as site report writing. Site programme competencies include the ability to use MT for access to information and interpretation, resource output management, on-site measurements and calculations, and equipment management. The ability to use MT for site investigation, layout, and facility management demonstrates site organisation skills. Communication, collaboration, and information transfer and exchange are the areas of expertise in site communication. The article identified critical mobile devices, mobile services, and mobile apps that could be used to achieve these skills.

2.3 Barriers to mobile technologies proficiency

There is adequate information to suggest that MT is beneficial to construction activities and processes (Mandičák *et al*., 2021: 379; Hasan *et al*., 2018: 14). In an exploratory study on the impact of MT on productivity in construction projects, Hasan *et al*. (2018) found that the absence of training and guidelines on compelling utilisations of these technologies in construction projects was found as a significant bottleneck. The study indicated that distinctions in utilisation style and user mentality have restricted the general effect of MT on efficiency.

Some studies have contended that the advantages and utilisation of MT rely upon future professionals' understanding and knowledge of emerging MT (Cline & Davis, 2015: 30; Huang *et al*., 2020: 3548; Redden, Collins & Kim, 2017: 537; Leveaux & Ornate, 2019: 20; Kim, 2018: 124; Solnyshkova & Dudysheva, 2020: 4). In view of this perspective, MT-based educational and training methodologies have been proposed to facilitate instruction of MT use in construction management and improve the effectiveness of students upon graduation. In Cline & Davis (2015), for instance, the

employed university provided iPads in construction management classes to expose students to MT before they enter the workforce. The study also led a pre-and post-test review of first-year and upper-level construction management students to examine their comfort with MT, their knowledge about MT in construction, and their views on whether they think that they can use mobile technologies in the workplace and for what tasks. The investigation discovered that, while certain students entered with an exceptionally low comfort level with mobile devices, there were gains in comfort level by nearly all of the students. The study likewise announced that most of the students were able to envision how MT could be utilised within the construction industry to perform various tasks, and their visions increased from the beginning of the semester to the end, even though no conventional guidance was done in this area.

The study by Huang *et al*. (2020) examined the influence of constructivist and traditional learning beliefs on university students' intentions to use mobile learning in China and Spain. In addition, social contrasts were also tested in the study. The results of the study gave proof of the significance of learning convictions as a predecessor of the importance of learning beliefs as an antecedent of perceived usefulness and perceived compatibility.

In an examination of the value of augmented reality in the business of building management, Leveaux and Ornate (2019) applied augmented reality in building management systems, using an exploratory industry-based case study approach. The study focused on viable implementations of augmented reality in building management and presents a solution that can bring tangible benefits to the building management services sector. Solnyshkova and Dudysheva (2020) discussed hybrid laboratory construction to support the teaching of engineering geodesy. The study contended that hybrid laboratories give both physical and online forms of operation with the same equipment or devices of the same functionality. The study offered a simple configuration of a hybrid learning environment based on interactive virtual learning tools and mobile devices for the training of inexperienced students to make digital measurements on geodetic equipment. It was also guaranteed that a hybrid environment is equally suitable for use in stationary university laboratories and terrain practice.

2.4 Enablers of mobile technologies proficiency

Literature has proposed systems that would enable the utilisation of MT in information-intensive places such as construction sites (Khelifi & Hyari, 2016: 56; Konstantinov *et al*., 2017: 1515; Alshuwaikh *et al*., 2018; Núñez *et al*., 2018: 521). Khelifi & Hyari (2016), for instance, developed a mobile application system to support construction-site communication. The developed system is designed to upgrade communication among

home office employees, field office staff, and mobile users at the construction sites. It has two parts: a mobile application and a website. The mobile application part furnishes users with valuable features such as receiving sites' instructions, sending requests for interpretations, and retrieving information about projects. The website component allows users such as home office employees to track projects' progress and find projects' locations. The developed system can be used on MT, such as Android devices.

Alshuwaikh *et al*. (2018) developed a mobile application prototype that is expected to act as an automated procurement medium, a central medium of communication, and provide a direct link between clients and suppliers. The system has eight user and system functional requirements, including registering suppliers; registering clients; managing client and supplier records; creating and managing supplier stores; selecting material; placing an order; making payment, and managing the order. The system is accepted to upgrade the extreme cost and time of procured construction materials. Si *et al*. (2020) proposed an innovative Just-In-Time solution for the construction industry and addresses the specific case of networks of mobile on-site factories. As indicated by the study, the system shows an intriguing new and creative business model for decentralised manufacturing on-site. Núñez *et al*. (2018) proposed a user-centred mobile cloud computing platform for improving knowledge management in small to medium enterprises in the Chilean construction industry. As asserted in the study, the system is a feasible and alluring choice to address the knowledge management issues in SMEs of the Chilean construction industry, since it is possible to consider both technical and usability requirements.

