EVALUATING THE ADOPTION OF SMART SAFETY TECHNOLOGIES IN NIGERIAN CONSTRUCTION INDUSTRY: CHALLENGES AND BENEFITS

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ABSTRACT

This study investigates how smart safety technologies are being adopted in Nigeria's construction sector. The study used a quantitative methodology using a survey questionnaire to collect data from Nigerian construction industry professionals. The study's target group consisted of construction professionals who lived in Ogun State, Nigeria's Ijebu Ode Area. The researcher selected a sample size of 150. The exploratory factor analysis and principal component analysis extraction procedures were used to analyse the data. The study came to the conclusion that the application of smart safety technology in Nigeria's construction sector has improved project completion and success while lowering accidents and injuries. Thus, the study suggested that construction companies should increase the amount of money allocated to purchase new technologies and offer frequent training programs to teach their employees how to use them in order to help overcome the fundamental barriers that prevent the adoption of smart safety technology.

Keywords: *Construction Safety; Smart Safety Technologies; Project Management*

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INTRODUCTION

The advent of industrialisation and globalisation, together with the start of the current millennium, has drastically altered how technology is adopted and used in the workplace. This is because technology has changed how businesses function, and executives are starting to view technology as more than just a crucial component of company; it has become a widespread issue for organisations (Ibrahim et al., 2025). Numerous demands on the construction industry, including reducing health and safety hazards, meeting the ever-changing and sophisticated needs of clients, completing projects on schedule, preventing project cost overruns, overcoming supply chain issues, and enhancing service delivery, have compelled organisations to look for alternative solutions, and one of these is the adoption of digital technologies (Bello et al., 2024; Nnaji et al., 2019).

Construction work exposes employees to a range of occupational dangers due to its high risk and hazardous operations, as well as its physical demands (Obasa et al., 2024). Employees are subjected to a number of mishaps that negatively affect construction projects, including a rise in mental illness, a decline in productivity, a drop in employee morale, higher medical costs, and the potential for fatalities (Oyediran et al., 2025). In contrast to other businesses, the construction sector has been known to record the highest number of fatalities and accidents, despite being recognised as a significant contributor to the economic development of many nations (Osunsanmi et al., 2020). The International Labour Organisation (ILO, 2023) reports that work-related deaths are three times higher in wealthy nations than in other industries, and they are even worse in developing nations like Nigeria.

The Nigerian construction industry has encountered a number of significant challenges, including delays, poor safety management practices, cost escalation, and corruption (Babalola & Harinarain, 2024). As a result, many Nigerian construction companies have been unable to adjust to the complexity of the new technology-led business environment, which has had an impact on their ability to survive (Abina et al., 2023; Ilesanmi et al., 2024). Given that the construction industry is one of the most important sectors of a nation's economy, the high failure rate of construction projects and industries in Nigeria may be a sign of inefficiencies in identifying suitable project management techniques and utilising technological tools. Additionally, the construction industry has hampered Nigeria's economic growth (Ebekozien et al., 2023). Notwithstanding the government's efforts, there are still a lot of mishaps, illnesses, and injuries among Nigerian construction workers (Kissi et al., 2023).

Even though the construction industries in developing nations have different geographic, social, political, and economic foundations, prior research has shown that these industries face similar issues (Bello et al., 2024; Mahmoud et al., 2022; Olawumi & Chan, 2022). Additionally, researchers have shown that Nigerian construction project managers have resisted implementing new technologies, which has led to the ongoing insufficiency of automated assessment and tracking of construction project performance in the Nigerian construction sector (Mchunu et al., 2024; Osunsanmi et al., 2020). Other scholars have underlined that the high percentage of unsuccessful and abandoned building projects is due to a lack of understanding of the obstacles to technology adoption in Nigeria's construction sector (Ebekozien et al., 2022; Okafor et al., 2023). This study looks at the challenges and benefits of smart safety technology adoption in Nigeria's construction sector in an effort to close this gap.

LITERATURE REVIEW

The Nigerian Construction Industry

Nigeria's construction industry is a major force behind the country's economic growth since it contributes significantly to GDP, infrastructure development, and employment creation. About 3–4% of Nigeria's GDP comes from the construction industry, which is largely responsible for this since almost every other industry in the nation depends entirely on the goods and services provided by the sector to function (Oyediran et al., 2025). For instance, in order to conduct its manufacturing operations, the manufacturing sector requires infrastructure, including office buildings (Ebekozien et al., 2023). Despite being a major contributor to the Nigerian economy, the construction sector is also notorious for its risky operations, as evidenced by the fact that it has the highest accident rate among all other industries (ILO, 2023). As a result, industry-wide safety norms and regulations have been established, guaranteeing that employers on construction sites adhere to safety procedures in order to provide a secure workplace (Abina et al., 2023).

