

Intelligent Management of Construction Projects: The Nexus of Human and Artificial Expertise

Amadi Alolote Ibim*

Abstract

Conversations about digitalization and artificial intelligence (AI) have continued to gain traction in the project management discourse. Although human expertise remains the hallmark of professionalism in the construction industry, AI has emerged as the newest wave of digital technological innovation, which can significantly elevate human productivity in the performance of project management functions. However, for project management professionals in the Nigerian construction industry, the potential of AI is both thrilling and overwhelming, evidenced by resistance to its adoption. There are debates and arguments that AI is taking over human jobs. This is because there is a general lack of understanding of what AI means for the future of the project management profession. Understanding AI's role in project management and how it interfaces with human expertise is thus a necessary prerequisite for overcoming human resistance and fostering change. This study addresses these topical issues, which raise several questions that require clarification, and can be enriched with an understanding of AI's role in project management. A questionnaire survey was carried out on 200 professionals in the Nigerian construction industry, comprising five thematic dimensions: (1) AI awareness and adoption, (2) perceived benefits, (3) perceived challenges, (4) organizational readiness, and (5) impact of AI on project success. Organizational readiness emerged as a critical mediating factor in ensuring sustainable integration of AI. Firms that invest in digital training, change management, and infrastructure stand to gain the most from AI deployment. The findings affirm that AI adoption significantly enhances project management performance, aligning with global research trends that underscore AI's capacity to improve accuracy, optimize resource allocation, and minimize risk. Nevertheless, challenges such as limited technical expertise, ethical concerns, and interoperability constraints persist, echoing earlier studies that caution against overreliance on technology without adequate human oversight.

Keywords: Artificial expertise, artificial intelligence, technological innovation, quantity surveying, intelligent management

INTRODUCTION

The construction industry is experiencing a profound transformation driven by the rapid advancement of digital technologies; foremost among them, Artificial Intelligence (AI). In Nigeria, a nation characterized by a rapidly expanding population and pressing infrastructure demands, the integration of AI into construction and Quantity Surveying (QS) holds significant promise. Through the adoption of AI, stakeholders in Nigeria's construction sector can address persistent challenges such as cost overruns, project delays, inefficient resource utilization, and limited transparency.

AI technologies possess immense potential to revolutionize project management by minimizing

*Author for Correspondence

Amadi Alolote Ibim
E-mail: amadi.alolote@ust.edu.ng

Associate Professor, and Head, Department of Quantity Surveying, Rivers State University, Port Harcourt, Nigeria

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human effort and enhancing operational performance [1]. Specifically, AI can improve project management efficiency, transparency, and cost-effectiveness by automating routine and repetitive tasks, thereby enabling professionals to focus on strategic decision-making. Its advanced data analytics capabilities allow for the identification of cost-saving opportunities, optimization of project schedules, and mitigation of risks through predictive insights [2]. Consequently, the incorporation of AI in project management represents a paradigm shift from traditional practices toward data-driven, automated, and adaptive methodologies. Nonetheless, the human dimensions of leadership, creativity, critical thinking, and ethical reasoning remain indispensable to achieving project success [3].

AI should not be regarded as a futuristic innovation but rather as a present-day necessity for enhancing efficiency, accuracy, and sustainability within Nigeria's construction industry. Equipping project managers and allied professionals with the requisite digital skills and tools will enable the development of smarter, faster, and more cost-effective infrastructure [4]. The future of construction in Nigeria is anchored in data, automation, and intelligent systems, and that future is already unfolding.

The study explores how integrating AI and human skills can redefine the future of project management, highlighting both the transformative potential of this collaboration and the challenges it brings. This study explores the intersection of AI capabilities with human expertise, arguing for a synergistic model that combines the strengths of both. Through analysis of AI applications, enduring human roles, and the future of hybrid management, the study presents a forward-looking view on how to navigate the evolving landscape of project management.

LITERATURE REVIEW

Understanding the Science Behind Artificial Intelligence

Artificial Intelligence (AI) represents a transformative field of study focused on developing computer systems capable of performing tasks that typically require human intelligence [5]. It encompasses various branches of computer and data science dedicated to enabling machines to emulate cognitive functions such as learning, reasoning, problem-solving, perception, and natural language comprehension. Unlike traditional systems that rely on explicit programming, AI systems learn from data, enabling them to autonomously handle both complex and repetitive tasks while improving performance over time [6]. AI relies on algorithms that process data, identify patterns, and make informed predictions or decisions based on analytical reasoning. A defining feature of AI is its ability to continuously learn from experience, adapt to novel contexts, and refine its performance without explicit reprogramming [7].