Through a PESTEL framework and a value chain model, Oesterreich and Teuteberg (2016: 123) explored the state of practice of MT in Industry 4.0. The study revealed the political, economic, social, technological, environmental, and legal implications of adopting MT. In a survey of MT uptake by construction managers in the New Zealand construction industry, Liu, Mathrani and Mbachu (2019: 13) revealed a general uplifting outlook towards the utilisation of apps. Perceptions of top-management personnel differed slightly from those of middle managers. While the former expressed interest in mobile apps usage at a strategic level such as improving long-term client relationship management and satisfaction, the latter were keener on the apps used at functional and strategic levels such as a task- or project-level productivity improvement. A study by Hasan *et al*. (2019) showed that user characteristics such as age or years of experience are not the major factors affecting MT usage of construction management professionals in the Australian construction industry. The study observed that several barriers hinder the effective usage of MT,

specifically work-family spillover, system quality issues, inconsistency in the way of using MT, and the lack of organisational support.

Huang *et al*. (2020) contended that 5G MT will carry an uncommon measure of utilisations with its high speed. Hasan *et al*. (2018; 2019) empirically researched the main consequences of the use of mobile ICT in construction project management and how the use of MT can ultimately affect construction productivity in the Australian construction industry. The study distinguished five elements, specifically, improved communication and work relationship; distraction and waste of time; better information management on-site; better management of construction defects, and improved work planning, as the most important consequences of their use of MT.

3. METHODS

3.1 Research design

Using a quantitative research design, this study tested the impact of MT barriers and enablers on MT acceptance and proficiency. A structured questionnaire survey was done that allowed the researchers to generalise their findings from a sample population (Creswell, 2014). Measured results from the questionnaire were set as the variables of MT barriers and MT enablers on construction sites in Nigeria. EFA was used to reduce these measured variables to smaller sets of barriers and enablers (Rossoni, Engelbert & Bellegard, 2016: 201). Results from the EFA were subjected to a paired sample t-test to test two hypotheses: Hypothesis 1: barriers to MT acceptance affect MT acceptance (H1a) and proficiency (H1b), and Hypothesis 2: MT enablers influence MT acceptance (H2a) and proficiency (H2b). Correlation on the variables from the EFA was done to test for any significant impact that might show between the variables.

3.2 Population, sample, and response rate

Six hundred and fifty (650) construction site managers were purposefully selected from a list of construction projects maintained by the Lagos Building Control Agency (an agency tasked with enforcing and monitoring development control regulatory requirements) in Lagos State, Nigeria. Based on Krejcie and Morgan's (1970: 608) recommendations, a sample size should be 242 for a population of 650. The questionnaire was filled out and completed by 238 people, yielding a response rate of 98.34%. This indicates a valid sample and satisfactory response.

3.3 Data collection

Using a combination of standby-and-collect and drop-and-collect methods, 242 questionnaires were delivered to construction site managers throughout Lagos State from 14 July 2018 to 22 September 2019. The questionnaire included seven sections. Topics on the mobile services and technology used in the questionnaire were extracted from reviews from the literature. The questionnaire with Likert-type items on a five-point scale included close-ended questions about the respondents' profile, level of proficiency in the use of mobile devices (17 variables), level of proficiency in the use of mobile services (16 variables), level of proficiency in the use of mobile apps (19 variables), domain and areas of proficiencies in mobile technologies (38 variables), barriers to mobile technologies' proficiency among construction site managers (18 variables), and enablers of mobile technologies' proficiency among construction site managers (28 variables). The respondents were asked to rate their levels and areas of proficiency in the use of mobile technologies, and were also instructed to indicate their level of agreement with the statements describing the barriers and enablers of mobile technologies.

3.4 Data analysis method

Mean Score Analysis (MS) and EFA were used to analyse the data in SPSS version 21.0. The rating in the MS was done on a 5-point Likert scale, where 1 = Very low/Strongly disagree (≥1.00 and ≤1.80); 2 = Low/Disagree (≥1.81 and ≤2.60); 3 = Average/Neutral (≥2.61 and ≤3.40); 4 = High/Agree (≥3.41 and ≤4.20), and 5 = Very highly/Strongly agree (≥4.21 and ≤5.00), as recommended by Gliem and Gliem (2003).

An EFA with Varimax rotation as the method of rotation was performed to investigate the factor structure and the latent factors underlying the barriers and enablers of mobile technologies' proficiency among construction site managers. Bartlett's test of sphericity ($p<0.05$) and Keiser Meyer Olkin (KMO) with an overall KMO of greater than 0.50 were used to determine the suitability of the data for factor analysis (Watkins, 2018: 12-14). The number of factors to be extracted was estimated using parallel analysis and eigenvalues. The extracted factors were considered valid if they had convergent and discriminant validity and at least three measured variables and had initial eigenvalues above one. The Pearson correlation coefficients and significance generated by the paired two sample t-Test were used to validate the hypotheses and tested the impact that variables had on each other in this study. A paired sample t-test is an inferential test that determines whether the mean difference between the two sets of observations is zero (Xu *et al*., 2017). For this study, the following correlation coefficient values (r) were used: weak (between 0 and 0.3); moderate (between 0.3 and 0.7), and strong (between 0.7 and 1.0) (Ratner, 2009: 139). The significant level was $p<0.05$.