Construction Safety

Safety is the absence of injury or any other undesirable consequence (Ebekozien et al., 2023). Safety, according to Kissi et al., (2023), is a state in which risk and danger are absent. Safety in the construction sector can be defined as preventing accidents from occurring while working (Olanrewaju et al., 2024). Safety, which is defined as the means of preventing accidents, fatalities, and injuries, is extremely important in the construction sector (Okanlawon et al., 2024). Safety can be seen as a means of preventing mishaps, safeguarding employees, and cutting costs that are linked to mishaps, project delays, and injuries (Ejidike et al., 2022).

In contrast to other industries, the construction sector places a high priority on safety, which, if not completely executed, may impede project progress or completion. Unskilled workers, poor site management, dangerous working conditions, a lack of adoption of cutting-edge safety technologies, and a lack of emphasis on the value of safety inside organisations are all linked to these industry safety concerns (Ammad et al., 2021). Additionally, construction sites are known for their risky working conditions and are ranked among the most dangerous in the world (Ebekozien et al., 2022). It is impossible to overlook the effects of accidents resulting in injuries as they have an adverse effect on not just the individual but also on project completion, cost, and work progress (Oyediran et al., 2025).

Smart Safety Technology in Construction Industry

Building Information Modelling (BIM)

BIM is a computer program that simulates the building's construction and operation. It can be combined with other technologies, like virtual and augmented reality (Bello et al., 2024). In order to improve information flow and guarantee the overall safety management of construction projects, it was created especially to help a project team or individual systematise and coordinate project formulation (Ejidike et al., 2022). This tool has been used in many construction projects over the years to ensure that design errors are minimised through safety planning and design for safety. For instance, the model automatically checks all operational operations for safety regulations after they are developed, ensuring safety (Ebekozien et al., 2022).

Wearable Safety Technologies

Wearable safety technologies are tiny electronic devices that are worn on employees' bodies to provide a variety of safety advantages (Ibrahim et al., 2024). This technology is easy to use, reasonably priced, and used to monitor worker safety, particularly while on a dangerous construction site (Oyediran et al., 2025). The wearable inertial measuring unit (IMU), which is used to avoid falls, is one of the most popular wearable safety technologies (Ibrahim et al., 2025). The technology is worn on many parts of the body, including the lower back and ankles, to collect psychological data about the worker's dynamic movement along reference axes. According to several researchers, electrocardiography (ECG) and electroencephalography (EEG) are additional wearable safety technologies that evaluate employees' heart and brain activity, respectively (Ejidike et al., 2022; Mchunu et al., 2024). Additionally, Bello et al., (2024) recommend the usage of safety helmets and wristbands to monitor the worker's health.

Unmanned Aerial Vehicles (UAV)

These are known as drones, but as the name suggests, they don't need a pilot on board (Mchunu et al., 2024). Drones can be classified into four types: single-rotor, fixed-wing, fixed-wing hybrid, and multirotor. The multirotor drone is the most popular of them and is also, in my opinion, a more sophisticated technology (Olanrewaju et al., 2024). Because it can be operated remotely from the ground, this technology reduces the risk of exposure for workers, which makes it crucial for safety. Drones are used in construction to conduct safety and non-safety related supervision and inspections because they are equipped with sensors like motion and camera sensors that allow them to quickly gather visual data in hazardous and inaccessible areas (Kissi et al., 2023; Oyediran et al., 2025).

Automation and Robotics

Automation and robotics have been found to be highly beneficial in improving worker safety, particularly when doing high-risk and high-difficulty tasks (Ebekozien et al., 2023). Because of its ability to handle numerical data and perform inspection tasks in confined and hazardous areas, which could put workers at greater risk, robotics can now replace human functions when it comes to performing quality inspections, which are extremely labour-intensive and time-consuming (Oke et al., 2024). According to Ibrahim et al., (2025), robotics is equipped with sensors like thermal cameras and laser scanners that allow it to identify significant flaws that could endanger worker safety. Additionally, automatic fall prevention systems were a novel technological solution in reducing the health risks associated with falling from heights, such as elevation, which is one of the most common hazards or accidents on construction sites (Kissi et al., 2023).

Virtual Reality (VR)

Virtual reality (VR) is a visualisation technology that uses 3D and computerised representations of reality to provide people an artificial digital world. Engineers and contractors can visually monitor site conditions and spot possible safety hazards by wearing this device as a headset (Ejidike et al., 2022). The person or worker would be able to identify any possible collisions or hazards through the VR models' walkthroughs, and they could then take appropriate precautions to reduce the risk (Kissi et al., 2023). Additionally, workers would be able to visually identify the construction sequence, materials, and equipment specifications before construction began thanks to its unique features. This would allow them to implement safety plans based on the detected risk for improved operations (Ibrahim et al., 2024). Additionally, it has been described as a useful tool for building projects, particularly in the areas of safety management, safety training, and safety planning (Olawumi & Chan, 2022).