Three foundational components underpin AI functionality: data, algorithms, and computing power. Data serves as the foundation upon which AI systems learn and make decisions, requiring vast and diverse datasets for effective training. Algorithms, sets of mathematical rules and procedures, enable the system to process information and generate outputs [8]. Advanced learning algorithms, such as those used in machine learning, further enhance decision-making by identifying relationships and trends within data without explicit human instruction. These processes demand substantial computational resources to manage large datasets and execute complex models efficiently [9].

The key techniques, which are fundamental to the application of Artificial Intelligence, are underlain by a range of statistical learning methods, which have shaped the contemporary AI ecosystem. These include:

- *Machine learning (ML)*: ML employs mathematical models trained on “sample data” or “training data” to perform classification and prediction tasks without explicit programming [10]. Once trained, these models can classify new data and make predictions. Common ML algorithms include Random Forest (RF), Support Vector Machine (SVM), Decision Trees, and k-means clustering [11].
- *Deep learning (DL)*: DL addresses the limitations of traditional ML when processing raw, unstructured data. It uses multilayered neural networks to learn hierarchical data representations

with increasing abstraction at each layer [12].

- *Neural networks (NNs)*: Artificial Neural Networks (ANNs) are computational systems inspired by the structure of the human brain. They consist of interconnected nodes (“neurons”) that transmit information and learn to perform specific tasks through iterative training.
- *Natural language processing (NLP)*: NLP enables machines to understand, interpret, and generate human language. Applications include text classification, information retrieval, and extraction of structured data from unstructured documents [13].
- *Fuzzy logic*: Fuzzy logic extends classical Boolean logic to represent uncertainty more flexibly, allowing for reasoning between absolute true and false values (0 and 1). It underpins expert systems that combine inference engines and knowledge bases to derive solutions from imprecise data [14, 15].
- *AI-based heuristics*: Heuristics involve reasoning or problem-solving using approximate methods based on experience rather than exhaustive analysis. Common AI-based heuristic methods include Genetic Algorithms (GAs) and Ant Colony Optimization (ACO), both inspired by biological and behavioural processes [16].

Furthermore, AI development has progressed through several distinct “waves”, each representing advancements in capability and sophistication. The first wave was a Knowledge-based system that relied on expert-defined rules but lacked adaptability to uncertainty. The second wave, Data-driven statistical learning, improved accuracy but often operated as “black boxes” without interpretability. The third wave was a context-aware AI system capable of reasoning and responding dynamically, though requiring significant computational and research investments [17].

The fourth wave is the current era, which uses Generative AI and large language models (LLMs), such as ChatGPT, that leverage massive datasets to produce coherent text, images, and code. These technologies underpin virtual assistants, image recognition systems, and intelligent document processing tools, with applications spanning industries from construction to healthcare [16, 17]. The convergence of AI with emerging technologies, such as the Internet of Things (IoT), Blockchain, and quantum computing, continues to drive innovation across sectors.

AI Technologies Applied in Project Management

AI applications in project management primarily leverage Machine Learning (ML), Natural Language Processing (NLP), Large Language Models (LLMs), Generative AI, Robotic Process Automation (RPA), and Knowledge-Based Systems. Machine Learning (ML) algorithms enhance predictive analytics, resource allocation, and progress tracking. They can forecast project outcomes, anticipate risks, and identify budget or schedule deviations based on historical data [17]. ML models also optimize resource utilization and track project performance in real time. Natural Language Processing (NLP) allows AI systems to interpret project communications, extract key data, and analyse stakeholder sentiment [18]. It facilitates automated document classification, meeting summarization, and stakeholder communication analysis using tools like Google’s Gemini. Large Language Models (LLMs) generate coherent text for meeting summaries, project documentation, and communication support. LLMs power chatbots and virtual assistants that assist in scheduling, reporting, and query resolution [19].

