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# PROSPECTS AND CHALLENGES OF IMPLEMENTING DIGITAL TECHNOLOGIES IN NIGERIAN CONSTRUCTION FIRMS

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## Abstract

The construction industry in Nigeria is undergoing a gradual transformation toward digitization, yet the adoption of digital technologies remains limited due to several systemic and operational barriers. This study assesses the prospects and challenges of implementing digital technologies such as Building Information Modeling (BIM), Internet of Things (IoT), drones, augmented and virtual reality (AR/VR), 3D printing, cloud computing, and artificial intelligence (AI) in Nigerian construction firms. Using a quantitative research methodology, data were collected from 255 construction professionals in Abuja to identify the most significant barriers and benefits associated with digital adoption. Findings revealed that the major impediments include lack of expertise and awareness, poor infrastructure, security concerns, high investment costs, and unclear government policies. Conversely, the benefits identified include improved site conditions, reduced project delays, precise estimation of work quantities, enhanced collaboration among stakeholders, and better cost management. The study concludes that despite evident challenges, digital transformation holds significant potential to drive productivity, efficiency, and sustainability in Nigeria's construction industry. Strategic recommendations include improved capacity building, investment in infrastructure, and policy support to promote the widespread adoption of digital technologies in construction practices.

**Keywords:** Digital technologies, construction industry, BIM, IoT, drones, challenges



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# Introduction

The construction industry is experiencing an increasing implementation of digital technologies such as Building Information Modelling (BIM), augmented and virtual reality (AR/VR), laser scanning, robotics, 3D printing, prefabrication and Design for manufacturing and assembly (DfMa) platforms, analytics software, blockchain, digital twins, the internet of things (IoTs), and machine learning solutions throughout the built asset lifecycle (e.g., project, organisation, and industry levels) (Ibem & Laryea, 2014; Koch *et al.,* 2019; Singh, 2019).

Globally, industry practitioners comprising construction professionals, construction companies, professional bodies, and government agencies have expressed their preferences for implementing digital technologies in construction (Koch *et al.,* 2019). McKinsey & Company reported that top players in the construction industry agree that digital technologies are critical to their sustenance (Buisman, 2018), and the innovative ones are aggressively implementing them. Some of these technologies, such as BIM, have become the norm in construction project delivery and are on the path to maturity in many companies (Maskuriy *et al.,* 2019).

The implementation of digital technologies encompasses transformational effects known as digital transformation (DT). Conceptually, DT refers to the changes (or disruptions) that the implementation of digital technologies brings to existing business models, which may be experienced in the construction production process, construction companies, and the construction supply chain (Hausberg *et al.,* 2019; Nadkarni & Prügl, 2020).

The implementation of digital technologies within the construction industry has encountered challenges that hinder its smooth implementation. These obstacles include social inertia, which is a resistance to change (Olanrewaju *et al.*, 2020), insufficient investment in technology (Abioye *et al.*, 2021; Adekunle *et al.,* 2021), inadequate skills to effectively utilise innovative technologies (Aliu *et al.*, 2021), high costs associated with acquiring these technologies (Aghimien *et al.,* 2021), and limited mechanisation of activities and processes (Durdyev & Hosseini, 2020) among various other factors. As a result, the construction industry has shown a sluggishness in embracing cutting-edge technology which has make them not to act effectively and completely compete with other industries, so lagging behind other sectors like aviation, business, education, energy, finance, health, and others (Chen *et al.,* 2021). Failure to adopt these advancements in technology could leave Abuja's construction sector at a disadvantage, reducing its competitiveness both locally and internationally, and exacerbating inefficiencies. Moreover, the lack of digital transformation may further delay projects, inflate costs, and reduce the quality of construction outcomes, potentially impacting the city's rapid urbanization and infrastructure development (Aghimien *et al.,* 2018). Thus,



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this research seeks to address the following core problem: What are the prospects and challenges of implementing digital technologies in Nigerian construction firms.

**PROBLEM STATEMENT**

According to Berger (2016) digitalisation is more about working with tools and practices based on information and communication technology. Castagnino *et al.* (2016) observed that digitalisation can be crucial in the transformation of the three major life-cycle phases of construction projects; that is the design and engineering phase, construction phase and operation phase.