Augmented Reality (AR)

Augmented Reality (AR) is a visualisation technology that overlays virtual data on a physical environment. To put it another way, it creates an environment in which the user's vision of a real-world situation is overlayed with computerised data (Osunsanmi et al., 2020). Both the actual and virtual things will appear in an augmented reality environment thanks to its 3D virtual models, which can visualise job site environs onto real-time films. This means that the real world has been enhanced with relevant information (Bello et al., 2024). Oyediran et al., (2025) claim that this technology is utilised to conduct advanced safety training, which improves workers' capacities and skills in recognising risks.

Challenges Facing the Adoption of Smart Safety Technologies in Construction Industry

Organizational Size

An organization's capacity to adopt new technologies is significantly impacted by its size. In this instance, a complex or highly technical technology necessitates a significant amount of resources from the organisation, and it is more likely that only large organisations, as opposed to smaller businesses, will be able to adjust to these technologies (Olanrewaju et al., 2024). According to Ebekozien et al., (2022), an organization's size plays a significant role in determining its financial capacity; that is, a larger organisation is more likely to have a resource advantage when it comes to innovation and the adoption of new technology.

High Initial Investment Capital

Adoption of a new technology necessitates a large initial investment because of the costs associated with the system, software, and operating product (Ebekozien et al., 2023). According to Osunsanmi et al., (2020), the startup cost is also known as adopters' development and initial costs, and it includes the expenses incurred when a company decides to switch from an outdated system to a new one or when a new technology is accepted. The adoption of new technology is difficult, according to Oyediran et al., (2025), because it is expensive and may significantly affect the viability of the company, particularly small and medium-sized businesses.

Complex Operation

Complexity can be defined as the degree of difficulty in utilising a new technology, which is associated with the amount of work or knowledge required to become acquainted with it (Oke et al., 2024). According to Ejidike et al., (2022), businesses are more likely to be deterred from implementing new technology if it appears complex or challenging to use. The complexity of such situations is one of the primary reasons for adopting a new method of operation. The hope is that the new technology will be able to reduce potential risk and accidents, but the complexity of such technology will limit its usability and effectiveness (Ibrahim et al., 2024).

Lack of Top Management Support/Lack of Financial Support

The deployment of advanced and emerging technology in an organisation is greatly influenced by management or leadership support. This is because such support can take the form of adequate financial resources, resource allocation, and the creation of training and development activities; if it is denied, the technology may not be adopted (Ebekozien et al., 2022; Olanrewaju et al., 2024). Since top management is viewed as both a facilitator and a hindrance to the adoption of new technologies, it would be difficult or impossible for such technology to be successfully adopted in the organisation without their support and commitment (Oyediran et al., 2025).

Lack of Experience and Skill

When it comes to adopting new technology, training is crucial because it gives the employee or individual the skills and knowledge they need to use the technology to complete their tasks and perform at their best (Bello et al., 2024). According to Oke et al., (2024), it is very difficult to ensure that employees in an organisation have the requisite knowledge and expertise when it comes to using technology, and when they do not, they are much less likely to embrace new technologies.

Benefits of Smart Safety Technology in Construction

Building Information Modelling (BIM), wearable safety technologies, unmanned aerial vehicles (UAV), automation, and robotics are examples of smart safety technologies that are designed specifically for real-time data monitoring and risk analysis. These technologies help make decisions that will prevent accidents and anticipate potential risks before they materialise (Bello et al., 2024). For example, technologies such as Augmented Reality (AR) and Virtual Reality (VR) might produce a virtual model of construction sites, allowing workers to perform proactive hazard assessment and mitigation (Oyediran et al., 2025). Ebekozien et al., (2022) assert that smart safety technologies are essential for bolstering safety protocols since they are equipped with sensors that help detect and identify potential hazards before they create an accident.