3.5 Limitations of the study

The site managers were unable to be interviewed about their requirements for a mobile device suitable for construction sites. A significant limitation is the lack of categorisation and differentiation of the various mobile apps. The perspectives of construction workers would also have enriched the study's findings. Future investigations should investigate the relationship between jobsite accidents, safety compliance, and the use of MT on construction sites.

4. RESULTS

4.1 Profile of respondents

As shown in Table 1, based on frequency of occurrence, most of the respondents (64.1%) worked in organisations that operate nationally in Nigeria. The vast majority of the respondents' (87.6%) organisations are involved in building construction projects (47.9%), and projects that involve building construction and civil engineering (39.7%). Although 17.8% of the organisations existed between 11 and 15 years, the majority of them (79.5%) have been in existence for 16 years and more. Of these organisations, the majority (41.1%) employs between 100 and 150 employees. This proves that the organisations have adequate involvement in the Nigerian construction industry to give information that could help in making deductions on MT acceptance, proficiency, barriers, and enablers, in order to determine the impact of MT barriers and enablers on MT acceptance and proficiency on Nigerian construction sites.

Table 1: Respondents' profile

Demographic	*Characteristic*	*Frequency (n=238)*	*%*
Operation level	Local	5	1.4
	State	51	21.4
	Inter-state	27	11.5
	National	153	64.1
	International	2	0.3
Project involvement	Building construction	114	47.9
	Civil engineering	17	6.8
	Building construction and civil engineering	95	39.7
	Industrial construction	5	1.4
	Special construction	7	2.7

Demographic	*Characteristic*	*Frequency (n=238)*	*%*
Company existence	6-10 years	5	1.4
	11-15 years	44	17.8
	16-20 years	98	41.1
	21 years and above	91	38.4
Company size	50-100 employees	56	23.3
	100-150 employees	182	76.7

4.2 Acceptance of the use of mobile technologies

MT acceptance was divided into mobile devices, mobile services, and mobile apps. To determine MT acceptance, the respondents' level of proficiency in every category was examined, by requesting that the site managers rate their degree of proficiency in the utilisation of mobile devices, mobile services, and mobile apps. Results in Table 2 show that, overall, respondents had high proficiency in the use of mobile services (MS=4.18) and average proficiency in the use of mobile devices (MS=2.99) and mobile apps (MS=2.96).

Table 2: Acceptance of the use of mobile technology

Variables (n=238) *1 = Very low (≥1.00 and ≤1.80); 2 = Low (≥1.81 and ≤2.60); 3 = Average (≥2.61 and ≤3.40); 4 = High (≥3.41 and ≤4.20), and 5 = Very high (≥4.21 and ≤5.00)*					
Cronbachs' alpha= 0.839		*Cronbachs' alpha= 0.888*		*Cronbachs' alpha= 0.812*	
Mobile devices	*MS*	*Mobile services*	*MS*	*Mobile apps*	*MS*
Android phones	4.32	Phone calls	4.63	PDF viewers	3.86
Laptops	4.14	Short Message Services	4.56	WhatsApp	3.86
Samsung Galaxy phones	3.93	Phone camera	4.46	Google Map and Calendars	3.64
Tablets	3.78	Wireless Fidelity (Wi-Fi)	4.39	Calendar application	3.61
Blackberry phones	3.49	Electronic mail services	4.30	Blackberry Messenger (BBM)	3.59
Point of Sale machine	3.24	Phone video	4.19	Mobile CAD application	3.30
iPhone	3.24	Video calls	4.08	Instagram	3.29
Cell phone	3.15	Modems	3.89	Asset tracker	3.00
Personal Digital Assistant	2.94	Hotspots	3.79	Tekla Field 3D	2.94

Variables (n=238) *1 = Very low (≥1.00 and ≤1.80); 2 = Low (≥1.81 and ≤2.60); 3 = Average (≥2.61 and ≤3.40); 4 = High (≥3.41 and ≤4.20), and 5 = Very high (≥4.21 and ≤5.00)*					
Cronbachs' alpha= 0.839		*Cronbachs' alpha= 0.888*		*Cronbachs' alpha= 0.812*	
Mobile devices	*MS*	*Mobile services*	*MS*	*Mobile apps*	*MS*
Active RFID tags	2.71	Bluetooth	3.73	iOS application/ Site Monitor	2.91
Gyroscope	2.61	Dropbox	3.72	Project Wise Explorer Mobile	2.82
RFID ready phones	2.45	Wireless Local Area Network (WLAN)	3.71	Mobile BIM application (BIM360)	2.71
iPod touch	2.36	Phone voice recorder	3.63	Autodesk Bluestreak mobile	2.61
Passive RFID tags	2.31	Universal Mobile Telecommunication	3.24	Autodesk Buzzsaw mobile	2.56
Netbook	2.25	General Packet Radio Service (GPRS)	3.09	Apple's keynote	2.56
Telenav	2.12	Plotters	2.86	iTunes	2.46
Zoom	1.95			Facebook	2.43
				Facebook	2.43
				iAnnotate	2.40
				Twitter	2.24
Composite score (Average)	2.99		4.18		2.96

With mean score ratings higher than 4.21, respondents have very high proficiency in the use of Android phones (MS=4.32), phone calls (MS=4.63), short message services (MS=4.56), phone camera (MS=4.46), Wi-Fi (MS=4.39), and electronic mail services (MS=4.30). There was no very high level of proficiency in the utilisation of mobile apps.