Staub-French & Fischer (2017) noted that using digital technologies go a long way in distinguishing clashes in design, and facilitates outlines of schedule in the construction procedure. Aside from this, it was also discovered that less rework and fewer change orders are recorded when digitalisation is adopted. These reworks are in most cases costly and occur due to countless encounter that is undiscovered until they are experienced in the construction phase. Proactive plans are required to implement digitalization at all organization hierarches throughout the supply chain and the lack of standard tools and business models is a challenge for digital technologies (Manavalan & Jayakrishna 2019). In an international market, several organizations are not able to capitalize on their prospects as they lack the fundamental principles of digital technologies and thus do not realize the advantages of implementing digital technologies principles which has an adverse effect on environment which would in return save them a lot of money (Jaeger & Upadhya, 2020; Kumar *et al.* 2021).

**Lack of infrastructure:** In the time of increasing technological standards, an updated system infrastructure is required which can handle and integrate the different components or devices (Jaeger & Upadhyay 2020). The lack of high-quality infrastructural resources plays an important role in moving forward in digital technologies implementation (Rajput & Singh 2019). With the lack of quality system and infrastructure, interfacing different components in the system would be a challenge thereby making it difficult to interact with the physical world. Lack of infrastructure can also cause obstructions which in turn leads to overall delays in the supply chain network which in turn gives rise to internal software attacks which leads to change in information which the user receives. Therefore, this study intend to fill the existing gap by implementing digital technologies in construction firms such as, Building Information Modeling (BIM), Internet of Things (IoT), drones, augmented and virtual reality (AR/VR), 3D printing, cloud computing, and artificial intelligence (AI) in Nigerian construction firms.

**OBJECTIVE OF THE RESEARCH**

This study assesses the prospects and challenges of implementing digital technologies such as Building Information Modeling (BIM), Internet of Things (IoT), drones,

augmented and virtual reality (AR/VR), 3D printing, cloud computing, and artificial intelligence (AI) in Nigerian construction firms.

## LITERATURE REVIEW DIGITAL TECHNOLOGIES IN CONSTRUCTION

Rouse (2017) posited that digitalisation is the process of organising and transforming information into a distinct data set that is digital in nature. This transformed information becomes the binary data that is understandable and can be processed by computers and other devices with computing capacity. According to Berger (2016) digitalisation is more about working with tools and practices based on information and communication technology. Castagnino *et al.* (2016) observed that digitalisation can be crucial in the transformation of the three major life-cycle phases of construction projects; that is the design and engineering phase, construction phase and operation phase.

Adopting digital technologies for the various construction processes within these different construction life-cycle phases will largely reduce uncertainty and promote satisfactory construction products. The advantages of utilising digital technologies as part of development in construction are great. In fact, Hashim *et al.* (2013) identified the benefits of using digital technology in procuring construction projects to include among others, improvement in process quality, adequate savings in construction cost, adequate clients and participants satisfaction, increased responsiveness and productivity, expansion in market, and project delivered in the most effective manner.

Staub-French & Fischer (2017) noted that using digital technologies go a long way in distinguishing clashes in design, and facilitates outlines of schedule in the construction procedure. Aside from this, it was also discovered that less rework and fewer change orders are recorded when digitalisation is adopted. These reworks are in most cases costly and occur due to countless encounter that is undiscovered until they are experienced in the construction phase.

Above all, the adoption of digitalisation gives better cost control.

### The Nigerian Construction Industry and Digitalization

The Nigeria construction industries have been a major contributor to the Nigerian economy as it contributes significantly to the GDP of the nation. Despite its impressive performance, the industry faces several challenges, including a lack of local skilled labour, power shortage, nonavailability of materials, and unethical practices which is common in the industry (Usman & Said, 2014). The construction industry engages in a wide range of activities, including the building of commercial buildings, underground structures, private residences, and other essential structures like bridges, dams, flyovers, and roads. In addition to alteration, the industry also deals in repairs for buildings and structures. This makes it very important sector for national development and to Nigeria's economy as a

developing nation (Moshood *et al.,* 2020). The need for the industry to be able to stand with the other construction industry made digitalization very important.

Adegoke (2022) stressed the need for the adoption of digitization to enhance project performance and promote efficiency in the construction sector. He described digitization as the use of digital devices, like phones and tablets to enhance project performance and construction. The study conducted by Yusuf *et al.* (2021) highlighted the challenges of digitalization in Nigeria as technological backwardness, low financial capacity, lack of government support, lack of public private partnership, cyber threat, lack of top management support and fear of unemployment. Also, Ezeokoli *et al.* (2016) identified aligning and managing resources and teams to focus on digital services, limited availability of the right digital skills and capabilities, lack of collaborative and sharing culture and managing change among others. The Nigerian construction industry needs to harness the benefits of digitalization to improve performance and productivity. Digitalization seeks to adapt ways of making work easier and more sustainable (Adegoke, 2022).

