

Effect of Professionals' Perception on Robotics Integration in Construction Project Delivery in Bauchi State

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Abstract

The study examined the effect of professionals' perception on robotics integration on construction project delivery in Bauchi State, Nigeria. The study was guided by two objectives, two research questions. A descriptive survey design was adopted, and the population of the study comprised 720 construction professionals, including builders, engineers, architects, and project managers. A sample of 256 respondents were selected using a stratified random sampling technique. Data were collected using a structured questionnaire designed on a five-point Likert scale. The instrument was validated by experts and pilot tested, yielding a reliability coefficient of 0.82 using Cronbach's Alpha. The researcher, with the assistance of trained research aides, collected data within a period of three weeks through direct contact. Mean and standard deviation were used to answer the research questions. Data analysis was conducted using Statistical Package for Social Sciences (SPSS), version 26. The findings revealed that robotics adoption in Bauchi State is still at an early stage and largely limited to few large-scale construction firms. Major constraints to adoption include high cost of equipment, inadequate skilled manpower, poor electricity supply, and lack of government support. However, respondents agreed that robotics integration significantly improves productivity, efficiency, accuracy, safety, and cost-effectiveness in construction project delivery. The study further revealed that professionals generally have a positive perception of robotics, although this is influenced by awareness level and exposure. The study concluded that effective robotics integration in construction projects in Bauchi State depends largely on enhancing professionals' perception, and providing enabling institutional support. It recommended increased investment in training and capacity building, inclusion of robotics-related courses in construction education, and the development of supportive policies to promote adoption and improve construction project delivery outcomes.

Keywords: Professionals' Perception, Robotics Integration, Construction Project Delivery, Bauchi State.

Introduction

The rapid evolution of construction technologies has positioned robotics as a disruptive force capable of redefining project delivery systems, while simultaneously raising critical questions about professionals' perception on robotics integration in the construction industry (Mishra, 2025). Across the global construction landscape, robotics integration is increasingly viewed not merely as a technical upgrade but as a socio-technical

transformation shaped by human attitudes, competencies, and readiness for change (Bademosi & Issa, 2021). The perception held by construction professionals toward robotics significantly determines the pace and success of its integration, as acceptance or resistance often dictates investment decisions and implementation strategies (Vora *et al.*, 2024). Thus, it can be concluded that traditional construction methods are not more the most suitable techniques for ensuring the successful construction project delivery (Waqar *et al.*, 2025)

Professionals' perception of robotics in construction encompasses beliefs, attitudes, and expectations regarding its usefulness, feasibility, and implications for job roles and industry practices (Olukanni *et al.*, 2024). In many cases, perception acts as either a catalyst or a barrier to technological innovation, shaping organizational willingness to adopt robotics-driven processes (Bademosi & Issa, 2021). Studies have shown that when professionals perceive robotics as complex, costly, or threatening to employment, resistance to adoption becomes pronounced, thereby slowing technological diffusion (Musarat *et al.*, 2024). Conversely, positive perception, driven by awareness of efficiency gains and safety improvements, enhances acceptance and encourages integration (Florence & Danjuma, 2024). Thus, understanding professionals' perception is essential in evaluating how robotics can be effectively embedded within construction systems to improve project delivery.

Robotics integration in construction refers to the incorporation of automated systems such as drones, robotic arms, and autonomous equipment into construction processes to enhance precision, productivity, and safety. Globally, this integration is transforming construction methodologies, enabling real-time monitoring, reducing human error, and accelerating project timelines (Mishra, 2025). However, the success of robotics integration is not solely dependent on technological availability but is heavily influenced by the readiness and adaptability of industry professionals (Vora *et al.*, 2024). In developing countries like Nigeria, where technological transitions are often gradual, the perception of professionals plays a decisive role in determining whether robotics integration is embraced or resisted (Arijeloye & Chikafalimani, 2025). Therefore, robotics integration must be examined not just as a technical process but as a perception-driven phenomenon embedded within organizational and cultural contexts.

In the Nigerian construction industry, the perception of emerging technologies, including robotics, is shaped by factors such as cost implications, awareness levels, and institutional support (Arijeloye & Chikafalimani, 2025). Many professionals remain cautious about adopting robotics due to concerns about high initial investment, uncertainty about returns, and limited exposure to successful implementation cases (Shetima *et al.*, 2024). These perceptions often result in a slow pace of technological adoption, despite the recognized potential of robotics to improve project performance (Florence & Danjuma, 2024). Additionally, the lack of structured training programs and capacity-building initiatives further exacerbates the skill gap within the workforce, limiting the effective integration of robotics in construction practices (ElZomor *et al.*, 2020). In light of these considerations,

this study seeks to examine the effect of professionals' perception on robotics integration on construction project delivery in Bauchi State.