In the category mobile devices, respondents have high proficiency (MS between 3.41 and 4.20) in the use of laptops (MS=4.14), Samsung Galaxy phones (MS=3.93), tablets (MS=3.78), and Blackberry phones (MS=3.49). They have high proficiency in the use of mobile services, including phone video (MS=4.19), video calls (MS=4.08), modems (MS=3.89), hotspots (MS=3.79), bluetooth (MS=3.73), dropbox (MS=3.72), WLAN (MS=3.71), and phone voice recorder (MS=3.63). In the category mobile apps, respondents have high proficiency in using PDF viewers (MS=3.86), WhatsApp (MS=3.86), Google maps and calendars (MS=3.64), and calendar applications (MS=3.61).

4.3 Construction site management and mobile technologies' proficiencies

To analyse the proficiencies of the respondents in the utilisation of MT in construction site management, the article recognised site documentation, site programme, site administration, site organisation, and site communication as the categories of MT application in construction site management (see 2.2). Results in Table 3 show that, with mean score ratings higher than 4.21, respondents had very high MT proficiency in almost all areas in site documentation, especially for 'site report writing and processing' (MS=4.99) and taking pictures (MS=4.57) and videos (MS=4.54) for work documentation. In the site communication category, respondents had very high proficiency in connecting and communicating via the internet (MS=4.30), and in general communication on site (MS=4.28).

Table 3: Mobile technologies' proficiencies in construction site management

Category	*Variable/area (n=238) 1 = very low 5 = very high Cronbachs' alpha = 0.826*	*MS*	*Composite score (Average)*
Site documentation	Site report writing and processing	4.99	4.37
	Taking pictures for work documentation	4.57	
	Taking videos for work documentation	4.54	
	Documenting project information	4.24	
	Reviewing of documents	4.21	
	Documenting work process and information	4.06	
	Keeping records of site personnel	4.01	
Site programme	Accessing project information and documents	3.96	3.58
	Scheduling tasks and time	3.73	
	Calculating data on site	3.62	
	Tracking of materials and equipment	3.61	
	Cost coding for labour and equipment	3.52	
	Checking the availability of staff on site	3.58	
	Vehicle diagnostics and compliance	3.31	
	Monitoring of fuel consumption	3.27	

Category	*Variable/area (n=238) 1 = very low 5 = very high Cronbachs' alpha = 0.826*	*MS*	*Composite score (Average)*
Site administration	Transferring and updating project information	4.19	3.78
	Sending and obtaining money	4.12	
	Processing of payroll	3.82	
	Sites surveillances and security	3.79	
	Tracking construction vehicles	3.76	
	Tracking labour hours and project cost	3.57	
	Preventing theft of stored merchandise	3.49	
	Tracking workers' performance	3.46	
Site organisation	Networking the site office to the internet	4.21	3.68
	Networking the headquarters to the site office	4.14	
	Navigation purposes on site	3.75	
	Assessing site conditions	3.51	
	Location of site facilities	3.46	
	Setting out and surveying	3.38	
	Securing access to a private network	3.33	
Site communication	Connecting and communicating via the internet	4.30	3.89
	General communication on site	4.28	
	Connecting and communicating with other devices and people	4.25	
	Collaborating with project/site team members	3.85	
	Scheduling site meeting	3.77	
	Data networking services	3.74	
	Holding virtual meetings	3.58	
	Dial-up services	3.38	

Mean score ratings between 3.41 and 4.19 showed that respondents had high MT proficiency in almost all areas in the categories site administration and site organisation showing high ratings for 'transferring and updating project information' (MS=4.19), and 'networking the headquarters to the site office' (MS=4.14).

Overall, respondents had high MT proficiency in documenting work process and information (MS=4.06), keeping records of site personnel (MS=4.01),

sending and obtaining money (MS=4.12), accessing project information and documents (MS=3.96), processing the payroll (MS=3.82), collaboration with project/site team members (MS=3.85), in site surveillances and security (MS=3.79), scheduling site meetings (MS=3.77), tracking construction vehicles (MS=3.76), and scheduling tasks and time (MS=3.73).

4.4 Barriers to mobile technologies' proficiency among construction site managers

This article sought to comprehend the barriers to MT proficiency among construction site managers. Results in Table 4 show the high cost of data (MS=3.46), constant change in MT (MS=3.39), short battery life of mobile devices (MS=3.35), and limited network coverage as the barriers associated with the mobile devices, apps, and services. The 18 barriers to MT proficiency among construction site managers were subjected to CFA to study the trend of inter-correlations between items, and to group these items with similar characteristics into a set of reduced factors (barriers) according to the hidden components in the collected data. Only the factors extracted with communalities loadings of 0.5 and above were subjected to EFA. Table 4 shows that three factors were retained, as factor 1 (complicated interfaces) explains 37.985% of the total variance; factor 2 (security concerns), 17.555%, and factor 3 (network hitches), 16.659%. The utilisation of EFA was justified by the result of the Bartlett test (X^2_{650}=153, p<.05), the result produced a statistically significant *chi*-square (p<.001). A KMO value of 0.62 was obtained, which is greater than 0.50, showing that the data is suitable for conducting factor analysis.