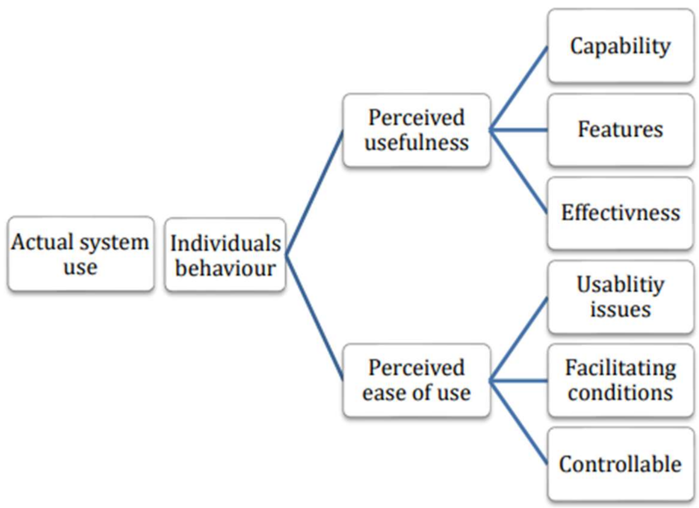
According to Oke et al., (2024), smart technologies aid in automating and enhancing post-accident response protocols. For instance, they could send out emergency rescue requests and give managers and employees on the job site the best evacuation routes thanks to their automated system. In their study, Ammad et al., (2021) found that cutting-edge technologies like unmanned aerial vehicles and wearable safety devices can clear up uncertainty right after an occurrence, allowing for quick and efficient responses. Advanced technologies like Building Information Modelling (BIM), Wearable safety devices, Unmanned Aerial Vehicles (UAV), Automation and Robotics, and Augmented Reality (AR) also enable workers and managers to monitor accident scenarios in real time, allowing for timely and informed actions (Ejidike et al., 2022).

Furthermore, the scope of construction safety training has expanded thanks to safety-related modern technologies like virtual reality (VR) and augmented reality (AR). This is because the environment has been designed to mimic real building sites, giving workers hands-on experience and enabling them to acquire abilities that go beyond their conventional theoretical trainings in handling such situations (Abina et al., 2023; Olanrewaju et al., (2024). According to Osunsanmi et al., (2020), incorporating these smart technologies into training programs greatly increases workers' awareness of safety issues and gives them the skills they need to control risk factors on building sites. According to Ibrahim et al., (2024), workers who are more knowledgeable and skilled in recognising risks and mitigating them are less likely to have accidents on construction sites, which enhances the safety of construction environments.

Underpinning Theory

Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) can be used to explain how people behave while adopting new technology (Davis 1989). Two important acceptance variables, perceived usefulness (PU) and perceived ease of use (PEU) (Davis et al. 1989; Lu et al. 2011), were used to explain this user behaviour (see figure 1). Perceived usefulness (PU), the first TAM construct, explains why people tend to believe in new technology only when they know it could help them accomplish their goals or do better work. Perceived ease of use (PEU) explains why people believe in a technology when they know it will be easy for them to use (Davis & Granic, 2024). The construction industry relies on these two factors for technology adoption, and in order for workers to embrace these technologies, they must feel comfortable with their usefulness and get guidance (Ebekozien et al., 2022).



Source: Davis, 1989

Figure 1
TAM Model

METHOD

A quantitative research approach was used to accomplish the study's goal, which is to investigate the use of smart safety technology in Nigeria's construction sector. One of the best options for research methodology is the quantitative approach, which boosts the study's dependability and reproducibility while enabling the use of standardised procedures (Saunders & Lewis, 2019). The target population of the study were construction professional that are domiciled in Ijebu Ode Area of Ogun State, Nigeria. This research location was chosen because it is home to a number of businesses, including manufacturing and construction, making it a pertinent case study for the construction sector. Additionally, the city's economic expansion and development open up opportunities for building projects and the researcher's knowledge with the region.

The researcher selected a sample size of 150, which validated Gorsuch's (2015) claim that a factor analysis requires a minimum sample size of 100. Engineers, construction managers, quantity surveyors, and architects are among the study's respondents. The characteristics of the participants led to the use of convenience sampling, affirming Dubey and Kothari (2022) claim that convenience sampling is the simplest and most feasible method of reaching a certain responder group and selecting participants based on their availability and willingness to participate. The questionnaire was selected as the research tool, and this is made possible by its capacity to reach a sizable number of respondents in a condensed amount of time, as well as by enabling research that is both objective and quantifiable (Saunders et al., 2023). Three components made up the questionnaire. The first piece collected data on the respondents' demographics, including their level of education, number of construction projects completed in the previous 10 years, and year of experience. The degree of adoption or application of smart safety technologies in the construction industry was examined in the second section; the difficulties or obstacles to adoption or application of smart safety technologies and restrictions were indicated in the third section; and information about the advantages or opportunities of the smart safety technologies was gathered in the final section. A five-point Likert scale was used in the questionnaire's design.

