

Investigating Barriers to the Adoption of Innovative Technologies for Health and Safety on Construction Sites

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Abstract

Purpose– Construction sites are hazardous, exposing workers to frequent risks of injury and illness despite the potential of emerging technologies to improve construction health and safety. However, the adoption of advanced technologies in health and safety remains limited in the construction industry. This study investigates the barriers hindering technological implementation, with the goal of enhancing workers' health and safety and boosting operational efficiency on sites.

Design/methodology/approach– A quantitative research approach was employed, focusing on gathering numerical data via structured questionnaires to determine the barriers to the adoption of innovative technology in construction. Questionnaires were distributed to 200 construction professionals, including Builders, Civil Engineers, Architects, H&S Officers, and Quantity Surveyors. A convenience sampling technique was utilised to ensure that the required sample was achieved. The data were analysed using descriptive statistics.

Findings – The study reveals that high implementation costs, limited access to training, insufficient collaboration, lack of government support, and low awareness are the key barriers that influence innovative technology adoption in the construction industry in Nigeria.

Conclusion/Theoretical/Social/Practical implications – The findings provide actionable insights for construction stakeholders, policymakers, and training institutions on the critical barriers that must be addressed to enhance the successful adoption of innovative technologies. Targeted interventions could reduce accidents and illnesses, improve worker well-being, and boost project performance.

Originality/value – The study contributes to the body of literature on technology adoption in construction safety by providing empirical evidence on key adoption barriers. It emphasises the need for sustainable strategies and policies that support technological integration within the construction sector

Keywords: Adoption, Barriers, Construction, Health and Safety, Innovative Technologies

Introduction

The construction industry plays a pivotal role in global socio-economic advancement by generating employment, fostering urban development, and supporting critical

infrastructure projects (ILO, 2015; Ofori, 2012). Despite these contributions, it remains one of the most hazardous industries due to persistently high rates of workplace accidents and fatalities (Kukoyi et al., 2021; Hinze et

al., 2013; and Lingard & Rowlinson, 2005). In Nigeria, particularly in the densely populated Lagos State, the surge in urban expansion and infrastructure demands has further exacerbated safety risks on construction sites (Awolusi et al., 2018; Adenuga et al., 2022). Conventional H&S practices, are often manual and reactive, creating a pressing need for technological innovation to improve site safety. The construction sector is increasingly turning to innovative technologies such as Building Information Modelling (BIM), Internet of Things (IoT), robotics, drones, and wearable tech to transform safety management (Zhou et al., 2012; Li et al., 2015; Teizer et al., 2017). In developed economies such as the United States, Japan, and Singapore, these innovations are employed to improve hazard identification, site monitoring and response to emergencies. For example, drone technology enables real-time aerial surveillance of construction zones, while AI and wearable devices detect early signs of danger through predictive analytics (Cheng et al., 2017; Chi et al., 2012; Ghosh et al., 2021). Furthermore, technologies such as augmented reality (AR), real-time location systems (RTLS), and immersive training platforms equip workers with the tools to understand and avoid hazards before they occur (Zabihi et al., 2019; Kim et al., 2020). In contrast, developing economies such as Nigeria, are slow to adopt these innovations due to numerous obstacles, including high implementation costs, limited technical expertise, regulatory gaps, and cultural resistance to change (Olaniyan, 2019; Oyenuga, 2023). Inadequate awareness and insufficient digital training among construction professionals further restrict the use of these technologies (Oke et al., 2024; Akindoyeni et al., 2020). Furthermore, weak policy enforcement and fragmented

institutional structures also hinder progress toward modernising H&S practices (Ezeokoli & Okoye, 2021a).

Current research has focused heavily on the technical competences of these tools; there is a gap in literature regarding the systemic barriers that discourage their practical implementation in the construction industry in Nigeria. Factors such as rigid leadership and organisational culture, high initial costs, and worker resistance create a divide between technological availability and field-level usage. Without a comprehensive integration of existing knowledge on these barriers, the industry will continue to invest in innovations that fail to be adopted, leaving construction workers exposed to preventable risks. Therefore, there is an urgent need to identify and analyse these influential barriers that hinder the adoption of innovative technologies on construction sites. To bring Nigeria's health and safety (H&S) protocols in line with global standards, it is vital to implement policy reforms, strengthen digital skills across the workforce, and invest in technological infrastructure. These tools not only prevent accidents but also support data-based project planning and decision-making fostering long-term productivity and worker protection (Teizer et al., 2017; Ahn et al., 2021). In addition, there are limited studies to the factors that prevents the adoption of innovative technologies on construction sites therefore, the objective of this study is to determine the barriers to the adoption of innovative technologies in enhancing construction site safety and health. The findings are expected to contribute valuable insights to H&S performance in the Nigerian construction industry.