**Digital Technologies Adopted in the Construction Industry**

The construction industry can be characterized as a dynamic sector that is always confronted by uncertainty. A building project is a multidisciplinary endeavour involving many parties, including the project owner and various professionals, contractors and suppliers, manpower and subcontractors. Due to the complexity of the endeavour and the wide range of people involved, cost management on such projects is notoriously difficult, often leading to cost overruns. The construction sector has numerous obstacles that hinder its success and ability to achieve its goals (Albtoush & Doh, 2019). The digital technologies adopted in the construction industries are as follows:

**Building information modeling (BIM):** BIM is a platform that consolidates and interconnects all building-related data, thereby providing a digital representation of the entire structure. It is a digital planning technology that combines all building-related data and planning information on a single platform. BIM is a repository of knowledge and a data management platform. The levels of data that can be integrated into a building information model can be defined using different dimensions. As further information becomes available, it can be incorporated into a design (e.g., cost and time), resulting in a more comprehensive picture of the project/asset (Dowd & Marsh, 2020).

**3D printing: Additive Manufacturing (AM):** Using a digital design and locally sourced multiple types of materials, 3D printing accurately reproduces three-dimensional objects, layerby-layer in the real world, thereby avoiding costly errors. 3D printing is capable of creating not only objects but also a whole structure (BigRentz Construction, 2022). 3D printing proves to be a key technology in the adoption of a circular economy; an

economic approach that seeks to maximize the use of resources and reduce waste. It helps mitigate the construction industry's environmental effects. Key advantages of this technology are less raw material usage and waste generation. The creation of a variety of different products, using almost the precise quantity of material required to make becomes available due to the use of recyclable and recycled materials (Afshari and Górecki, 2019; Ferreira *et al.,* 2020) Material utilization is optimized via 3D printing, allowing for the possibility of zero-waste production.

**AR and VR:** Real-time information is presented by combining one's physical surroundings with computer-generated content in an immersive environment by using advanced camera and sensor technologies (AR). The combination of augmented reality (AR) and building information modelling (BIM) permits the demonstration of a realistic project outcome and the opportunity for clients to make changes before the construction project's launch. Thanks to its ability to provide construction teams with a complete walk-through of the project, AR is seen to provide benefits of project delays prevention, cost overrun mitigation and mistakes elimination before they would occur. AR improves efficiency, enhances collaboration, helps better manage project costs and provides better safety on the construction site (BigRentz Construction, 2022). Inspections and progress reports on construction projects benefit greatly from augmented and virtual reality technologies. It can be utilized in the gathering of project cost data and the management of building assets. They can be utilized for automated measurements. Invaluable for use in other project-related activities, such as planning and monitoring (Igwe *et al.,* 2020).

**Internet of Things (IoT):** The use of IoT technology and tools includes worker safety, cost cutting, quality control, optimization of energy usage, material utilization, optimal waste and resources management, prediction of weather conditions, etc. IoT refers to the network of interconnected devices and objects that exchange data via embedded sensors, that enable remote operation or data collection from those objects, allowing the person connecting to another device to execute data analysis for prompt and improved decision-making, resulting in time and cost saving.

**Cloud Computing:** A failure to effectively communicate causes project delays and cost overrun. Throughout a project, information is often transferred and updated among various stakeholders and throughout various stages. Cloud computing may be utilized as a powerful tool to solve these problems (Hemanth *et al.,* 2017). Cloud computing "refers to the use of virtual servers where users access stored data through an Internet connection" Sage, (2019) Connecting all key team members, expanding opportunities for team collaboration, and enhancing management and owner visibility are all best accomplished through the use of cloudbased technologies. When everyone involved in a project has instantaneous access to the most up-to-date information, they are better able

to work together, which in turn reduces the likelihood of costly mistakes and delays (Sage, 2019). Consequently, construction companies will gain a competitive advantage and operational edge as they will be able to reduce the cost of completing a project (Bello *et al.,* 2021)

**AI and machine learning:** Time and cost estimates for ongoing projects can be more accurately estimated with the help of real-time monitoring, automated site data gathering, image processing, artificial intelligence, and analytics technologies (Sawhney *et al.,* 2020). Based on the project plans in a database of already existing structures, an AI-based system can create design alternatives. Designers and engineers can enter design objectives and attributes like geometric requirements, performance, materials, cost, and more into generative design software. The software then investigates all potential variations of a solution, utilizing AI to produce design options that adhere to all parameters. The software becomes a more effective tool with each project thanks to iterations that teach it how to make better design choices.