A pilot study was carried out and according to Islam et al., (2022), it is used to determine the validity and reliability of the research tool (questionnaire). A total of 20 questionnaires were given to the respondents and collected. With a result over 0.7, the Cronbach's alpha analysis yielded a value of 0.883, indicating strong reliability of the study instrument (Polonsky & Waller, 2019). The exploratory factor analysis and principal component analysis extraction procedures were used for the data analysis. Finding underlying elements or constructs that aid in explaining the link between the research variables is made much easier with the help of this data analysis technique (Hammond & Wellington, 2007). In order to ascertain the variance in the original variables, it also aids in the conversion of comparable linked variables' attributes utilising specific factors that are linearly correlated and explained using a variety of constructs (Wilson, 2014).

RESULTS AND DISCUSSION

Exploratory Factor Analysis

The multivariate statistical method known as exploratory factor analysis (EFA) is frequently used to find the underlying structure in a collection of observed variables (Schreiber, 2021). Its main goals are to find latent structures and enable researchers to reduce a huge number of connected variables into a smaller, easier-to-understand collection of factors (He et al., 2021). The EFA process incorporates a number of crucial criteria that direct the decision-making process. Prior to extraction, the data's appropriateness needs to be evaluated. With values nearer 1 signifying more appropriateness, the Kaiser-Meyer-Olkin (KMO) measure of sample adequacy should be at least 0.6. Likewise, Bartlett's Test of Sphericity must be statistically significant ($p < 0.05$) to validate that factor analysis is warranted due to the strength of the correlations between variables (Watkins, 2021). EFA's last phase entails interpretation and decision-making. Both statistical support and theoretical significance are taken into consideration while evaluating, naming, and keeping factors. Items that exhibit high cross-loadings or don't satisfy permissible loadings might be excluded from additional analysis (He et al., 2021). In the end, EFA results give researchers a clear framework that improves comprehension of the data and establishes the groundwork for further confirmatory research (Goretzko et al., 2024).

Table 2
Factor Loading and Variance Explained

Factor profile	Factor loading	Variance explained (%)	Cronbach	Average mean
Dimension 1: Smart Safety Technologies	–	19.468	0.854	4.123
Virtual Reality (VR)	0.795	–		
Building Information Modelling (BIM)	0.741	–		
Unmanned Aerial Vehicles (UAV)	0.662	–		
Augmented Reality (AR)	0.659	–		
Wearable safety technologies	0.615	–		
Automation and Robotics	0.567	–		
Dimension 2: Challenges Facing the Adoption of Smart Safety Technologies		19.911	0.841	4.472
Organizational Size	0.832	–		
High Initial Investment Capital	0.828	–		
Complex Operation	0.821	–		
Lack of Top Management Support/Lack of Financial Support	0.697	–		
Lack of Experience and Skill	0.677			
Dimension 3: Benefits/Opportunities of Smart Safety Technologies		17.402	0.879	3.716
Improved worker safety	0.875	–		
Improved project delivery	0.854	–		
Reduced accidents and injuries	0.822	–		
Improved material selection	0.764	–		
Enhanced workers training	0.882			
Improve hazard identification	0.868	–		
Provision of technical solutions	0.793	–		
Increased productivity	0.713			
Cumulative variance explained		56.781	0.920	
Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy		0.848		
Bartlett's test of sphericity Approx. χ^2		1642.649		
df		182		
Sig.		0.000		

Extraction Method: Principal Component Analysis
3 components extracted
Source: Field Survey; 2025

The study used exploratory factor analysis (EFA) as its data analysis approach in order to thoroughly investigate and assess the efficacy of smart safety technology in Nigeria's construction industry. Key variables that serve as the study's constructs were identified as a result of this methodology. The output confirmed the validity of the factor analysis with correlation values over 0.3. Additionally, the Kaiser-Meyer-Olkin (KMO) and Bartlett's test of sphericity were used to assess the factorability and sample adequacy of the survey data. Pallant (2005) explains that in order to maintain the eligibility for factor analysis, the Bartlett's test of sphericity must have a significant value less than 5% ($p < 0.05$). Table 1 shows that the analysis value for the KMO is 0.848 with a p-value of 0.00. The KMO value is higher than the 0.50 value required to determine the sufficiency of sampling for factor analysis.

The variances exhibit the required significant difference, as indicated by the Bartlett's test of sphericity of 1642.649 ($\rho < 0.05$). The findings, when paired with the Cronbach alpha validity test, yielded a value of 0.920, further confirming the data set's appropriateness for EFA. Furthermore, the table showed a cumulative variance of 56.8%. The first component, which consisted of six variables with factor loadings ranging from 0.795 to 0.567, represented 19.5% of the total; the second component, which consisted of five variables with factor loadings ranging from 0.832 to 0.665, represented 19.9% of the factors influencing the adoption of emerging technologies for construction safety; and the third component, which consisted of eight variables with factor loadings ranging from 0.875 to 0.713, represented 17.4% of the advantages and opportunities of smart safety technologies in the construction industry.