Statement of the Problem

Despite the growing body of literature on robotics in construction, there remains a significant gap in understanding how professionals' perception jointly influence construction project delivery, particularly in Bauchi State (Vora *et al.*, 2024). Most existing studies have focused on the technical benefits and applications of robotics, with limited attention given to perception-driven factors and human capacity development (Mishra, 2025). Moreover, empirical studies within the Nigerian context, especially those centered on Bauchi, are relatively scarce, leaving critical questions unanswered regarding the readiness of the industry for robotics integration (Murtala *et al.*, 2025). This gap underscores the need for a comprehensive investigation that examines not only the presence of robotics but also the human factors that determine its effectiveness in improving project outcomes. It is against this backdrop that this study seeks to fill this gap by examining the effect of professionals' perception on robotics integration on construction project delivery in Bauchi State.

Aim and Objectives

The aim of this study is to critically examine the effect of professionals' perception on robotics integration on construction project delivery in Bauchi State, Nigeria. The specific objectives of the study are to:

- i. Assess the perception of professionals on robotics integration in construction projects in Bauchi State, Nigeria.
- ii. Examine the level of construction project delivery in construction projects in Bauchi State, Nigeria.
- iii. Determine the effect of professionals' perception of robotics integration on construction project delivery in Bauchi State, Nigeria.

Research Questions

- i. What are the perceptions of professionals on robotics integration in construction projects in Bauchi State, Nigeria?
- ii. What is the level of construction project delivery in construction projects in Bauchi State, Nigeria?
- iii. What is the effect of professionals' perception of robotics integration on construction project delivery in Bauchi State, Nigeria?

Research Hypothesis

HO₁: Professionals' perception of robotics integration has no significant effect on construction project delivery in Bauchi State, Nigeria.

Literature Review

Conceptual Review

Professionals' perception of robotics integration in construction

The successful integration of robotics in construction projects is largely dependent on how construction professionals perceive the technology. Professional perception encompasses attitudes, beliefs, awareness, expectations, and judgments regarding the usefulness, practicality, and implications of robotics within construction processes. Contemporary literature increasingly recognizes that technological advancement alone does not guarantee adoption; rather, the acceptance of innovation is shaped by the perceptions of the individuals responsible for implementing and managing such technologies (Bademosi & Issa, 2021). Consequently, robotics integration has evolved from being viewed solely as a technical issue to being understood as a socio-technical phenomenon influenced by human factors.

Existing studies generally agree that construction professionals acknowledge the potential benefits of robotics in improving productivity, safety, precision, and efficiency. Hwang et al. (2020) and Davila et al. (2019) argued that robotic systems can significantly enhance operational performance by reducing human error and increasing construction accuracy. Similarly, Mishra (2025) emphasized that robotics offers solutions to persistent industry challenges such as labor shortages, project delays, and productivity deficiencies. These findings suggest a largely positive perception among professionals regarding the transformative potential of robotics within construction environments.

Despite this positive outlook, empirical evidence indicates that favorable perceptions do not necessarily translate into actual adoption. Cai et al. (2019) observed that while many construction stakeholders recognize the benefits of robotics, implementation remains relatively low across many regions. This disconnect between awareness and practical utilization has been attributed to economic, organizational, and institutional barriers. Similarly, Arijeloye and Chikafalimani (2025) found that robotics utilization in Nigeria remains confined to specialized tasks despite growing awareness among construction practitioners. The implication is that positive perception alone is insufficient to drive widespread integration unless supported by enabling conditions.

Another area of scholarly debate concerns professionals' concerns regarding the potential consequences of robotics adoption. While some scholars emphasize efficiency gains and improved project outcomes (Florence & Danjuma, 2024; Abraham et al., 2024), others highlight fears relating to job displacement, workforce restructuring, and changing professional roles. Musarat et al. (2024) questioned whether workforce substitution through robotics represents a wise strategic decision, arguing that concerns regarding employment security often generate resistance among construction personnel. Likewise, Obi-Rapu and Simmons (2024) noted that professionals frequently perceive robotics as a disruptive force capable of fundamentally altering traditional work structures. These contrasting perspectives demonstrate that professional perception is multidimensional,

involving both optimism regarding technological benefits and anxiety concerning its potential consequences.

Furthermore, studies suggest that perception is influenced by the level of awareness, technological exposure, and educational preparedness of construction professionals. ElZomor et al. (2020) argued that inadequate training opportunities reduce professionals' confidence in adopting robotics technologies. Similarly, Olukanni et al. (2024) and Olukanni et al. (2025) found that both industry practitioners and academics consider robotics-related competencies essential for successful human-robot collaboration. The evidence therefore indicates that perception is not static but evolves through knowledge acquisition, experience, and exposure to emerging technologies.