**Benefits of Implementing Digital Technologies by Construction Firms.**

The adoption of digital technology by construction industry activities and processes (planning and forecasting) has been recognized for the time and cost reductions that prevent project delays (Al-Rakhami *et al.,* 2020). As for the efficiency of the construction budget, the application of digital technologies enables accurate estimates due to the use of technological devices and models such as iPads, sensors, and digital trackers.

Thus, precise quantities of work/tasks are derived from the design stage. Overestimation of the cost is quelled to the barest minimum, while the process is kept within the commensurate budget. Golovina *et al.* (2016) argued that Radio Frequency Identification (RFID) and the Global Positioning System (GPS) are examples of sensing technology and related image-based technologies that can be useful in obtaining valuable data from multiple construction sites (Golovina *et al.,* 2016).

The data obtained can help in formulating a generalized model to produce reliable site layout plans that are critical in the planning phase of the construction project. The prototype systems have been accepted by evaluators and compared to the present manual technique of delivering status information if the prototype enhances the progress operation and monitoring (Akanmu *et al.,* 2013). Some evaluators have called for more research on how to tell when the installed components are genuinely in place rather than merely being in the proper spot, and several sensors can be used to track several placement situations. Hence, it may be more viable to adopt placement sensors, since they will determine when components are placed next to each other. However, these types of sensors track a single parameter (Akanmu *et al.,* 2013).

Therefore, it has limited applications due to the numerous stakeholders involved in the construction process (Tang & Bittner, 2014). Cyber/digital technologies can also improve the traditional means of construction activities and products (Akanmu *et al.,* 2013). The integration of innovative technologies into construction activities and the process can lead to better decision making between project team members, enhanced communication flow, improved efficiency in operations, timely delivery, and increased productivity of the workforce (Golovina *et al.,* 2016; Fan *et al.,* 2015).

**Challenges to Implementing Digital Technologies by Construction Firms**

Despite the advancement of these technologies, many industries are hesitant to adopt the technologies. Digital technologies weren't implemented by many industries due to a lack of efficient leadership. Support from the senior management level is vital for promoting sustainable strategies throughout any organization. This approach plays a very crucial role in achieving their long-time goals.

**Lack of knowledge expertise and awareness on digital technology implementation**: Proactive plans are required to implement digitalization at all organization hierarches throughout the supply chain and the lack of standard tools and business models is a challenge for digital technologies (Manavalan & Jayakrishna 2019). In an international market, several organizations are not able to capitalize on their prospects as they lack the fundamental principles of digital technologies and thus do not realize the advantages of implementing digital technologies principles which has an adverse effect on environment which would in return save them a lot of money (Jaeger & Upadhya, 2020; Kumar *et al.* 2021).

**Lack of infrastructure:** In the time of increasing technological standards, an updated system infrastructure is required which can handle and integrate the different components or devices (Jaeger & Upadhyay 2020). The lack of high-quality infrastructural resources plays an important role in moving forward in digital technologies implementation (Rajput & Singh 2019). With the lack of quality system and infrastructure, interfacing different components in the system would be a challenge thereby making it difficult to interact with the physical world. Lack of infrastructure can also cause obstructions which in turn leads to overall delays in the supply chain network which in turn gives rise to internal software attacks which leads to change in information which the user receives.

**Security challenge:** Hacking, incorrect information pose a lot of security challenges as they are embedded with a lot of critical information. Security and technical vulnerability of the information are some of the main technological barriers. According to researchers, there are a lot of transactions which happen in the supply chain network in which the authentication details are available which in turn tends to be insecure. As a result, it could

also lead to significant privacy concerns for the users. Due to lack of security, further progress in a business environment is limited. Intensified security would be the prime challenge to give a secure flow of data and information (Mathivathanan *et al.* 2021).

**The negative perception towards new technology adoption:** Negative perception largely focuses on the public image which plays a large role in adopting or implementing a new technology towards digital technologies development. Of late, it has been a negative perception in adopting new technologies mainly because of the lack of security involved in the supply chain which in turn gives rise to other illegal activities which in turn leads to hesitation in organizations adopting new technologies. Further, there is a significant relationship between the barriers, security and adopting new technologies which require a strong attention to overcome (Lohmer & Lasch 2020). While security acts as the mediator barrier, it is also known that technology access, i.e., lack of proper IT resources could also be a potential challenge to overcome the negative impact of adopting new technologies.