Discussion

Smart Safety Technologies

Virtual reality (VR), building information modelling (BIM), unmanned aerial vehicles (UAV), augmented reality (AR), wearable safety technologies, and automation and robotics are the six factors that make up the first component, according to the EFA's results. Smart safety technologies is the name given to this component. According to this research, all of these technologies are employed in Nigeria's construction sector to assist lower the risk of mishaps and hazards. This is supported by Mahmoud et al., (2022), who found that since the advent of technology, the construction industry has embraced technologies like virtual reality (VR), building information modelling (BIM), wearable safety devices, automation, and robotics to streamline operations. In their studies, Abina et al., (2023) claimed that technologies like wearable safety devices, augmented reality (AR), and unmanned aerial vehicles (UAV) could enable safety because they capture real-time data on the job site, enabling an efficient decision to lower risk or hazards during construction projects.

Challenges Facing the Adoption of Smart Safety Technologies

The second component includes six variables that are explained as the main determinants of the adoption of safety smart technologies in the construction industry: organisational size, high initial investment capital, complex operation, lack of top management support/lack of financial support, and lack of experience and skill. This is in line with a study by Mchunu et al., (2024), who believed that one of the reasons why smart technologies aren't used as much on construction sites is because top management and finance don't support their application. Additionally, Ilesanmi et al., (2024) noted in their study that an organization's size has an impact on its ability to adopt new technologies, with larger organisations having the capacity and capability to do so more readily than smaller ones. The results of Obasa et al., (2024) concur that a worker's insufficient abilities and knowledge would restrict their ability to use a technology.

Benefits/Opportunities of Smart Safety Technologies

The third component includes eight variables that explain the advantages of smart safety technology adoption in the construction industry: increased productivity, better worker safety, better project delivery, fewer accidents and injuries, better material selection, better worker training, better hazard identification, and the provision of technical solutions. This is in line with the conclusions of a number of researchers, including Ebekozien et al., (2023), Nnaji et al., (2019), and Osunsanmi et al., (2020), who found that the primary goal of implementing smart safety technologies in construction projects is to reduce accidents and injuries. Wearable safety technologies, for example, would help protect workers and identify potential hazards while they are working, and virtual reality is a crucial tool for giving workers training that would impro This supports the claim made by Okanlawon et al., (2024) that smart safety solutions are the only way to increase worker safety.

CONCLUSION AND SUGGESTION

The development of smart safety technology has benefited the construction sector in a number of ways and offered creative solutions. The study has been able to offer a number of advantages that come with the construction industry's adoption of smart safety technologies, such as improved worker safety, better project delivery, fewer accidents and injuries, better material selection, better worker training, better hazard identification, technical solutions, and higher productivity.

Therefore, the study recommended that in order to overcome the fundamental barriers to the adoption of smart safety technology, construction companies should increase funding for the purchase of new technologies, offer frequent training programs to teach their employees how to use these technologies, and fortify their safety culture by allocating adequate resources, promoting safety behaviours, and involving their staff in safety committees, which could result in a more engaged workforce.

This study provides useful insights into the adoption of smart safety technologies in Nigeria's construction sector but also highlights areas for further exploration. Future research could expand beyond Ijebu Ode to cover other regions, include larger and more diverse samples, and apply mixed methods to gain deeper insights. Longitudinal or comparative studies across countries would help track adoption patterns and highlight best practices. Additionally, future studies could focus on specific technologies, assess the role of policies and safety culture, and conduct cost-benefit analyses to evaluate financial feasibility. Such directions would strengthen understanding and support wider adoption of smart safety technologies in the construction industry.

REFERENCES

Abina, O. G., Ogunbayo, B. F., & Aigbavboa, C. (2023, November). Assessing Health and Safety Practices in the Nigerian Construction Industry in the Era of the Fourth Industrial Revolution: Issues and Challenges. In *International Conference on Engineering, Project, and Production Management* (pp. 267-278). Cham: Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-56544-1_18

Ammad, S., Alaloul, W. S., Saad, S., & Qureshi, A. H. (2021). Personal protective equipment (PPE) usage in construction projects: A systematic review and smart PLS approach. *Ain Shams Engineering Journal*, *12*(4), 3495-3507. https://doi.org/10.1016/j.asej.2021.04.001

Babalola, A., & Harinarain, N. (2024). Policy barriers to sustainable construction practice in the Nigerian construction industry: an exploratory factor analysis. *Journal of Engineering, Design and Technology*, *22*(1), 214-234. https://doi.org/10.1108/JEDT-07-2021-0375

