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EXPLORING THE BARRIERS TO THE IMPLEMENTATION OF AI IN CONSTRUCTION PROJECT MANAGEMENT AND STRATEGIES TO IMPROVE EFFECTIVE CONSTRUCTION PROJECT MANAGEMENT IN SOUTH EAST, NIGERIA.

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Abstract
The construction industry is increasingly adopting Artificial Intelligence (AI) to improve project planning, scheduling, cost estimation, risk management, quality control, and decision-making. However, AI adoption in developing countries such as Nigeria remains limited due to technological, organizational, and economic challenges. This study investigated the barriers to AI implementation in construction project management and identified strategies for improving its effectiveness in South East Nigeria. The study population comprised 5,230 construction professionals across Abia, Anambra, Ebonyi, Enugu, and Imo States, from which 372 respondents were selected using a stratified random sampling technique. Data were collected using a structured questionnaire and 342 valid responses, representing a 91.9% response rate, were analysed. Descriptive statistics, including frequency, percentage, mean, and standard deviation, together with the Relative Importance Index (RII), were employed for data analysis. The findings showed that High cost of staff training, Uncertainty about AI reliability and accuracy and Poor ICT performance were the most significant barriers to AI implementation. Similarly, continuous professional training, government investment in ICT infrastructure and financial incentives emerged as the most important strategies for improving AI adoption. The study concludes that addressing financial, technical, infrastructural, and organizational constraints through professional capacity development, improved digital infrastructure, supportive government policies, financial incentives, and stronger industry–academia collaboration can enhance AI implementation and improve construction project delivery in South East Nigeria.

Keywords: Artificial Intelligence, Construction Project Management, Barriers, Strategies, South East Nigeria.

1. Introduction

Artificial Intelligence (AI) is increasingly being applied in the construction industry to support activities such as project scheduling, cost estimation, risk prediction, quality control, safety monitoring, progress tracking, and resource optimization. Its capacity to analyse large volumes of project data and generate predictions can improve managerial decision-making and project performance (Darko et al., 2022; Zabala-Vargas et al., 2023). However, the availability of AI

technologies does not necessarily translate into their effective use in construction organizations.

It is important to distinguish AI acceptance, adoption, and implementation. Acceptance refers to an individual's willingness or intention to use an AI technology; adoption refers to the decision by an individual or organization to take up or begin using the technology; while implementation concerns the actual integration, deployment, and sustained use of the technology within organizational processes and project activities. Thus, an organization may accept or adopt AI without possessing the infrastructure, skills, financial resources, organizational readiness, or institutional support required for successful implementation. This distinction is particularly relevant in developing construction markets, where the transition from awareness and intention to actual technological implementation can be constrained by contextual factors (Darko et al., 2022; Osuizugbo & Alabi, 2022).

In Nigeria, the construction industry operates within a context characterized by infrastructure limitations, fluctuating economic conditions, skills shortages, fragmented project practices, and varying levels of digital readiness. These conditions can influence the capacity of construction organizations to implement emerging technologies. Osuizugbo and Alabi (2022) found that factors including inadequate operational skills, financial constraints, low awareness and acceptance, electricity supply, organizational culture, and government policies affect the application of AI among built-environment professionals in Nigeria. While this provides important evidence of national-level challenges, it does not establish how these barriers influence AI implementation specifically within construction project management in South East Nigeria.

The South East region, comprising Abia, Anambra, Ebonyi, Enugu, and Imo States, has an active construction sector involving residential, commercial, industrial, and infrastructure projects. Construction professionals in the region increasingly operate within an environment where digital technologies are becoming important for project coordination, information management, planning, and decision-making. Nevertheless, the extent to which AI has progressed from awareness and interest to practical implementation within construction project management remains insufficiently documented. The region's construction organizations may face particular constraints associated with investment capacity, availability of skilled personnel, digital infrastructure, organizational readiness, data management, and institutional support. Consequently, findings from international studies or studies conducted in other Nigerian contexts cannot automatically be assumed to represent the realities of construction organizations in South East Nigeria.