Literature Review

The construction sector plays a pivotal role in fostering economic growth and infrastructural development, especially in urbanising and developing nations. Although the construction industry plays a vital role in job creation and contributes significantly to national productivity, it is widely acknowledged as one of the most dangerous sectors, frequently recording high rates of workplace injuries and fatalities (Kukoyi et al., 2023; Lingard & Rowlinson, 2005). In Nigeria, where the pressures of urban expansion and population growth have fueled a surge in construction projects, concerns over workers' H&S remain acute and unresolved (Awolusi, Fagbenle, & Joshua, 2018). Traditional H&S strategies such as on-site supervision, manual inspections, and basic protective gear have struggled to keep pace with the evolving nature and scale of modern construction operations. As these conventional methods fall short in preventing accidents, many scholars argue that the industry must shift toward more advanced, proactive systems that leverage technology (Zhou, Goh, & Li, 2012; Teizer, Allread, Fullerton, & Hinze, 2017). In response to this growing awareness, global research has increasingly emphasised the potential of digital technologies to revolutionise construction site safety. Technological innovations such as BIM, IoT, drones, wearable health monitors, AR, and RTLS are among the tools explored for their capacity to reduce hazards on-site. Li et al. (2015) state that BIM offers predictive advantage by identifying potential safety issues during the design stage. Ghosh et al. (2021) posit that IoT devices allow continuous monitoring of environmental variables and worker conditions, supporting early intervention and reducing the probability of incidents.

Despite these benefits, the adoption of safety-enhancing technologies is not without critique. Kim et al. (2020) point out that excessive dependence on automated systems could introduce novel risks, such as system errors or inaccurate data interpretation. Likewise, Ahn et al. (2021) raise ethical questions surrounding wearable tech, particularly the invasion of workers' privacy and the potential resistance this could provoke. These concerns underscore the importance of integrating technological innovation with ethical considerations and robust risk assessment practices. In countries like Japan, Singapore, and the United States, these advanced tools have been linked with stronger regulatory compliance and noticeable improvements in accident reduction (Cheng et al., 2017; Teizer et al., 2017a).

However, translating such success to the Nigerian context presents significant hurdles. Research by Olaniyan (2019) and Oke et al. (2024) identifies key challenges, including the high financial cost of technology, lack of trained personnel, and limited infrastructure, all of which hinder widespread implementation, particularly among the small and medium-sized enterprises (SMEs) that dominate the industry. There is also scholarly disagreement regarding the feasibility of technology use under Nigeria's prevailing institutional conditions. Ezeokoli and Okoye (2021b) argue that without strong regulatory frameworks and enforcement mechanisms, new technologies will fail to yield meaningful safety improvements. Conversely, Akinradewo et al. (2020) suggest that the introduction of advanced technologies could act as a catalyst for broader institutional reforms, enhancing oversight and transparency through data-driven accountability. Another fundamental

challenge is the limited technical know-how among construction workers. Akindoyeni et al. (2020) report that most site personnel are not adequately trained in digital tools due to outdated academic programs that neglect practical technology applications.

Cultural factors also play a role in hindering adoption. Idowu et al. (2023) established that some professionals, particularly those with long-standing industry experience, are hesitant to embrace new technologies due to fears of job displacement or skepticism about their effectiveness. Chi et al (2012) make a similar observation, emphasising that successful implementation requires strategic change management and user buy-in. In contrast, Teizer et al. (2017a) argue that cultural resistance is weakening, particularly among younger professionals who are more receptive to digital innovation due to their tech-savvy backgrounds. Furthermore, Akinradewo et al. (2020) reiterated that Nigeria's infrastructural challenges such as unreliable power supply and unstable internet connectivity pose additional obstacles to technological adoption.

Another obstacle is the fragmented nature of Nigeria's construction industry, where competition and lack of coordination impede sharing of best practices and collective learning. In contrast, countries like Singapore have benefited from centralised data platforms and public-private innovation partnerships. In this regard, Cheng et al. (2017) and Teizer et al. (2017b) propose collaborative models for Nigeria, while Oke et al. (2024) highlight the essential role of academic institutions in promoting a culture of technological awareness and safety innovation. In this study, these factors are used to integrate the existing knowledge on the barriers that could influence the

implementation of innovative technologies on construction sites in Lagos, Nigeria with the view of enhancing safety and health of construction workers.