Bello, A. O., Abdulraheem, A. A., Agboola, S. A., & Afolabi, O. P. (2024). Factors Influencing the Adoption of Distributed Ledger Technology in Developing Countries: An Examination of Nigerian Construction Industry. *International Journal of Construction Education and Research*, 1-31. https://doi.org/10.1080/15578771.2024.2384375

Davis, D. F. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. Management Information Systems Research Center, MIS Quarterly Vol (13), 319-340. https://doi.org/10.2307/249008

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User Acceptance of Computer Technology: A Comparison of Two Theoretical Models. Management Science, 35(8), 982–1003. https://doi.org/10.1287/mnsc.35.8.982

Davis, F. D., & Granic, A. (2024). The Technology Acceptance Model 30 Years of TAM (1st ed. 2024.). Springer International Publishing. https://doi.org/10.1007/978-3-030-45274-2

Dubey, U. K. B., & Kothari, D. P. (2022). *Research methodology: Techniques and trends*. Chapman and Hall/CRC. https://doi.org/10.1201/9781315167138

Ebekozien, A., Aigbavboa, C., Aliu, J., Thwala, W. D., & Emuchay, F. E. (2022, July). Improving safety on building project sites: the role of sensor-based technology. In *Construction Industry Development Board Postgraduate Research Conference* (pp.23-32). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-031-22434-8_3

Ebekozien, A., Aigbavboa, C., & Samsurijan, M. S. (2023). An appraisal of blockchain technology relevance in the 21st century Nigerian construction industry: perspective from the built environment professionals. *Journal of Global Operations and Strategic Sourcing*, *16*(1), 142-160. https://doi.org/10.1108/JGOSS-01-2022-0005

Ejidike, C. C., Mewomo, M. C., & Anugwo, I. C. (2022). Assessment of construction professionals' awareness of the smart building concepts in the Nigerian construction industry. *Journal of Engineering, Design and Technology*, *22*(5), 1491-1504. https://doi.org/10.1108/JEDT-05-2022-0263

Goretzko, D., Siemund, K., & Sterner, P. (2024). Evaluating model fit of measurement models in confirmatory factor analysis. *Educational and Psychological Measurement*, *84*(1), 123-144. https://doi.org/10.1177/00131644231163813

Gorsuch, R.L., (2015). *Factor Analysis.* 2nd ed. New York: Routledge.

Hammond, M. & Wellington, J. (2007) *Research Methods. The Key Concepts.* London and New York, Routledge. Available as an e-book via library catalogue.

He, Y., Wang, Z., & Xu, G. (2021). A note on the likelihood ratio test in high-dimensional exploratory factor analysis. *psychometrika*, *86*(2), 442-463. https://doi.org/10.1007/s11336-021-09755-4

Ibrahim, K., Simpeh, F., & Adebowale, O. J. (2024). Awareness and adoption of wearable technologies for health and safety management in the Nigerian construction industry. *Frontiers in Engineering and Built Environment*, *4*(1), 15-28. https://doi.org/10.1108/FEBE-11-2022-0041

Ibrahim, K., Simpeh, F., & Adebowale, O. J. (2025). Benefits and challenges of wearable safety devices in the construction sector. *Smart and Sustainable Built Environment*, *14*(1), 50-71. https://doi.org/10.1108/SASBE-12-2022-0266

Ilesanmi, O. O., Oke, A. E., Moyanga, D. T., & Aliu, J. (2024). Unveiling the Imperatives: Drivers for Incorporating Smart Building Technologies in the Construction Sector in Nigeria. In *Industry 5.0 and Emerging Technologies: Transformation Through Technology and Innovations* (pp. 199-215). Cham: Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-70996-8_10

International Labour Organisation. (2023). Occupational safety and health. [Online]. Available: https://www.ilo.org/resource/news/nearly-3-million-people-die-work-related-accidents-and-diseases?utm_source (Accessed: 21 May 2025).

Islam, M. R., Khan, N. A., & Baikady, R. (Eds.). (2022). *Principles of social research methodology*. Springer Nature.