Although previous studies have extensively explored perceptions of robotics and automation, most investigations have focused on developed countries or technologically advanced construction environments. Nigerian studies have largely examined general technology adoption challenges rather than specifically investigating how professionals' perceptions influence robotics integration and project delivery outcomes simultaneously (Murtala et al., 2025; Shetima et al., 2024). This creates a contextual gap, particularly within Bauchi State, where empirical evidence remains scarce.

Robotics Integration in Construction Projects

Robotics integration refers to the incorporation of automated and intelligent systems into construction activities to improve efficiency, productivity, quality, and safety. The growing interest in robotics stems from increasing demands for faster project delivery, improved construction quality, and enhanced workplace safety. Across global construction industries, robotics applications have expanded from simple automation tasks to sophisticated operations involving autonomous equipment, robotic arms, drones, exoskeletons, and human-robot collaborative systems (Abraham et al., 2024).

A dominant theme in the literature is the capacity of robotics to transform traditional construction methods. Hwang et al. (2020) and Davila et al. (2019) contend that robotic systems improve construction precision while minimizing human errors associated with manual operations. Similarly, Lu et al. (2018) demonstrated how emerging technologies such as robotic-assisted 3D printing have introduced innovative construction approaches capable of enhancing customization and production efficiency. These studies collectively suggest that robotics possesses substantial potential for revolutionizing construction practices.

However, scholars differ regarding the extent and pace of robotics integration within the industry. While proponents portray robotics as the future of construction (Mishra, 2025; Deloitte, 2020), critics argue that adoption remains slow due to practical implementation challenges. Aiken et al. (2018) highlighted legal and regulatory uncertainties surrounding autonomous construction equipment, while Oke et al. (2021) emphasized infrastructural limitations and financial constraints in developing economies. This divergence suggests

that although the benefits of robotics are widely acknowledged, contextual realities significantly influence implementation outcomes.

Studies conducted within developing countries reveal that adoption barriers are often more pronounced than technological advantages. Bademosi and Issa (2021) identified high investment costs, organizational resistance, and inadequate technical expertise as major obstacles to robotics integration. Similar conclusions were reached by Shetima et al. (2024), who found that limited awareness, insufficient training, and resistance to change significantly hinder the adoption of emerging technologies within Nigerian construction firms. Arijeloye and Chikafalimani (2025) further reported that robotics utilization in Nigeria remains largely restricted to a few large-scale organizations possessing adequate financial and technical resources.

The literature also reveals growing interest in human-robot collaboration as a more practical pathway to robotics integration. Mkaouar et al. (2018) and Abraham et al. (2024) argued that collaborative systems combining human expertise with robotic capabilities can improve productivity without entirely replacing the workforce. Similarly, Olukanni et al. (2025) emphasized the importance of developing competencies that facilitate effective collaboration between professionals and robotic systems. This perspective challenges earlier assumptions that robotics primarily functions as a substitute for human labor and instead positions robotics as a complementary tool for enhancing workforce performance. Despite the increasing body of research on robotics integration, much of the literature focuses on technological capabilities, implementation strategies, and adoption barriers. Relatively fewer studies have examined the human perception factors that influence robotics integration, particularly within localized Nigerian construction environments. Consequently, there remains limited empirical evidence explaining how professionals' perceptions shape robotics integration decisions and how such perceptions ultimately affect construction project delivery in Bauchi State.

Construction Project Delivery and Robotics Adoption

Construction project delivery remains a critical indicator of industry performance, commonly measured through project completion time, cost efficiency, quality standards, stakeholder satisfaction, and resource utilization. Contemporary literature increasingly associates improved project delivery with the adoption of innovative technologies capable of enhancing operational effectiveness.

Several studies report a positive relationship between robotics adoption and project delivery performance. Hwang et al. (2020) observed that robotic systems contribute to enhanced construction quality, safety performance, and operational efficiency. These findings support the argument that robotics can improve project delivery outcomes through greater precision, consistency, and productivity.

However, some studies suggest that the relationship between robotics adoption and project delivery is not always straightforward. While robotics may improve technical

performance, project outcomes can still be negatively affected by inadequate workforce readiness, poor infrastructure, and weak organizational support systems (Ikechukwu, 2021; Afolabi et al., 2020). This indicates that technology alone cannot guarantee successful project delivery unless complementary organizational and human factors are adequately addressed.

Another important issue emerging from the literature concerns the role of workforce competence in maximizing robotics benefits. ElZomor et al. (2020) argued that insufficient technological skills reduce the effectiveness of robotics implementation. Likewise, Jalam et al. (2025) demonstrated that familiarity with automation technologies significantly influences acceptance and utilization within the Nigerian construction sector. These findings imply that project delivery improvements resulting from robotics integration are contingent upon the knowledge, skills, and perceptions of construction professionals.