Research Method

This study employs a quantitative research design, using structured questionnaires to gather data on barriers to the adoption of innovative technologies in Lagos State. Lagos State was chosen because of the high construction outlay. Construction professionals were selected based on a convenience sampling method. The data was obtained by distributing 280 questionnaires to construction professionals but 200 were retrieved for analysis yielding a response rate of 71.43%, which was adequate for the research. The questionnaire was self-administered and sent electronically. A covering letter to the questionnaire was attached to explain the aim of the research and its confidentiality. The questionnaire was divided into sections A which provided demographic data of the respondents and section B consists of questions to answer the research questions. The five-point Likert scale was adopted to determine how strongly the respondents disagree or agree with the factors provided on the Likert scale on the following scale of 1 = strongly disagree 5 = strongly agree then N = neutral. The study sought to investigate the barriers to adopting innovative technologies on construction sites in Lagos. The study targeted construction professionals such as civil engineers, architects, quantity surveyors, builders, and estate managers to ensure knowledgeable representation across construction professions. Descriptive statistics were employed to analyse the data.

Findings and Discussion

The results from the analysis from part A of the questionnaire revealed that 51.5% of the respondents are between the ages of 21-30, 21.5%, are between the ages of 31-40, while 41-50 years make up 17.5%. Builders were 41% of the respondents, Civil Engineers constituted 15%, Architects, Estate Managers, and Quantity Surveyors each represent 10%. H&S Officers were 6.5%, Urban Planners and Land Surveyors were less represented, with 1.5%. This distribution provides a comprehensive view of the professional landscape, emphasising the

diversity of expertise involved in the research.

Table 1 shows the respondents perception of the barriers to adopting innovative technologies in construction health and safety on construction sites in Lagos State. Mean Scores (MSs) were used to rank the 10 factors. Notably, all ten barriers recorded mean scores between 3.40 and 4.25. This indicates that these variables exert a moderate to high influence on the adoption of innovative technologies, thereby limiting health and safety performance on construction sites.

TABLE 1. Barriers to the adoption of innovative technologies in construction H&S

Barriers	SD	D	N	A	SA	MSs	Rank
Cost of implementing H&S technologies	3	10	23	66	98	4.23	1
Limited access to training programmes and resources	4	11	25	84	76	4.08	2
Limited collaboration and communication among stakeholders	3	15	28	78	76	4.04	3
Inadequate government support and policies	2	18	25	82	73	4.02	4
Lack of awareness	5	20	18	32	75	4	5
Technical know-how	8	10	31	90	61	3.92	6
Resistance from workers due to unfamiliarity	2	24	41	84	49	3.77	7
Regulatory barriers and compliance	9	22	39	77	53	3.71	8
Concerns about the reliability and durability	13	17	51	78	41	3.59	9
Concerns about data security	13	20	65	68	34	3.45	10

Cost of implementing H&S technologies, Limited access to training programmes and resources, limited collaboration and communication among stakeholders and inadequate government support and policies and lack of awareness ranked first, second, third, fourth and fifth with MSs 4.23, 4.08, 4.04, 4.02 and 4. respectively. In addition, regulatory barriers and compliance, concerns

about the reliability and durability and concerns about data security ranked eighth, ninth and tenth with MSs 3.71, 3.59 and 3.45 respectively. It is notable that all barriers are significant in limiting the adoption of innovative technologies in construction safety.

The dominance of small and medium-sized construction firms with limited financial capacity hence operating on tight margins and prioritise immediate project delivery over long-term investment in technology reflects on the cost of these technologies. Additionally, access to credit facilities or technology funding is often restricted, further discouraging firms from adopting costly innovations. There is a noticeable gap between educational curricula and industry practice (Osuzugbo et al., 2022), and very few institutions or firms offer specialised training on emerging H&S technologies. As a result, many professionals and workers remain unaware of how to utilise these technologies or lack the technical expertise to do so effectively, further compounding resistance and inefficiency. The challenge of limited collaboration and communication among stakeholders; this is amplified in the fragmented construction environment. Projects often suffer from inadequate coordination between consultants, contractors, and clients, leading to a silo mentality where decisions are made independently rather than collaboratively. This lack of synergy significantly hampers the collective adoption of technologies that require integrated planning and cross-functional alignment. Inadequate government support, lack of awareness, and limited technical know-how, regulatory frameworks for technology adoption and enforcement of H&S standards are either weak, outdated, or poorly implemented. Government incentives for technology adoption in the construction industry are nearly non-existent, and awareness campaigns are limited. Resistance from workers due to unfamiliarity is a natural consequence in a labour-intensive industry such as in Nigeria, where the workforce is largely composed of artisans and labourers with inadequate formal education