**Immaturity of technology:** Due to lack of development in technology, software threat arises which leads to cyber-attacks and also economic and financial losses. Considering the supply chain as global, we cannot expect everyone to be equipped with the latest technologies (Luthra & Mangla 2018). This gives rise to the question as to how to establish or adopt on large scale. If there are large complex transactions taking place, high-powered systems are required since low-powered systems can cause a lot of delays (Karmaker *et al.,* 2021). Many industries are yet to equip themselves with the latest technologies or some industries are unaware of the latest tools which have had an indirect impact on security challenges and negative perception towards technology (Kouhizadeh *et al.,* 2021).

**Unclear government policy:** Government support plays an important role in adopting CE techniques in connection with sustainable management. Governments would not be in favor of promoting the latest technology innovations with regards to sustainable supply to encourage the promotion of digital technologies despite the availability of many resources due to plenty of rules and regulations. Further, in developing countries, governmental incentives and support would be a substantial barrier in the development of digital technologies if not provided (Mittal *et al.,* 2018).

**Dependent on 3rd party technology providers**: For the efficient implementation of digital technologies, high-quality real-time data would be vital. Since the IT resources and infrastructure are not equipped with the latest technologies, the dependency on third-party providers becomes more prominent (Yadav *et al.,* 2020) which in turn has led to plenty of questions and concerns regarding system safety and security.

**Limited scalability:** Limited scalability is one of the important barriers which limit the technology for widespread production use. Due to limited scalability, there is



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vulnerability and insecurity of the technical resources available for further use. Most business models identify scalability as the major challenge (Tönnissen & Teuteberg 2020). One of the main reasons for limited scalability could be the lack of development in technology towards digital technologies implementation.

## RESEARCH METHODOLOGY

Quantitative research methodology was adopted for this study. Quantitative research is a form of conclusive research involving large representative samples and fairly structured data collection procedures in which collected data are mostly expressed in numbers. The targeted populated research sample consists of individuals employed in the construction industry. The research population consists of 255 construction professionals officially registered with the Abuja Business Directory in Abuja.

## RESULT AND DISCUSSION

Table 1: Barriers to implementing digital technologies by construction firms

| S/N | Barriers to implementing digital technologies by construction firms | MIS | Rank | Kruskal–Walli's test | Decision |
|---|---|---|---|---|---|
| 1 | Lack of knowledge expertise and awareness on digital technology implementation | 4.50 | 1st | 0.06 | Very Significant |
| 2 | Lack of infrastructure | 4.45 | 2nd | 0.46 | Significant |
| 3 | Security challenge | 4.34 | 3rd | 0.42 | Significant |
| 4 | Disruption to existing jobs | 4.25 | 4th | 0.20 | Significant |
| 5 | Limited scalability | 4.22 | 5th | 0.84 | Significant |
| 6 | Lack of roadmap for successful implementation of industry 4.0 | 4.18 | 6th | 0.53 | Significant |
| 7 | The negative perception towards new technology adoption | 4.15 | 7th | 0.32 | Significant |
| 8 | Dependent on 3rd party technology providers | 4.12 | 8th | 0.33 | Significant |
| 9 | Unclear government policy | 4.12 | 8th | 0.43 | Significant |
| 10 | Unclear benefits | 4.09 | 10th | 0.03 | Significant |
| 11 | Investment cost | 4.09 | 10th | 0.03 | Significant |
| 12 | Immaturity of technology | 4.07 | 12th | 0.19 | Significant |
| 13 | Difficulty and complexity in changing organizational culture | 3.80 | 13th | 0.00 | Significant |
| | ***Average MIS*** | ***4.18*** | | | **Significant** |