Table 4: Barriers to mobile technologies' proficiency among construction site managers

Descriptive analysis (n=238) Cronbachs' alpha= 0.858 1 = strongly disagree 5 = strongly agree		*Exploratory factor analysis (rotated matrix)*			
Barriers (items)	*MS*	*Complicated interfaces*	*Security concerns*	*Network hitches*	*Commu-nality*
High cost of data access	3.46	.505		.540	.748
Constant charge in mobile technologies	3.39	.584		.583	.843
Short battery life of mobile devices	3.35	.739			.684
Virus attack	3.34		.804		.747
Security risks	3.33			.614	.901

Descriptive analysis (n=238) Cronbachs' alpha= 0.858 1 = strongly disagree 5 = strongly agree		*Exploratory factor analysis (rotated matrix)*			
Barriers (items)	*MS*	*Complicated interfaces*	*Security concerns*	*Network hitches*	*Commu-nality*
Slow connection on wireless network	3.32	.619			.553
Non-longevity of battery	3.31	.682			.646
Automated and cumbersome interfaces	3.30	.762			.866
Limited network coverage	3.28		.874		.780
Non-durability of mobile devices	3.21	.560			.762
Difficulty in navigation of mobile devices	3.18	.681			.713
Slow data transfer	3.16	.641			.637
Exposure to the external environment	3.16	.772			.696
High learning curve	3.04	.750			.687
Difficulty in operating mobile devices	2.96	.632			.823
Small screen size of mobile devices	2.94	.569	-.584		.798
High cost of mobile devices	2.85	.697			.539
Mobile computers are not supportive of multiple actions	2.64	.710			.573
Composite score (Average)	3.18				
Eigenvalue		6.837	3.665	2.338	
% of total variance		37.985	17.555	16.659	
Total variance				72.199	

4.5 Enablers of mobile technologies' proficiency among construction site managers

With mean score ratings above 4.21, results in Table 5 show that respondents strongly agreed that six enablers contribute to MT proficiency among construction site managers. These are easy and fast sharing of information (MS=4.41); reduction in paper reporting (MS=4.39); less

paperwork (MS=4.38); multiple presences on several construction sites (MS=4.36), and faster and accurate communication and information (MS=4.25). This outcome affirmed the efficiency advantages of MT, as claimed by Rivera *et al*. (2020), Ulhaq *et al.* (2020), and Huang *et al*. (2020).

Table 5: Enablers of mobile technologies' proficiency among construction site managers

Descriptive analysis (n=238) Cronbachs' alpha= 0.866 1 = strongly disagree 5 = strongly agree		*Exploratory factor analysis (rotated matrix)*				
Enablers (items)	*MS*	*Cyber operative*	*Task smooth-ening*	*Work process accele-ration*	*Paper & time saving*	*Commu-nality*
Easy and fast sharing of information	4.41			.701		.787
Reduction in paper reporting	4.39				.738	.717
Less paperwork	4.38	.825				.850
Multiple presence on several construction sites	4.36	.709				.766
Faster and accurate communication and information	4.25					.796
Improvement in work quality	4.21	.813				.801
Flexibility, convenience, and handiness	4.19		.792			.852
Easy access to information	4.19					.793
Improved communication among team members	4.19			.738		.862
Instant analysis and correction of work	4.17		.792			.758
Improvement in planning and forecasting	4.14					.876
Effective planning and tracking of work orders	4.09		.752			.844

Descriptive analysis (n=238) Cronbachs' alpha= 0.866 1 = strongly disagree 5 = strongly agree		*Exploratory factor analysis (rotated matrix)*				
Enablers (items)	*MS*	*Cyber operative*	*Task smooth-ening*	*Work process accele-ration*	*Paper & time saving*	*Commu-nality*
Improved quality of works	4.07					.847
Cost reduction in site management	4.06		.525			.718
Ease of synchronisation	4.03	.857				.801
Reliable and accurate inventory control	4.00					.814
Reduction in waste	3.87			.807		.814
Improved cash flow	3.86			.706		.783
Control of equipment	3.79					.757
Reduction in logistical costs	3.75					.825
Quick approval of requests and variations	3.73					.870
Improvement in efficiency of workers	3.65					.811
Possibility of wireless monitoring	3.64				.599	.849
Performance improvement	3.59					.812
Cost reduction in work administration	3.50					.719
Possibility of remote connection	3.49	.509				.611
Reduction in claims	3.47					.751
Reduction in work cycle time	3.38				.790	.767
Composite score (Average)	3.96					
Eigenvalue		5.270	3.340	1.770	1.502	
% of total variance		31.139	17.3124	12.2212	18.820	
Total variance					79.471	