Kissi, E., Aigbavboa, C., & Kuoribo, E. (2023). Emerging technologies in the construction industry: challenges and strategies in Ghana. *Construction Innovation*, *23*(2), 383-405. https://doi.org/10.1108/CI-11-2021-0215

Lu, W., Huang, G. Q., & Li, H. (2011). Scenarios for applying RFID technology in construction project management. Automation in Construction, 20(2), 101–106. https://doi.org/10.1016/j.autcon.2010.09.007

Mahmoud, A. S., Hamdan Ahmad, M., Mohd Yatim, Y., & Aminu Dodo, Y. (2022). Safety performance framework at construction site for self-regulation by building developers. *Engineering, Construction and Architectural Management*, *29*(9), 3394-3414. https://doi.org/10.1108/ECAM-10-2020-0808

Mchunu, J. S., Anugwo, I. C., & Anugwo, J. C. (2024, August). Evaluating Impact of Smart Technologies Within Construction Site and Office Operations Among South African Contractors. In *International Conference on Computing in Civil and Building Engineering* (pp. 585-598). Cham: Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-87364-5_49

Nnaji, C., Gambatese, J., Karakhan, A., & Eseonu, C. (2019). Influential safety technology adoption predictors in construction. *Engineering, Construction and Architectural Management*, *26*(11), 2655-2681. https://doi.org/10.1108/ECAM-09-2018-0381

Obasa, A. J., Akinradewo, O. F., & Olanipekun, A. O. (2024). Impact of technologies towards addressing stress-related problems among practicing quantity surveyors in Lagos, Nigeria. *International Journal of Construction Management*, *24*(6), 623-632. https://doi.org/10.1080/15623599.2022.2135943

Okafor, C. C., Aigbavboa, C., & Thwala, W. D. (2023). A Delphi approach to evaluating the success factors for the application of smart mobility systems in smart cities: a construction industry perspective. *International Journal of Construction Management*, *23*(8), 1289-1298. https://doi.org/10.1080/15623599.2021.1968567

Okanlawon, T. T., Oyewobi, L. O., & Jimoh, R. A. (2024). Assessment of barriers to the implementation of blockchain technology in construction supply chain management in Nigeria. *Frontiers in Engineering and Built Environment*, *4*(1), 59-73. https://doi.org/10.1108/FEBE-04-2023-0017

Oke, A. E., Aliu, J., Fadamiro, P., Jamir Singh, P. S., Samsurijan, M. S., & Yahaya, M. (2024). Robotics and automation for sustainable construction: microscoping the barriers to implementation. *Smart and Sustainable Built Environment*, *13*(3), 625-643. https://doi.org/10.1108/SASBE-12-2022-0275

Olanrewaju, O. I., Bello, A. O., Semiu, M. A., & Mudashiru, S. A. (2024). Critical barriers to effective communication in the construction industry: evidence from Nigeria. *International Journal of Construction Management*, 1-19. https://doi.org/10.1080/15623599.2024.2362018

Olawumi, T. O., & Chan, D. W. (2022). Developing project evaluation models for smart sustainable practices implementation in construction projects: a comparative study between Nigeria and Hong Kong. *Engineering, Construction and Architectural Management*, *29*(3), 1522-1552. https://doi.org/10.1108/ECAM-11-2020-0906

Osunsanmi, T. O., Aigbavboa, C. O., Emmanuel Oke, A., & Liphadzi, M. (2020). Appraisal of stakeholders' willingness to adopt construction 4.0 technologies for construction projects. *Built Environment Project and Asset Management*, *10*(4), 547-565. https://doi.org/10.1108/BEPAM-12-2018-0159

Oyediran, A. O., Oke, A. E., Ikuabe, M. O., Aliu, J. O., Adeosun, F. E., & Aigbavboa, C. O. (2025). Exploring application areas of cyber-physical systems in the construction industry: a case of Nigeria. *International Journal of Construction Management*, 1-13. https://doi.org/10.1080/15623599.2025.2482216

Pallant, J., (2005). *SPSS Survival Manual: A Step-By-Step Guide to Data Analysis Using SPSS for Windows (Version 12),* 2nd Edition, Allen and Unwin, Crow's Nest.

Polonsky, M.J. & Waller, D.S. (2019) *Designing and Managing a Research Project: A Business Student's Guide.* 4th edn. London, SAGE.

Saunders, M. & Lewis, P. (2019) *Doing Research in Business and Management: An Essential Guide to Planning Your Project*. 2nd edn. Harlow: Pearson Education Ltd.

Saunders, M.N.K, Lewis, P. & Thornhill, A. (2023) *Research Methods for Business Students*. 9th edn. Harlow: Pearson Education Ltd.

Schreiber, J. B. (2021). Issues and recommendations for exploratory factor analysis and principal component analysis. *Research in Social and Administrative Pharmacy*, *17*(5), 1004-1011. https://doi.org/10.1016/j.sapharm.2020.07.027

Watkins, M. W. (2021). *A step-by-step guide to exploratory factor analysis with SPSS*. Routledge. https://doi.org/10.4324/9781003149347

Wilson, J. (2014) *Essentials of Business Research: A Guide to Doing Your Research Project*. 2nd edn. London: SAGE.