(Osuzugbo et al., 2022). The fear of being replaced or the discomfort of adapting to new methods can create significant pushback against technological change. Similarly, regulatory barriers stem from inconsistent enforcement of construction policies, overlapping regulatory authorities, and bureaucratic delays, which further discourage firms from venturing into uncharted technological territory.

The barriers identified by respondents in this study align with findings from previous research, which consistently highlight cost, training, and institutional challenges as key impediments to technological integration in H&S. The high cost of implementation, which emerged as the most significant barrier which is widely recognised in literature. Zhou et al. (2015) argue that financial constraints are primary limitations to the adoption of advanced safety technologies, particularly in developing economies. However, studies such as Ajayi et al. (2016) and Ameh et al. (2010) argue that what is often perceived as high implementation cost is largely influenced by inefficient financial planning, misallocated budgets within organisations, wasteful practices and reluctance to innovate may pose a greater financial burden than the initial investment in H&S technologies hence the need for adequate financial planning and budgets for improving safety performance. In the Nigerian context, Kukoyi et al. (2021) and Oyewobi and Ogunsemi (2010) further emphasised that budgetary limitations often prevent contractors from investing in safety-enhancing innovations. Similarly, limited access to training programmes and resources, corresponds with earlier findings by Osuzugbo et al. (2022) and Chan et al. (2016), the authors noted that insufficient training opportunities restrict the capacity of workers and professionals to adopt and utilise

new technologies effectively. Adebowale et al. (2021) reiterate that lack of training is a fundamental barrier to sustainable construction practices in Nigeria. Furthermore, Lingard et al. (2011) observed that fragmented communication structures often lead to inconsistent application of H&S technologies. Also, weak integration among project teams hamper innovation diffusion in the construction industry; inadequate government support, lack of awareness, and limited technical know-how are also corroborated by the findings of Umar and Egbu (2018) and Oladapo (2007). Workers' resistance and regulatory barriers align with Gibb et al. (2014) findings, the study noted that reluctance among workers to engage with unfamiliar technologies which often stems from fear of change and job displacement. Regulatory uncertainty, as posited by Zhang et al. (2013), creates complications in regulatory integration processes by creating ambiguity around compliance standards.

Conclusion and Recommendations

A broad description of the barriers to the adoption of innovative technologies in the construction industry is explained. The study determined the barriers to H&S innovative technology integration in the construction sector in Lagos, Nigeria. The findings reveal that high implementation costs, limited access to training, and weak stakeholder collaboration emerged as high-ranked barriers to the adoption of innovative technologies in improving health and safety on construction sites. The study also points out that some barriers, such as concerns about data security and government support, show less variability in perception, suggesting a more uniform concern across different groups. In addition, technical know-how and resistance from workers ranked sixth and seventh.

The findings point to financial limitations, fragmented institutional structures, cultural resistance to change, and inconsistent policy support as the foremost barriers. At the core of the issue lies a lack of organisational, professional, and systemic readiness to embrace innovation hence, technology adoption in H&S remains a technical add-on rather than a strategic and cultural shift. Further, construction firms adopt reactive positions, which undermines long-term sustainability and effectiveness of H&S practices. The evidence suggests that the sector must move from fragmented, compliance-driven models to holistic, innovation-led approaches. Such a shift from the current practices, to greater strategic foresight, and transformation in the way construction firms conceptualise safety and technology. This research therefore recommends that strategic and tactical measures be implemented across various levels of the construction ecosystem. Government agencies and regulatory bodies should shift from current practices such as issuing general guidelines to establishing enforceable, incentivised frameworks that encourage innovation. Enhancing workforce capacity must be prioritised through the establishment of continuous, context-driven learning environments. The construction industry must cultivate an environment that embraces change and values innovation. The use of questionnaires and descriptive analysis for the study limits the generalisation of the research findings due to low response rate and bias therefore caution should be taken. Further research should examine from a qualitative perspective to improve construction H&S practices on construction sites.

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