The 23 enablers of MT proficiency among construction site managers were subjected to CFA to study the trend of inter-correlations between items and to group these items with similar characteristics into a set of reduced factors (enablers) according to the hidden components in the collected data. Only the factors extracted with communalities loadings of 0.5 and above were subjected to EFA. The utilisation of EFA was justified by the result of the Bartlett test ($X^2_{1080.482}$=378, p<.05), the result produced a statistically significant *chi*-square (p<.001). A KMO value of 0.651 was obtained, which is greater than 0.50, showing that the data is suitable for conducting factor analysis. Table 5 confirms the retaining of four factors, where factor 1 (cyber operative) explains 31.139% of the total variance; factor 2 (task smoothening), 17.3124%; factor 3 (work process acceleration), 12.2212%, and factor 4 (paper and time saving), 18.820%.

4.6 Impact of MT barriers and enablers on MT acceptance and proficiency

In Table 6, the Pearson's *chi*-square test result (r) shows a strong positive correlation between MT barriers and MT acceptance (r=.732, n=44, p=.000) and proficiency (r=.665, n=44, p=.000). There was a strong positive correlation between MT enablers and MT acceptance (r=.744, n=44, p=.000) and proficiency (r=.729, n=44, p=.000). This validates that the barriers to MT acceptance affect MT acceptance (H1a) and proficiency (H1b) and that MT enablers influence MT acceptance (H2a) and proficiency (H2b) on Nigerian construction sites. Results from the paired two sample t-Test show a significant strong difference between the effect of barriers (=.363, n=44, p=.000) and the effect of enablers (t=.723, n=44, p=.000) on the acceptance of MT. The result implicates that MT enablers had a stronger effect on the acceptance of MT than the MT barriers. There was a significant moderate difference between the effect that barriers (t=.379, n=44, p=.000) and the effect that enablers (t=.402, n=44, p=.000) had on the proficiency of MT on Nigerian construction sites. The result implicates that participants' proficiency of MT is equally affected by MT barriers and MT enablers.

Regarding the impact of barriers on mobile technology acceptance and proficiency, complicate interfaces have a strong effect on site documentation (r=.709, t_{44}=.355, p=.000), security concerns have a very strong effect on mobile devices (r=1.000, t_{44}=.717, p=.000), and site communication (r=1.000, t_{44}=.488, p=.000). Network hitches have a very strong effect on mobile services (r= .000, t_{44}=1.447, p=.000), mobile apps (r=1.000, t_{44}=.905, p=.000), site documentation (r=1.000, t_{44}=.637, p=.000), site programme (r=.919, t_{44}=.551, p=.000), and site administration (r=.831,

Table 6: Paired two sample t-Test estimation of the effect of MT barriers and enablers on MT acceptance and proficiency

Categories for barriers and enablers	*Mobile technology acceptance*			*Mobile technology proficiency*				
	Mobile devices	*Mobile services*	*Mobile apps*	*Site documentation*	*Site programme*	*Site administration*	*Site organisation*	*Site communication*
Barriers (n=44)								
Complicate interfaces	r=0.574 p=0.000 t= 0.287	r=0.564 p=0.000 t=0.482	r=0.645 p=0.000 t=0.323	r=0.709 p=0.000 t=0.355	r=0.209 p=0.000 t=0.109	r=0.645 p=0.000 t=0.197	r=0.492 p=0.00 t=0.246	r=0.564 p=0.000 t=0.452
Security concerns	r=1.000 p=0.000 t=0.717	r=0.633 p=0.000 t=0.483	r=0.422 p=0.000 t=0.317	r=0.591 p=0.000 t=0.376	r=0.655 p=0.000 t=0.524	r=0.543 p=0.000 t=0.055	r=0.634 p=0.000 t=0.761	r=1.000 p=0.000 t=0.488
Network hitches	r=0.752 p=0.000 t=1.554	r=1.000 p=0.000 t=1.447	r=1.000 p=0.000 t=0.905	r=1.000 p=0.000 t=0.637	r=0.919 p=0.000 t=0.551	r=0.831 p=0.000 t=0.332	r=0.653 p=0.000 t=0.392	r=0.538 p=0.000 t=0.215
Total	r=0.775 p=0.000 t=0.852	r=0.732 p=0.000 t=0.804	r=0.689 p=0.000 t=0.515	r=0.766 p=0.000 t=0.456	r=0.594 p=0.000 t=0.394	r=0.673 p=0.000 t=0.194	r=0.593 p=0.000 t=0.466	r=0.700 p=0.000 t=0.385
Total hypothesis 1	H1a (supported) r=0.732 p=0.00 t=0.723			H1b (supported) r=0.665 p=0.00 t=0.379				