Existing literature has largely concentrated on the potential applications and benefits of AI in construction or has examined adoption and acceptance of digital technologies more broadly. For example, Darko et al. (2022) identified technological, organizational, financial, and human-related challenges to AI adoption in construction, while Zabala-Vargas et al. (2023) examined the role of AI, big data, and data science in the Architecture,

Engineering, and Construction industry. More recent research has continued to demonstrate the expanding role of AI in project management while identifying organizational, technical, and data-related challenges to implementation (Nenni et al., 2024). However, empirical evidence linking these barriers specifically to actual AI implementation in construction project management within South East Nigeria remains limited.

This represents an important empirical gap. In particular, it is not sufficiently known which barriers are most critical to AI implementation among construction professionals in South East Nigeria, how these barriers are prioritized within the regional construction context, and which practical strategies stakeholders consider most effective for overcoming them. Addressing this gap is important because identifying the benefits of AI without understanding the conditions that prevent its implementation provides limited guidance for construction firms and policymakers seeking to achieve meaningful digital transformation.

Therefore, this study investigates the barriers to the implementation of Artificial Intelligence in construction project management and strategies for improving effective construction project management in South East Nigeria. Specifically, the study identifies and ranks the major barriers to AI implementation and evaluates strategies for overcoming these barriers. The study contributes to existing knowledge by providing context-specific empirical evidence from South East Nigeria, distinguishing implementation challenges from general technology acceptance or adoption, and providing practical strategies that can inform construction organizations, professional bodies, policymakers, and educational institutions in promoting effective AI implementation and improved project delivery.

Statement of the Research Problem

Construction projects in South-East Nigeria continue to face persistent problems of cost overruns, project delays, poor resource utilization, inadequate project monitoring, safety risks, and ineffective decision-making. These challenges can negatively affect project quality, productivity, profitability, and timely delivery.

Artificial Intelligence (AI) offers opportunities to address these problems through predictive analytics, automated scheduling, cost estimation, risk prediction, progress monitoring, quality control, and resource optimization (Darko et al., 2022; Zabala-Vargas et al., 2023). However, the practical implementation of AI in the Nigerian construction industry remains limited. Evidence indicates that high implementation costs, inadequate technical skills, poor infrastructure, limited awareness, unreliable electricity, organizational resistance, and inadequate institutional support constrain AI application among built-environment professionals (Osuizugbo and Alabi, 2022).

These barriers limit construction organizations' ability to benefit from AI, resulting in continued reliance on conventional project-management practices and reduced opportunities to improve cost, time, quality, safety, productivity, and decision-making. While existing studies have examined AI applications and adoption challenges in construction, there is limited empirical evidence identifying and ranking

the specific barriers to AI implementation in construction project management in South-East Nigeria and the strategies required to overcome them.

The research problem addressed by this study is therefore the limited implementation of AI in construction project management in South-East Nigeria despite its potential benefits, and the inadequate empirical understanding of the barriers responsible for this situation and the strategies for overcoming them.

Central Research Question:

What are the major barriers to AI implementation in construction project management in South-East Nigeria, and what strategies can be adopted to overcome these barriers and improve project-management effectiveness?

Aim and Objectives

Aim

To examine the barriers to the implementation of Artificial Intelligence (AI) in construction project management and identify strategies for improving effective construction project management in South-East Nigeria.

Objectives

The study seeks to:

1. Identify the major barriers to the implementation of AI in construction project management in South-East Nigeria.
2. Assess the level of influence of the identified barriers on AI implementation in construction project management.
3. Examine the strategies that can be adopted to overcome the barriers to AI implementation in construction project management.
4. Develop recommendations for promoting effective AI implementation in construction project management in South-East Nigeria.

2. LITERATURE REVIEW

Concept of Artificial Intelligence

Artificial Intelligence (AI) is a branch of computing concerned with developing systems capable of performing tasks that typically require human intelligence, including learning, reasoning, perception, problem-solving, decision-making, and pattern recognition. The concept was formally introduced by John McCarthy and colleagues at the 1956 Dartmouth conference and has since evolved into a practical technology used across numerous sectors (McCarthy, 2007; Russell & Norvig, 2021). Unlike conventional software that operates mainly through predefined instructions, AI systems can analyse data, identify patterns, generate predictions, and improve their performance through learning (Russell & Norvig, 2021). AI encompasses technologies such as machine learning, deep learning, computer vision, natural language processing, robotics, expert systems, and predictive analytics. These technologies enable organizations to automate processes, improve productivity, optimize resources, and support data-driven decision-making (Abioye et al., 2021; Dwivedi et al., 2021).