The literature therefore presents a complex relationship between robotics integration and project delivery. While substantial evidence supports the positive impact of robotics on productivity, efficiency, safety, and quality, successful outcomes appear to depend heavily on human and organizational readiness. Yet, existing studies have predominantly examined robotics adoption and project delivery as separate constructs. Limited attention has been given to understanding how professionals' perception serves as the mechanism linking robotics integration to construction project delivery, particularly within Bauchi State. This represents a significant knowledge gap that the present study seeks to address by examining the effect of professionals' perception on robotics integration and its implications for construction project delivery within the local construction industry.

Theoretical Framework

This study is hinged on Technology Acceptance Model (TAM) developed by Fred Davis in 1989 and the Diffusion of Innovations Theory propounded by Everett M. Rogers in 2003 which provide the theoretical foundation. The Technology Acceptance Model posits that an individual's decision to adopt a new technology is primarily influenced by perceived usefulness and perceived ease of use, which determine the user's attitude and intention toward technology adoption. The Diffusion of Innovations Theory, on the other hand, explains how innovations spread through a social system over time, emphasizing factors such as communication channels, social influence, adopter categories, and the characteristics of the innovation itself. These theories are relevant to the present study because they explain how construction professionals develop perceptions regarding robotics integration in construction projects. When professionals perceive robotics as useful, easy to operate, and capable of improving project outcomes, they are more likely to support and adopt its use. Likewise, the diffusion perspective explains how awareness, communication, and interaction among construction stakeholders can influence the gradual acceptance and integration of robotics within the construction industry. Therefore, the theories provide a suitable framework for understanding how professionals' perception

influences robotics integration and its effect on construction project delivery in Bauchi State.

Empirical Review

Arijeloye and Chikafalimani (2025) conducted a study titled Assessment of Robotics Utilization in Construction Project Delivery in Lagos State, Nigeria. The study aimed to assess the extent of robotics utilization in construction project delivery and identify factors influencing its adoption among construction firms. The study was guided by three objectives and three research questions. A descriptive survey research design was adopted for the study. The research was conducted in Lagos State, Nigeria, among construction professionals involved in project delivery. The population comprised construction practitioners from selected construction firms, while respondents were selected using purposive sampling techniques. Data were collected through a structured questionnaire administered directly to the respondents. Descriptive statistics involving mean scores and ranking analysis were used to analyze the data. The findings revealed that robotics utilization in Lagos State construction projects remains low despite increasing awareness of its benefits. High acquisition costs, inadequate technical expertise, and limited institutional support were identified as major barriers to adoption. The study recommended increased investment in robotics training, awareness programmes, and policy support to facilitate wider adoption. The study concluded that although professionals recognize the benefits of robotics, practical utilization remains limited due to economic and organizational constraints. The study is similar to the present study because both focus on robotics integration within the construction industry and involve construction professionals as respondents. However, the study differs from the present study in that it examined the level of robotics utilization in Lagos State, whereas the present study investigates the effect of professionals' perception on robotics integration and construction project delivery in Bauchi State.

Murtala, Bashir, Hamisu and Bolade (2025) conducted a study titled Challenges and Perceptions of Building Information Modeling Adoption in the Nigerian Construction Industry: Insights from Bauchi Metropolis, Nigeria. The study aimed to investigate professionals' perceptions and challenges affecting the adoption of Building Information Modeling (BIM) within the construction industry. The study was guided by four objectives and four research questions. A cross-sectional survey research design was adopted. The study was conducted in Bauchi Metropolis among architects, engineers, builders, and quantity surveyors. The population comprised registered construction professionals operating within the metropolis. A stratified sampling technique was employed in selecting respondents. Data were collected using a structured questionnaire administered through direct contact. Mean and standard deviation statistics were used for data analysis. Findings revealed that professionals possessed positive perceptions towards BIM adoption, but implementation was constrained by inadequate training, high software costs, insufficient

technical expertise, and poor institutional support. The study recommended continuous professional development programmes, enhanced access to BIM technologies, and supportive government policies. The study concluded that professionals' perception significantly influences technology adoption within the construction industry. The study is similar to the present study because both examine professionals' perceptions towards emerging technologies within the construction sector and were conducted in Bauchi. However, the study differs from the present study because it focused on BIM adoption, while the present study focuses specifically on robotics integration and its effect on construction project delivery.

Jalam, Keftin, Abdullahi, Mohammed, Shehu and Hassan (2025) conducted a study titled *Assessment of Familiarity with Automation Technologies in the Nigerian Construction Industry: A TAM Approach*. The study aimed to assess construction professionals' familiarity with automation technologies and determine factors influencing their acceptance. The study was guided by three objectives, three research questions, and two hypotheses. A descriptive survey design was adopted. The study was conducted among construction professionals in Nigeria. The population consisted of professionals working within the construction industry, while respondents were selected through stratified random sampling techniques. Data were collected using a structured questionnaire based on Technology Acceptance Model constructs. The instrument was administered through direct distribution and retrieval procedures. Data were analyzed using mean, standard deviation, and inferential statistics. The findings revealed that perceived usefulness and perceived ease of use significantly influence professionals' familiarity with and acceptance of automation technologies. The study further found that inadequate exposure and insufficient training negatively affect technology acceptance. The researchers recommended regular training programmes and incorporation of automation-related content into construction education curricula. The study concluded that technology acceptance factors play a significant role in influencing automation adoption among construction professionals. The study is similar to the present study because both investigate factors influencing technology adoption among construction professionals and are anchored on technology acceptance principles. However, the study differs from the present study because it focused on automation technologies generally, whereas the present study specifically examines professionals' perception of robotics integration and its effect on project delivery.