Categories for barriers and enablers	*Mobile technology acceptance*			*Mobile technology proficiency*				
	Mobile devices	*Mobile services*	*Mobile apps*	*Site documentation*	*Site programme*	*Site administration*	*Site organisation*	*Site communication*
Barriers (n=44)								
Enablers (n=44)								
Cyber operative	r=0.666 p=0.000 t=0.199	r=0.898 p=0.000 t=0.347	r=0.449 p=0.000 t=0.137	r=0.898 p=0.000 t=0.538	r=0.450 p=0.000 t=0.203	r=0.780 p=0.000 t=0.466	r=0.980 p=0.000 t=0.421	r=0.450 p=0.000 t=0.319
Task smoothening	r=0.732 p=0.000 t=0.219	r=1.000 p=0.000 t=0.717	r=1.000 p=0.000 t=0.822	r=1.000 p=0.000 t=0.629	r=0.744 p=0.000 t=0.417	r=0.743 p=0.000 t=0.305	r=1.000 p=0.000 t=0.922	r=1.000 p=0.000 t=0.225
Work process acceleration	r=0.656 p=0.000 t=0.328	r=0.656 p=0.000 t=0.262	r=0.899 p=0.000 t=0.369	r=0.898 p=0.000 t=0.529	r=0.449 p=0.000 t=0.216	r=0.449 p=0.000 t=0.316	r=0.980 p=0.000 t=0.215	r=0.450 p=0.000 t=0.486
Paper and time cutback	r=0.500 p=0.000 t=0.212	r=0.510 p=0.000 t=0.204	r=0.919 p=0.000 t=0.368	r=0.911 p=0.000 t=0.510	r=0.500 p=0.000 t=0.238	r=0.500 p=0.000 t=0.341	r=0.510 p=0.000 t=0.307	r=0.899 p=0.000 t=0.602
Total	r=0.638 p=0.000 t=0.239	r=0.766 p=0.000 t=0.382	r=0.829 p=0.000 t=0.469	r=0.926 p=0.000 t=0.551	r=0.535 p=0.000 t=0.268	r=0.618 p=0.000 t=0.357	r=0.867 p=0.000 t=0.466	r=0.699 p=0.000 t=0.408
Total hypothesis 2	H2a (supported) r=0.744 p=0.00 t=0.363			H2b (supported) r=0.729 p=0.00 t=0.402				

Significant p<0.05

t_{44}=.332, p=.000). The effect of network hitches on the other variables was found to be moderate.

Regarding the impact of enablers on mobile technology acceptance and proficiency, cyber operatives have a very strong effect on site organisation (r=.980, t_4 =.421, p=.000) and site documentation (r=.898, t_{44}=.538, p=.000). Task smoothening has a very strong effect on mobile devices (r=.732, t_{44}=.219, p=.000), mobile apps (r=1.000, t_{44}=.822, p=.000), site documentation (r=1.000, t_{44}= .629, p=.000), site organisation (r=1.000, t_{44}=.922, p=.000), and site communication (r=1.000, t_{44}=.225, p=.000). The effect of work process acceleration on mobile apps (r=.899, t_{44}=.369, p=.000), site documentation (r=.898, t_{44}=.529, p=.000), and site organisation (r=.980, t_{44}=.215, p=.000) was very strong. Paper and time cutback only have a moderate effect on mobile apps (r=.919, t_{44}=.368, p=.000), site documentation (r=.911, t_{44}=.510, p=.000), and site communication (r=.899, t_{44}=.602, p=.000).

5. DISCUSSION

According to the findings, overall, the site managers' MT capability is average, as they can effectively use only four of the 18 mobile devices identified (MS=2.99) and four out of the 19 mobile apps (MS=2.96). Site managers can effectively use 13 of the 16 recognised mobile services (MS=4.18). This result suggests that the site managers' proficiency is in their effective use of mobile services. It could also imply that mobile services are the primary component of MT (Hasan *et al*., 2021). Mobile services could be used to perform most of the functions of mobile apps (Khelifi & Hyari, 2016; Kim, 2018). Mobile services are similar to the custom apps that came with mobile devices (Hasan *et al*., 2018). This could be due to the fact that site managers are not limited to popular mobile apps and are exploring other mobile apps, or they are unaware of construction-related apps on their mobile devices. It could also imply that site managers are treating mobile devices as general or personal belongings rather than as a tool that could be used on site. Given the pattern of proficiency in the use of mobile devices, this contention could be supported. Mobile devices designed specifically for construction-related tasks were uncommon among site managers. Personal digital assistants, passive and active RFID tags, barcodes, and RFID-ready phones, for example, were not thoroughly evaluated as mobile devices in which site managers are proficient. This suggests that the site managers are primarily using mobile devices for social and personal purposes. Mobile devices are only used for construction-related activities that overlap with social and personal activities. This finding implies that site managers require information and understanding of the practical application of MT for construction site management.

This study reviewed the current state of Architectural, Engineering, Construction, and Operation (AECO) education in Nigeria. Clearly, the AECO educational programme is not fully informed about the state of progress in AECO research (Huang *et al*., 2020; Leveaux & Ornate, 2019). This result is consistent with previous studies on the use of MT in the construction industry (Hasan *et al*., 2019; Hu *et al*., 2020). The conclusion is that the site managers are extremely capable of using MT for site documentation (MS=4.37) and communication (MS=3.89), compared to various areas of application for MT in construction site management. These findings support the conclusion that site managers are highly capable of using mobile services. Mobile services such as phone cameras, Wi-Fi, e-mail, modems, and hotspots, used by site managers, correspond with site documentation and communication. The vast majority of MT application areas for site communication team members, such as scheduling site meetings, collaborating with site team members, and general communication on site, are linked via phone calls, e-mails, video calls, and hotspots. Phone cameras and video are useful for documenting project information, handling site reports, taking photos and recording for work documentation, and archiving the work process.