In the construction industry, AI is increasingly applied to project scheduling, cost estimation, risk prediction, safety monitoring, quality inspection, progress tracking, equipment management, and resource optimization. By analysing large volumes of project data, AI can assist project managers in identifying potential risks, predicting delays, and making more informed decisions (Abioye et al., 2021;

Pan & Zhang, 2021). Recent developments in generative AI have further expanded these applications to areas such as document analysis, report generation, contract review, design support, and stakeholder communication (Taiwo et al., 2025). Currently, most practical applications of AI in construction represent Artificial Narrow Intelligence (ANI), which is designed to perform specific tasks rather than general human-level intelligence (Russell and Norvig, 2021). However, adoption remains uneven, particularly in developing countries such as Nigeria, where inadequate digital infrastructure, high implementation costs, limited technical expertise, low digital awareness, and weak institutional support can constrain implementation (Olanrewaju et al., 2020; Osuizugbo & Alabi, 2022). Thus, AI has considerable potential to transform construction project management by improving planning, monitoring, resource utilization, risk management, productivity, and decision-making. However, realizing these benefits requires addressing the technological, financial, organizational, and institutional barriers affecting its adoption.

Artificial Intelligence in Construction Project Management

Artificial Intelligence (AI) refers to computer-based systems capable of performing tasks associated with human intelligence, including learning, reasoning, prediction, pattern recognition, and decision-making. In construction, AI encompasses technologies such as machine learning, deep learning, computer vision, robotics, natural language processing, and predictive analytics. These technologies are increasingly being applied to improve project planning, scheduling, cost estimation, risk management, safety monitoring, quality control, and resource allocation (Abioye et al., 2021; Pan & Zhang, 2021).

AI can improve construction project management by analysing large volumes of project data and providing predictions and recommendations that support managerial decisions. For example, machine-learning models can assist with cost and schedule forecasting, while computer vision can support construction progress monitoring and defect detection. The integration of AI with Building Information Modelling (BIM), Internet of Things (IoT), drones, and other digital technologies further enhances real-time monitoring and project coordination (Abioye et al., 2021; Pan & Zhang, 2021).

However, the benefits of AI do not automatically translate into widespread adoption. Construction organizations, particularly in developing countries, face technological, financial, organizational, and human-resource limitations that affect their ability to implement AI effectively.

Barriers to AI Implementation

Several barriers have been identified in the literature. High implementation costs constitute a major challenge because AI adoption may require investment in software, hardware, data infrastructure, training, maintenance, and technical support. This can be particularly difficult for small and medium-sized construction firms with limited financial resources (Abioye et al., 2021).

Lack of technical expertise is another significant barrier. AI implementation requires professionals who understand data analytics,

machine learning, digital construction platforms, and related technologies. Limited digital skills among construction professionals can therefore reduce organizations' ability to implement and utilize AI effectively (Abioye et al., 2021).

In Nigeria, challenges associated with digital technology adoption include inadequate technical knowledge, cost, limited organizational readiness, and insufficient supporting infrastructure. Olanrewaju et al. (2020), for example, identified several barriers to BIM implementation in Nigeria, including cost, lack of knowledge, and government-related factors. Although BIM is not synonymous with AI, these findings provide useful evidence about the broader difficulties associated with digital transformation in the Nigerian construction industry.

Other barriers include poor ICT infrastructure, unreliable electricity and internet connectivity, resistance to organizational change, inadequate data, cybersecurity concerns, and limited management support. These challenges can reduce construction organizations' readiness to adopt emerging technologies and limit the effectiveness of AI applications (Abioye et al., 2021).

Strategies for Improving AI Adoption

The literature suggests that overcoming AI implementation barriers requires coordinated technological, organizational, financial, and institutional interventions. One important strategy is continuous professional training and capacity building. Construction professionals need opportunities to develop competencies in AI, data analytics, BIM, and other digital technologies.