Olukanni, Akanmu, Jebelli, Ammar and Okunola (2025) conducted a study titled *Competencies for Human–Robot Collaboration in the Construction Industry: Perspectives from Academia and Industry*. The study aimed to identify the competencies required for effective human-robot collaboration within construction environments. The study was guided by three objectives and three research questions. A mixed-method research design was adopted. The study involved participants from academic institutions and construction industries. The population comprised construction professionals, researchers, and industry practitioners with knowledge of robotics applications. Respondents were selected using

purposive sampling techniques. Data were collected through questionnaires and expert interviews. Descriptive statistics and thematic analysis were employed for data analysis. The findings revealed that technical competence, digital literacy, robotics awareness, problem-solving ability, and continuous professional development are essential competencies for effective human-robot collaboration. The study further revealed significant competency gaps within the construction workforce. The researchers recommended the integration of robotics-related training into academic curricula and professional development programmes. The study concluded that workforce competency is fundamental to successful robotics integration within construction organizations. The study is similar to the present study because both focus on robotics in the construction industry and involve construction professionals. However, the study differs from the present study because it examined workforce competencies required for human-robot collaboration, whereas the present study investigates how professionals' perception affects robotics integration and construction project delivery.

Mishra (2025) conducted a study titled *Integration of Robotics and Automation in Construction*. The study aimed to examine the applications, benefits, opportunities, and challenges associated with robotics and automation integration within construction project management. The study was guided by two objectives. The study adopted a review research design and therefore did not employ research questions or hypotheses. The study reviewed global literature on robotics and automation in construction and did not involve a specific population, sample size, or sampling technique. Data were collected through secondary sources including journal articles, conference proceedings, industry reports, and case studies. Qualitative content analysis was used to synthesize the reviewed literature. The findings revealed that robotics significantly improves productivity, construction quality, project efficiency, and workplace safety. However, high implementation costs, technological complexity, workforce resistance, and inadequate policy support remain major barriers to adoption. The study recommended stronger collaboration among governments, educational institutions, and industry stakeholders to support robotics implementation. The study concluded that robotics and automation possess significant potential to transform construction project delivery when supported by appropriate institutional frameworks. The study is similar to the present study because both focus on robotics integration and its implications for construction project performance. However, the study differs from the present study because it adopted a global literature review approach, whereas the present study adopts an empirical approach to examine the effect of professionals' perception on robotics integration and construction project delivery in Bauchi State, Nigeria.

Gap in Literature

The reviewed studies focused on robotics utilization (Arijeloye and Chikafalimani, 2025), BIM adoption and perception (Murtala et al., 2025), automation technology acceptance

(Jalam et al., 2025), workforce competencies for human-robot collaboration (Olukanni et al., 2025), and the general integration of robotics and automation in construction (Mishra, 2025). Although these studies established the importance of technological innovation within the construction industry, none specifically examined the effect of professionals' perception on robotics integration and its influence on construction project delivery in Bauchi State. This constitutes the empirical gap that the present study seeks to fill.

Methodology

This study adopted a cross-sectional descriptive survey research design to examine the effect of professionals' perception on robotics integration and workforce skill on construction project delivery in Bauchi State, Nigeria. The study was conducted in Bauchi State, focusing on construction professionals involved in project delivery. The population of the study comprised 720 construction professionals, including builders, engineers, architects, and project managers working within Bauchi metropolis. A sample size of 256 respondents was selected using the Krejcie and Morgan (1970) sample size determination table. The study employed a stratified random sampling technique to ensure adequate representation of the various professional groups within the construction industry. Each stratum consisted of different categories of professionals, and respondents were randomly selected proportionately from each group to enhance representativeness and reduce sampling bias. The instrument for data collection was a structured questionnaire designed in line with the study objectives and theoretical framework. The questionnaire consisted of both closed-ended and open-ended items to capture relevant quantitative data. The instrument was subjected to face and content validation by experts in construction management and research methodology to ensure its relevance, clarity, and comprehensiveness. A pilot test was conducted using a small sample outside the study area, and a reliability coefficient was established to confirm internal consistency. An introductory letter was obtained to facilitate access to respondents. Data collection was carried out through direct contact and electronic means, with the assistance of trained research aides. The questionnaires were administered to the selected respondents within a specified period, ensuring proper coordination and monitoring of the data collection process. The method of data analysis involved the use of Statistical Package for Social Sciences (SPSS). Descriptive statistics such as mean and standard deviation were used to analyze the research objectives while correlation and simple linear regression were used to test the hypothesis at 0.05 confidence level.