The findings revealed that the site managers had not been using MT beyond the standard MT application. The use of MT in construction has been limited (El Jazzar *et al*., 2020). RFID tags, for example, were required for specialised MT applications such as vehicle diagnostics and compliance, as well as the prevention of theft of stored merchandise. However, the site managers lacked expertise in the use of RFID tags. This explains their lack of expertise in the areas of site programming and administration. Only when site managers are proficient in the use of construction-specific MT can they use it to programme site activities and manage it on construction sites. Checking on-site staff accessibility, tracking worker performance, laying out structures, and holding virtual site meetings all necessitate proficiency in the use of construction-specific MT. Because of the high cost of data and the poor network coverage in Nigeria, using mobile services is both expensive and frustrating. The design of mobile devices contributes to the constant change in mobile device variants, and the need to recharge their batteries consistently contributes to site managers' low MT proficiency. The outcome is unmistakable: the site managers' lack of MT proficiency is due to muddled mobile device interfaces, security concerns with mobile services, and network outages. According to the findings of this study, the impact of MT on construction productivity through reduced paperwork and time savings motivates construction site managers to become proficient in MT. Given these results and the factors identified, the nature of the factors also supports the conclusion that MT affects productivity, compelling site managers to pursue MT proficiency.

The results of the study on the effect of barriers and enablers on site manager acceptance and proficiency revealed that barriers have a significant impact on mobile technology acceptance and proficiency, with security concerns having a very strong effect on mobile devices (r=1.000, p=.000) and network outages having a very strong effect on mobile services (r=1.000, p=.000). Task smoothening has a very strong effect on mobile devices (r=.732, p=.000) and site communication (r=1.000, p=.000), and was found to have a significant impact on mobile technology acceptance and proficiency. The findings revealed that network outages would most likely have an impact on mobile service acceptance (r= .000, p=.000) and site managers' proficiency in using mobile technology for site programme planning (r=.919, p=.000). This means that poor internet connectivity and slow speeds discourage the use of mobile technology and make mobile technology proficiency difficult. The findings also revealed that mobile technology's work process acceleration and cyber-operational benefits would most likely influence its acceptance. Cyber-operation, task simplification, work process acceleration, paper savings, and time savings are all likely to have an impact on site managers' proficiency with mobile technology.

6. CONCLUSION

Site managers' acceptance and proficiency in MT were influenced by MT barriers and enablers. Network outages, as a major MT barrier, have an impact on site managers' MT acceptance and proficiency. Work process acceleration and cyber-operational benefits of mobile technology also influence MT acceptance. The use of Android phones, laptops, wireless fidelity, electronic mail services, PDF viewers, and Google Maps are among the site managers' MT skills. The ability of the site managers to use these MT is acceptable, as they can effectively use a few mobile devices for standard MT applications. Concerning the impact of barriers on mobile technology acceptance and proficiency, complicated interfaces have a strong impact on site documentation, and network outages have a very strong impact on mobile services, mobile apps, site documentation, site programming, and site administration. In terms of enablers' impact on mobile technology acceptance and proficiency, cyber operatives have a significant impact on site organisation and documentation. Mobile apps, site documentation, and site communication are only moderately affected by paper and time constraints. The site managers' primary use of MT has been for social and individual functions, and they regard MT as a personal possession. When construction site activities intersect with social and personal activities, site managers inadvertently employ MT. The cost of data, poor network coverage, the design of mobile devices, the constant change in variants of mobile devices, and the need to recharge their batteries on a regular basis

all influenced the nature of MT usage by site managers. Site managers are mostly motivated to use MT because it saves time and reduces paperwork.

The study's implications include, but are not limited to the inclusion of construction site-based MT applications in Nigeria's AECO curriculum. Future construction professionals must be prepared to fully integrate MT into their professional responsibilities. Without a doubt, MT increases productivity; thus, future professionals must be shown how to use it. Furthermore, information on the use of MT for construction activities, as well as the imagination and inventive capacities of future professionals, may be triggered. This could lead to the development of innovative MT-based solutions to address the challenges in the Nigerian construction industry. Digitally compliant construction professionals also represent the industry's most obvious opportunity for developing software, devices, and apps with construction-specific and preferred functionalities. A large portion of the digital solutions used in the construction industry were developed from the standpoint of software and computer engineers, with virtually no input from construction experts. This could be a barrier to the appropriateness and acceptance of mobile or digital technologies in the construction industry. Another implication of this study is the need to perceive the relevance and appropriateness of various MTs in various site contexts. The study's findings are useful in educating site managers on the most effective way of perceiving the various areas where MT can be applied. The findings offer recommendations for training construction site managers in the use and application of MT for various aspects of site management.

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