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The use of MIS to explain the barriers to implementing digital technologies by construction firms, in order of significance. Table I reveals the result of MIS for the thirteen identified barriers to implementing digital technologies by construction firms. It was shown that the most significant barriers are lack of knowledge, expertise, and awareness on digital technology implementation, lack of infrastructure, and security challenges, with MIS values of 4.50, 4.45, and 4.34, respectively. Difficulty and complexity in changing organisational culture were identified as the least significant, with MIS values of 3.80. On average, all the identified barriers to implementing digital technologies by construction firms in order of significance. in Abuja are significant (average MIS = 4.18). As a result, an ordinal-based nonparametric technique called the Kruskal-Walli's test was conducted to determine whether there are significant variations in the responses of the respondents with different professional backgrounds. As shown in Table I, the asymptotic 2tailed significance p-values were greater than 0.05 at the 95% confidence level for eleven barriers. This confirmed that there were no statistically significant variations in the responses of the respondents with different professional backgrounds. This study's findings are in line with those of Ball *et al.* (2018), who affirmed that many industries are reluctant to implement these technologies due to a lack of infrastructure, security challenges, disruption to existing jobs, limited scalability, and unclear government policy. Due to a lack of proper investment, many industries are not able to bring in new technologies such as machine learning, big data, and artificial intelligence.

Table II: Benefits of implementing digital technologies by construction firms

| S/N | Benefits of implementing digital | MIS | Rank | Krusal | Decision technologies by construction firms. Walli's |
|---|---|---|---|---|---|
| 1 | Improvement of site condition | 4.29 | 1st | 0.04 | **Significant** |
| 2 | Precise quantities of work/tasks are derived from the design stage | 4.26 | 2nd | 0.46 | **Significant** |
| 3 | Decrease time for data processing and communicating information. | 4.26 | 3rd | 0.84 | **Significant** |
| 4 | BIM tools allow project stakeholders to share information about sequencing, physical site topography, and clash detection; improve communication among the project stakeholders; and identify potential locations and times of hazardous and non-hazardous cons | 4.25 | 4th | 0.31 | **Significant** |



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| S/N | Benefits of implementing digital | MIS | Rank | Krusal | Decision technologies by construction firms. Walli's |
|---|---|---|---|---|---|
| 5 | Offer opportunities to enhance communication between participants in construction projects and to enable more effective and efficient communication. | 4.23 | 4th | 0.00 | **Significant** |
| 6 | Seamless working methodology | 4.23 | 6th | 0.00 | **Significant** |
| 7 | Increased safety practices | 4.21 | 7th | 0.66 | **Significant** |
| 8 | Overestimation of the cost is quelled to the barest minimum | 4.21 | 7th | 0.66 | **Significant** |
| 9 | Intelligence of sensor-based technology helps construct an interactive management platform, which is the integration of hardware and software for data processing, significantly improving the construction site monitoring capacity and providing guarantees. | 4.21 | 9th | 0.29 | **Significant** |

The use of MIS to explain the benefits of implementing digital technologies by construction firms in order of significance. Table II reveals the result of MIS for the twenty identified benefits of implementing digital technologies by construction firms. It was shown that the most significant prospects are improvement of site condition, precise quantities of work or tasks derived from the design stage, decreased time for data processing and communicating information, and BIM tools that allow project stakeholders to share information about sequencing, physical site topography, and clash detection; improved communication among the project stakeholders; and identification of potential locations and times of hazardous and non-hazardous cons with MIS values of 4.29, 4.26, 4.26, and 4.25, respectively.

While improved customer satisfaction, reducing the need for co-workers to be located in the same venue, and aiding operational improvement through communication of construction information for effective decision-making and coordination were identified



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as the least significant, with MIS values of 4.11 and 4.11, respectively. On average, all the identified benefits of implementing digital technologies by construction firms are ranked in order of significance. The benefits for implementing digital technologies in Abuja are significant, with an average MIS of 4.18. As a result, an ordinal-based nonparametric technique called the

Kruskal-Walli's test was conducted to determine whether there are significant variations in the responses of the respondents with different professional backgrounds. As shown in Table 4.5, the asymptotic 2-tailed significance p-values were greater than 0.05 at the 95% confidence level for fifteen prospects. This confirmed that there were no statistically significant variations in the responses of the respondents with different professional backgrounds.

**Conclusion**

It was shown that the most significant barriers are a lack of knowledge, expertise, and awareness about digital technology implementation, a lack of infrastructure, and security challenges. It was shown that the most significant prospects are improvement of site condition, precise quantities of work or tasks derived from the design stage, decreased time for data processing and communicating information, BIM tools that allow project stakeholders to share information about sequencing, physical site topography, and clash detection, and improved communication among the project stakeholders.

**Recommendations**

Construction firms should ensure that the various barriers to implement digital technologies are properly addressed, especially lack of knowledge, expertise, and awareness of digital technology implementation lack of infrastructure and security challenges

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