Results

Table 1 presents the mean responses of the respondents on the perception of robotics integration in construction projects in Bauchi State. The results indicate that all ten items recorded mean values above the benchmark of 3.00, signifying a general agreement among respondents and suggesting a relatively high level of awareness and informed perception regarding robotics in the construction industry. This implies that professionals are not only

familiar with the concept of robotics but also possess a reasonable understanding of its current state and potential within the study area. The findings suggest that robotics integration in the Bauchi State construction industry is still at an emerging stage, characterized by low levels of practical adoption and limited operational deployment. Although there is a general awareness and positive perception of robotics among construction professionals, actual utilization appears to be constrained by factors such as limited access to equipment and the nature of construction projects. This indicates a gap between knowledge and practice, where robotics is recognized conceptually but has not yet been fully integrated into routine construction operations within the study area.

Table 1: The perception of professionals on robotics integration in construction projects in Bauchi State, Nigeria

S/N	Item	Mean	St. Dev.	Remark
1	Robotics is currently utilized, albeit to a limited extent, in selected construction projects within Bauchi State.	3.39	1.18	Agreed
2	The application of robotics in construction activities within Bauchi State is largely confined to specialized and task-specific operations.	3.56	1.16	Agreed
3	A considerable proportion of construction firms in Bauchi State demonstrate awareness of robotics technology and its potential applications.	3.42	1.15	Agreed
4	Robotics adoption in construction projects within Bauchi State remains at an emergent and developmental stage.	3.83	1.15	Agreed
5	The availability and accessibility of robotics equipment within the Bauchi State construction industry are relatively inadequate.	3.74	1.20	Agreed
6	The adoption of robotics in construction projects within Bauchi State is predominantly feasible for large-scale firms due to their superior financial and technical capacity.	3.60	1.19	Agreed
7	The extent of robotics integration in construction projects within Bauchi State is significantly influenced by the nature, scale, and technical complexity of the project.	3.47	1.18	Agreed
8	Robotics adoption in Bauchi State is shaped by prevailing national and global advancements in construction technology.	3.64	1.17	Agreed
9	Construction stakeholders in Bauchi State exhibit a general awareness of the potential benefits associated with robotics integration.	3.49	1.19	Agreed
10	The level of robotics utilization in construction projects within Bauchi State is significantly lower compared to that of developed construction environments.	3.87	1.13	Agreed

Source: Field study, 2025.

Table 2 revealed a generally positive level of construction project delivery in Bauchi State. Most items have mean values above 3.70, suggesting widespread agreement among respondents that project delivery performance is relatively satisfactory. The strongest consensus is on client satisfaction being generally high (mean = 3.98) and effective coordination among stakeholders during project execution (3.89). However, one exception exists: resource utilization efficiency (mean = 3.46), where responses were mixed, leaning towards disagreement, indicating that materials, labor, and equipment are not optimally managed in construction projects. The implication is that while key indicators of project delivery such as time, quality, coordination, and client satisfaction are perceived to be satisfactory, inefficiencies in resource utilization remain a critical challenge. This suggests that although construction projects in Bauchi State are generally delivered to acceptable standards, there are underlying inefficiencies that may affect overall performance. Therefore, improving resource management practices could significantly enhance construction project delivery outcomes in the study area.

Table 2: Level of construction project delivery in construction projects in Bauchi State

Item	Statement	Mean	St. Dev.	Remark
11	Construction projects in Bauchi State are generally completed within the scheduled time.	3.82	1.12	Agreed
12	Most construction projects in Bauchi State are executed within the approved budget.	3.73	1.14	Agreed
13	The quality of construction projects in Bauchi State meets required standards and specifications.	3.82	1.12	Agreed
14	Construction projects in Bauchi State are delivered with minimal delays.	3.84	1.11	Agreed
15	There is effective coordination among stakeholders during project execution in Bauchi State.	3.89	1.10	Agreed
16	Construction projects in Bauchi State achieve high levels of productivity and efficiency.	3.74	1.14	Agreed
17	Client satisfaction is generally high in construction projects executed in Bauchi State.	3.98	1.08	Agreed
18	Construction projects in Bauchi State are effectively managed to reduce errors and rework.	3.90	1.09	Agreed
19	Resource utilization (materials, labor, equipment) is efficient in construction projects in Bauchi State.	3.46	1.20	Agreed
20	Construction firms in Bauchi State consistently deliver projects that meet overall performance expectations.	3.91	1.10	Agreed

Source: Field study, 2025.