Investment in digital infrastructure is also essential. Reliable electricity, internet connectivity, cloud computing, data-management systems, and appropriate hardware are necessary for the effective operation of AI applications. Construction firms should also develop organizational strategies that encourage innovation and provide management support for digital transformation (Abioye et al., 2021).

Government intervention is equally important. Supportive policies, financial incentives, research funding, digital standards, and regulatory frameworks can encourage organizations to invest in emerging technologies. Collaboration among universities, professional institutions, technology providers, and construction firms can also promote knowledge transfer, research, training, and the development of locally appropriate AI solutions.

Theoretical Perspective

This study is anchored on the Technology Acceptance Model (TAM) developed by Davis (1989). TAM explains technology acceptance through two main constructs: perceived usefulness (PU) and perceived ease of use (PEOU). Perceived usefulness refers to the belief that a technology will improve job performance, while perceived ease of use refers to the belief that it can be used with minimal effort (Davis, 1989).

TAM is relevant to this study because construction professionals are more likely to accept AI when they perceive it as useful for activities such as planning, scheduling, risk management, cost estimation, monitoring, and decision-making, and when they have the skills to use it. However, acceptance is

different from implementation. While TAM explains users' willingness to accept a technology, actual implementation may be affected by organizational and contextual factors.

In this study, barriers such as high training costs, uncertainty about AI reliability and accuracy, poor ICT infrastructure, resistance to organizational change, poor interoperability, lack of client demand, poor awareness, cybersecurity concerns, poor data quality, and lack of management commitment may prevent acceptance from translating into actual implementation.

TAM therefore provides a useful theoretical basis for understanding construction professionals' perceptions of AI, while the identified technical, financial, organizational, and institutional barriers provide the broader context for explaining challenges to AI implementation in construction project management in South-East Nigeria.

3. METHODOLOGY

Research Design and Population

The study adopted a quantitative cross-sectional survey design. The population comprised construction professionals involved in project management across Abia, Anambra, Ebonyi, Enugu, and Imo States. The professional groups included Architects(750), Builders(433), Engineers(2780), Quantity Surveyors(737), and Construction MANAGERS registered with CAC (530). The total population was 5,230 professionals,(Source: NIA, NIOB, NSE, NIQS and CAC Offices (2025))

Hence, the population of the research is 5,230 construction professionals.

Sample Size and Allocation

Using the Taro Yamane formula at a 5% precision level, a sample size of 372 respondents was obtained:

Where n = sample size, N = population, and e = precision level.

The 372 respondents were proportionately allocated across the professional groups.

Sampling Procedure

A stratified random sampling technique was used. Respondents were first grouped according to their professional disciplines. The sample was then proportionately allocated to each group, after which respondents were randomly selected.

Questionnaire Development

Data were collected using a structured questionnaire developed from the study objectives and relevant Development. It contained three sections: respondents' characteristics, barriers to AI implementation, and strategies for improving AI implementation.

A five-point Likert scale was used: 5 = Strongly Agree, 4 = Agree, 3 = Undecided, 2 = Disagree, and 1 = Strongly Disagree.

A total of 372 questionnaires were distributed, and 342 valid questionnaires were retrieved, giving a 91.9% response rate.

Validity and Reliability

The questionnaire was reviewed by experts in construction project management and research methodology to establish face and content validity.

In addition to being valid, the operational measures of the constructs must also be

reliable, Cronbach's alpha was adopted to test for reliability of the questionnaire survey.

Ethical Considerations

Respondents were informed of the purpose of the study and participation was voluntary. Informed consent was obtained, and confidentiality and anonymity of respondents were maintained. The data were used strictly for academic purposes.

Data Analysis

Data were analysed using Microsoft Excel. Frequency, percentage, mean, and standard deviation were used for descriptive analysis. The Relative Importance Index (RII) was used to rank the barriers and strategies.

The RII was calculated as:

Where W = weight assigned to each response, A = highest Likert weight (5), and N = number of respondents.

RII values range from 0 to 1. Higher values indicate greater importance. The barriers and strategies were ranked according to their RII values. A mean score above 3.00 indicated general agreement with an item, while a score below 3.00 indicated disagreement.