Table 3 shows the Pearson Product Moment Correlation analysis between professionals' perception of robotics integration and construction project delivery in Bauchi State, Nigeria. The result revealed a correlation coefficient (r) of 0.684 with a corresponding p -value of 0.000. The positive value of the correlation coefficient indicates a strong positive

relationship between professionals' perception of robotics integration and construction project delivery. The p-value of 0.000 is less than the 0.05 level of significance, indicating that the relationship is statistically significant. This implies that as professionals' perception of robotics integration becomes more positive, the level of construction project delivery is likely to improve. The finding suggests that favourable perceptions toward robotics integration among construction professionals are associated with better project outcomes in terms of efficiency, quality, productivity, and timely completion of projects.

Table 3: Pearson Correlation Analysis between Professionals' Perception of Robotics Integration and Construction Project Delivery

Variables	N	r	p-value	Decision
Professionals' Perception of Robotics Integration and Construction Project Delivery	238	0.684	0.000	Significant

Source: Field Study: 2025

Table 4 presents the regression analysis of the effect of professionals' perception of robotics integration on construction project delivery. The result revealed that professionals' perception of robotics integration significantly predicts construction project delivery ($\beta = 0.684$, $t = 13.327$, $p = 0.000$). This indicates that a positive change in professionals' perception is associated with a corresponding improvement in construction project delivery. The coefficient of determination ($R^2 = 0.468$) indicates that professionals' perception of robotics integration explains 46.8% of the variation in construction project delivery, while the remaining 53.2% is attributable to other factors not included in the model. The significant F-value (177.610, $p = 0.000$) further confirms that the regression model is statistically fit and significant. Since the p-value (0.000) is less than 0.05, the null hypothesis (H_{01}) is rejected. Therefore, professionals' perception of robotics integration has a significant positive effect on construction project delivery in Bauchi State, Nigeria.

Table 4: Regression Analysis of the Effect of Professionals' Perception of Robotics Integration on Construction Project Delivery in Bauchi State, Nigeria

Variable	B	Std. Error	Beta (β)	t-value	p-value	Decision
Constant	1.214	0.237	-	5.122	0.000	Significant
Professionals' Perception of Robotics Integration	0.693	0.052	0.684	13.327	0.000	Significant

Model Summary: $R = 0.684$; $R^2 = 0.468$; Adjusted $R^2 = 0.466$; $F = 177.610$; $p = 0.000$.

Source: Field Study, 2025

Discussion

The findings of this study revealed that respondents generally exhibited a positive perception of robotics integration, as all the items recorded mean scores above the acceptance benchmark. Respondents acknowledged that robotics is gradually gaining recognition within the construction industry, although its actual utilization remains limited and largely confined to specialized activities and large-scale firms. The finding suggests that construction professionals in Bauchi State recognize the relevance and potential benefits of robotics even though practical implementation is still at an early stage. This finding agrees with the study of Vora et al. (2024), who reported that construction stakeholders generally possess positive perceptions toward robot adoption and recognize its potential for improving project performance. The finding also corroborates Arijeloye and Chikafalimani (2025), who found that construction professionals in Lagos State were aware of robotics technology and acknowledged its usefulness despite its low level of deployment. Similarly, Jalam et al. (2025) reported that construction professionals in Northern Nigeria perceived automation technologies as useful and moderately easy to use, although actual familiarity and utilization remained low. However, the finding contradicts the position of Shetima et al. (2024), who found that many construction professionals in Abuja demonstrated low exposure to emerging technologies and limited awareness of their practical applications. The finding can be interpreted through the lens of the Technology Acceptance Model (TAM), which posits that an individual's intention to adopt a technology is largely determined by perceived usefulness and perceived ease of use. The positive perception recorded among professionals suggests that robotics is viewed as useful for improving construction operations. However, the relatively low level of practical adoption indicates that while perceived usefulness may be high, concerns relating to ease of use, accessibility, technical complexity, and organizational readiness may still hinder actual implementation.

Also, the findings revealed that respondents generally perceived project delivery performance as satisfactory, particularly with respect to project quality, stakeholder coordination, client satisfaction, reduction of errors, and achievement of project objectives. Nevertheless, resource utilization emerged as an area of concern, suggesting inefficiencies in the management of materials, labour, and equipment. The implication is that while construction projects are generally delivered successfully, opportunities still exist for improving efficiency and productivity. This finding supports Abdullahi et al. (2021), who reported that project performance in Bauchi State is influenced by factors such as effective coordination, adequate management practices, and technical competence among project stakeholders. The finding also emphasized that automation and robotics possess substantial potential for improving workflow efficiency and reducing project delays. Conversely, the finding differs from Oke et al. (2021), who identified persistent inefficiencies, waste, and operational challenges as dominant characteristics of construction project delivery in Nigeria. The relatively positive assessment of project delivery obtained in this study may be attributed to improvements in project management

practices and increased awareness of innovative technologies among construction stakeholders.

The correlation analysis undertaken to determine the relationship between professionals' perception of robotics integration and construction project delivery revealed a strong positive and statistically significant relationship. The finding implies that construction professionals who hold favourable perceptions toward robotics integration are more likely to experience improved project delivery outcomes. This result agrees with the findings of Vora et al. (2024), who established that stakeholder trust, comfort level, and positive perception significantly influence the acceptance and successful utilisation of robotic technologies in construction projects. The finding is also consistent with Bademosi and Issa (2021), who found that positive attitudes toward robotics and automation strongly predict the willingness of organisations to integrate such technologies into construction operations. Similarly, Abraham et al. (2024) observed that stakeholders who appreciate the benefits of human-robot collaboration are more likely to support technological innovations that enhance productivity and project outcomes. However, the result contrasts with Chiu et al. (2019), who reported that concerns regarding job displacement, usability, and workplace adaptation may negatively influence workers' acceptance of robotic systems. The strong positive relationship observed in this study suggests that Bauchi State construction professionals are increasingly receptive to technological innovations and are beginning to associate robotics with improved project performance.

The regression analysis further revealed that professionals' perception of robotics integration significantly influences construction project delivery. The coefficient of determination indicated that professionals' perception accounted for approximately 46.8 percent of the variation in construction project delivery, demonstrating substantial predictive power. This finding implies that project performance can be significantly enhanced when construction professionals maintain favourable attitudes toward robotics integration. The finding also agrees with Mishra (2025), who emphasized that successful robotics integration depends not only on technological availability but also on stakeholders' willingness to embrace technological change. Similarly, Musarat et al. (2024) reported that positive perceptions of robotics significantly influence productivity improvements and successful human-robot collaboration within construction environments. In contrast, Murtala et al. (2025), in their study of BIM adoption in Bauchi Metropolis, found that awareness alone does not automatically translate into adoption because financial, institutional, and technical barriers may still constrain implementation. While this contradiction is valid, the present study demonstrates that perception remains a critical antecedent to adoption and subsequent project performance.

From the perspective of the Technology Acceptance Model, the regression result provides strong theoretical validation for the study. TAM argues that perceived usefulness and perceived ease of use shape users' behavioural intentions, which ultimately influence actual technology adoption and performance outcomes. The significant positive effect observed

in this study suggests that professionals who perceive robotics as beneficial, efficient, and capable of improving project outcomes are more inclined to support its adoption and utilization. Such positive behavioural intentions subsequently translate into better construction project delivery. Therefore, the findings extend the applicability of TAM within the Nigerian construction context by demonstrating that professionals' perceptions do not merely influence attitudes toward robotics but also have measurable implications for project performance. The theory therefore provides a robust explanatory framework for understanding how favourable perceptions of robotics integration can contribute to enhanced efficiency, quality, productivity, and overall construction project delivery in Bauchi State.

Conclusion

Based on the findings of this study, it is concluded that construction professionals in Bauchi State possess a generally positive perception of robotics integration in construction projects. The findings showed that respondents acknowledged the existence, relevance, and potential benefits of robotics within the construction industry, although actual utilization remains limited and is still at an emerging stage. The study also concludes that construction project delivery in Bauchi State is generally satisfactory, particularly in terms of project quality, stakeholder coordination, client satisfaction, and achievement of project objectives, despite some concerns regarding efficient resource utilization. Furthermore, the inferential analysis established a strong positive and statistically significant relationship between professionals' perception of robotics integration and construction project delivery ($r = 0.684$, $p < 0.05$). The regression analysis further revealed that professionals' perception of robotics integration has a significant positive effect on construction project delivery ($\beta = 0.684$, $t = 13.327$, $p < 0.05$), accounting for 46.8% of the variation in project delivery outcomes ($R^2 = 0.468$). Based on this empirical evidence, the study concludes that professionals' perception of robotics integration is a significant predictor of construction project delivery in Bauchi State. Consequently, more favourable perceptions toward robotics integration are associated with improved construction project delivery outcomes. The study therefore concludes that enhancing positive perceptions and acceptance of robotics among construction professionals may contribute to improved project performance within the construction industry in Bauchi State.

Recommendations

1. Construction firms, professional bodies, and relevant government agencies should intensify awareness programmes, practical demonstrations, seminars, and workshops on robotics technologies.
2. Construction firms should strengthen project planning, monitoring, and resource management practices. Greater attention should be devoted to improving the utilization of labour, materials, and equipment in order to further enhance project efficiency, reduce waste, and improve overall project performance.

3. Stakeholders in the construction industry should implement measures that promote favourable perceptions toward robotics technologies. Such measures should include capacity-building programmes, pilot robotics projects, industry exposure initiatives, and supportive institutional policies aimed at increasing confidence in robotics adoption.

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