4. RESULTS AND DISCUSSION

Response Rate

Table 1: Questionnaire Response Rate

Questionnaire	Frequency	Percentage %
Distributed	372	100
Retrieved	342	91.9
Not retrieved	30	8.1

A total of 372 questionnaires were administered to registered construction professionals across the five states of South East Nigeria. Out of these, 342 questionnaires were correctly completed and returned, representing a 91.9% response rate, while 30 questionnaires (8.1%) were either not returned or were discarded due to incomplete responses. A response rate of 91.9% is considered adequate for statistical analysis.

Demographic Characteristics of Respondents

Profession

Table 2: Distribution of Respondents by Profession

Profession	Frequency	Percentage %
Architects	78	22.8
Builders	105	30.7
Quantity Surveyors	60	17.6
Structural Engineers	99	28.9
Total	**342**	**100**

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Table 2 indicates that Builders constituted the highest proportion of respondents (30.7%), followed by Structural Engineers (28.9%), Architects (22.8%), Quantity Surveyors (17.6%). This distribution suggests that the opinions presented in this study were obtained from professionals actively involved in construction project management.

Academic Qualification

Table 3: Academic Qualification

Qualification	**Frequency**	**Percentage %**
BSc	198	57.9
Masters	82	24.0
PhD	50	14.6
Others	12	3.5
Total	**342**	**100**

Table 3 presents the academic qualifications of the respondents. The results show that 198 respondents (57.9%) possessed a BSc, while 82 respondents (24%) had a Master's degree. Furthermore, 50 respondents (14.6%) held a PhD, while 12 respondents (3.6%) had other qualifications. This indicates that the majority of the respondents possessed a BSc qualification. In total, the 342 respondents accounted for 100% of the valid responses.

Years of Experience

Table 4: Years of Experience

Experience	**Frequency**	**Percentage**
1-8years	96	28.1
9-16years	112	32.7
17-24years	82	24.0
25years and above	52	15.2
Total	**342**	**100**

Table 4 shows the years of practice of respondents. It can be seen from the table that 28.1% of the respondents have service years between 1-8 years, 32.7% of the respondents have service years between 9-16 years, 24.0% of the respondents have service years between 17-24 years, and lastly, 15.2% of the respondents have worked for 25years and above. This implies that 100% of the respondents have worked actively for at least a year in the construction industry, therefore they have had experience with sustainable construction. More than 70% possess over five years' experience, indicating informed responses.

Barriers to the Implementation of Artificial Intelligence in Construction Project Management

Table 3: Mean Ranking of Barriers to AI Implementation.

S/N	**Barriers**	**Mean**	**SD**	**RII**	**Rank**

1.	High cost of staff training	4.63	0.61	0.926	1st
2.	Uncertainty about AI reliability and accuracy	4.55	0.68	0.910	2nd
3	Poor ICT infrastructure	4.48	0.72	0.896	3rd
4	Resistance to organizational change	4.41	0.77	0.882	4th
5	Poor awareness of AI	4.26	0.82	0.852	7th
6	Poor interoperability between construction technologies	4.37	0.74	0.874	5th
7	Lack of demand from clients	4.33	0.78	0.866	6th
8	Poor data quality	4.09	0.87	0.818	9th
9	Cybersecurity concerns	4.15	0.84	0.830	8th
10	Lack of management commitment	4.02	0.91	0.804	10th

Grand Mean = 4.33

The results indicate that high cost of staff training (Mean = 4.63; RII = 0.926) ranked as the most significant barrier to AI implementation. This was followed by uncertainty about AI reliability and accuracy(Mean = 4.55; RII = 0.910) and Poor ICT (Mean =4.48; RII = 0.896).

Strategies for Improving AI Implementation

Table 4: Mean Ranking of Improvement Strategies

S/N	Strategy	Mean	SD	RII	RANK
1	AI awareness programmes	4.42	0.75	0.884	6th
2	Continuous professional training|	4.72	0.53	0.944	1st
3	Government investment in ICT infrastructure	4.66	0.59	0.932	2nd
4	Strong management commitment	4.53	0.67	0.906	4th
5	Strong cybersecurity policies	4.22	0.84	0.844	9th
6	Financial incentives for AI adoption	4.60	0.63	0.920	3rd
7	Collaboration between industry and academia	4.47	0.71	0.894	5th
8	Increased research funding	4.29	0.81	0.858	8th
9	AI integration with BIM	4.35	0.78	0.870	7th
10	Collaboration with international AI experts	4.18	0.86	0.836	10th

Grand Mean = 4.44

The findings show that continuous professional training (Mean = 4.72; RII = 0.944) ranked as the most effective strategy for improving AI implementation, followed by government investment in ICT infrastructure (Mean = 4.66; RII = 0.932) and financial incentives (Mean = 4.60; RII = 0.920).

Summary of Findings

Based on the analysis, the following findings were made:

1.High cost of staff training was identified as the most significant barrier to AI implementation.

2.Uncertainty about AI reliability and accuracy, and poor ICT infrastructure were also major constraints.

3. Continuous professional training was ranked as the most effective strategy for improving AI implementation.

4. Government investment in digital infrastructure and financial incentives were considered essential for accelerating AI adoption.

Overall, the findings suggest that addressing financial, technological, and institutional barriers would significantly improve the implementation of Artificial Intelligence in construction project management in South East Nigeria.

5. Conclusion and Recommendations.

Conclusion

This study examined the barriers to Artificial Intelligence (AI) implementation in construction project management and strategies for improving its implementation in South-East Nigeria. Based on the results presented, High cost of staff training Uncertainty about AI reliability and accuracy, and Poor ICT infrastructure were identified as the major barriers to AI implementation. The findings also showed that Continuous professional training, Government investment in ICT infrastructure and Financial incentives for AI adoption were the most important strategies for addressing the identified barriers. The findings indicate that AI implementation in construction project management is influenced by financial, technical, infrastructural, organizational, and institutional factors. The study therefore concludes that addressing the identified barriers should be a priority for stakeholders seeking to improve the implementation of AI within the construction sector in South-East Nigeria. The study does not establish that AI adoption directly reduces project delays, cost overruns, or improves sustainability, as these outcomes were not directly measured.

Recommendations

Based directly on the identified barriers, the following recommendations are made:

1. High cost of staff training: Construction firms and professional bodies should provide affordable and continuous AI training programmes. Government and professional institutions should also consider training grants or subsidized programmes.
2. Uncertainty about AI reliability and accuracy: Construction organizations should conduct pilot projects and validation exercises before full-scale implementation to build confidence in the reliability and accuracy of AI outputs.
3. Poor ICT infrastructure: Government and construction organizations should invest in reliable internet connectivity, computing facilities, digital platforms, and other ICT infrastructure required for AI implementation.
4. Resistance to organizational change: Construction firms should involve employees in AI implementation, provide adequate training, and communicate the purpose and expected use of AI clearly to reduce resistance.
5. Poor interoperability: Organizations should prioritize AI solutions that can integrate with existing construction technologies and adopt common data

standards to improve communication between digital systems.

6. Lack of client demand: Construction professionals and firms should increase client awareness of the potential applications of AI in project management to encourage greater demand for AI-supported services.
7. Poor awareness of AI: Professional bodies and educational institutions should organize seminars, workshops, and awareness programmes on AI applications and implementation requirements in construction.
8. Cybersecurity concerns: Construction organizations should establish appropriate data-protection, access-control, cybersecurity, and information-management measures when implementing AI systems.
9. Poor data quality: Firms should improve their data collection, storage, validation, and management procedures to provide reliable data for AI applications.
10. Lack of management commitment: Senior management should demonstrate clear commitment to AI implementation by providing resources, establishing implementation policies, and integrating AI into organizational technology strategies

Study Limitations and Areas for Further Research

The study was limited to construction professionals in South-East Nigeria; therefore, the findings may not be directly generalizable to other regions of Nigeria. The study also relied on respondents' perceptions obtained through a questionnaire and did not measure the actual performance outcomes of AI implementation.

Future research should examine AI implementation using actual construction project data and investigate its measurable effects on project cost, time, productivity, quality, safety, and sustainability. Comparative studies across Nigeria's geopolitical zones and studies examining differences among professional groups and construction-firm sizes are also recommended.

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