On the other hand, Generative AI produces original content: text, visuals, or simulations, for use in brainstorming, personalized communication, and scenario planning [20]. It also supports data augmentation for improving model performance. Robotic Process Automation (RPA) automates repetitive administrative tasks, such as data entry and report generation, freeing project teams for more analytical and creative work [21]. Knowledge-Based Systems draw from domain expertise to assess risks, support complex decision-making, and deliver adaptive training to project personnel [22].

Human Expertise in the Era of AI-enabled Project Management

Project management (PM) has historically served as a vital discipline across industries, encompassing activities such as defining objectives, allocating resources, managing timelines, and ensuring

stakeholder satisfaction. Traditionally, these responsibilities required a balance of technical expertise, interpersonal competence, and intuitive judgment.

However, digital transformation has fundamentally redefined this landscape. AI-driven tools now automate numerous operational processes, enhancing efficiency and accuracy. Yet, rather than displacing human expertise, AI complements it, augmenting managerial capacity while preserving the need for human intuition, leadership, creativity, and ethical decision-making. The synergy between human intelligence and AI thus represents the cornerstone of next-generation project management.

Automation, cloud-based collaboration tools, and increasingly, Artificial Intelligence (AI) have entered the PM domain. AI now offers tools that can perform time-consuming tasks like scheduling, risk assessment, and performance tracking more quickly and accurately than humans.

AI thus introduces a shift by allowing machines to assess risk, automate scheduling, and analyse vast data sets in real time. The evolution from manual tracking to AI-driven platforms represents a leap not just in technology, but in how projects are understood and executed [23].

Although AI holds much promise in project management, it cannot function independently. This is because projects are inherently complex, often requiring adaptability, empathy, and nuanced judgment, traits that current AI systems lack. Effective project management, therefore, must balance the speed and efficiency of AI with the creativity, critical thinking, and ethical discernment of human expertise. Project management (PM) has historically relied on human experience and interpersonal skills to guide projects from conception to completion. AI offers predictive insights, automation, and process optimisation, enhancing the efficiency and scope of what project managers can achieve.

For Quantity Surveyors and other project management professionals, the integration of AI-powered chatbots and NLP technologies can revolutionise stakeholder interactions. AI chatbots and NLP capabilities can significantly support Qs in their interactions with stakeholders. The chatbot can efficiently handle questions related to project updates, cost estimates, and other common inquiries. Additionally, its NLP capabilities enable it to assist in information retrieval, accessing relevant construction and cost data from the firm's database. This automation streamlines communication and frees up valuable time for Qs to concentrate on more complex tasks and strategic decision-making. As a result, better communication with stakeholders is facilitated, leading to improved client relations and enhanced project management efficiency [24].

Yet, these technologies cannot replace the nuanced judgment, leadership, and emotional intelligence humans bring to the table. The next section of the study examines how AI and human expertise can be integrated to shape the future of project management.

SYNERGY BETWEEN AI AND HUMAN EXPERTISE

The most promising future for project management does not lie in choosing between Artificial Intelligence and human expertise, but in forging a productive partnership between the two. When properly integrated, AI and human capabilities can significantly enhance project performance, decision-making, and adaptability. This makes it an ideal tool for functions such as resource optimisation, risk forecasting, real-time reporting, and schedule management [25]. On the other hand, human project managers bring emotional intelligence, ethical reasoning, and a deep understanding of context and organisational culture to their roles, qualities that remain beyond the reach of current AI technologies. For example, an AI system may detect a scheduling delay based on past performance data and recommend reallocation of tasks. However, a human manager is needed to consider interpersonal dynamics, team morale, and long-term strategic goals before implementing changes. In this way, AI provides the analytical foundation, and humans provide judgment and context.

This integration gives rise to the concept of the "augmented project manager", a professional who uses AI tools not as a replacement but as an extension of their capabilities. By offloading administrative burdens to AI, managers can focus more on strategic leadership, innovation, and stakeholder engagement [26]. AI becomes a co-pilot, enhancing productivity rather than eliminating jobs. In practice, this could look like using AI-driven dashboards to monitor KPIs in real time, employing machine learning models to predict project risks, or using natural language processing tools to summarise lengthy stakeholder communications. The human manager interprets this information, decides on a course of action, and communicates it in ways that align with team dynamics and organisational vision.

In the construction industry, AI-powered project management is used to simulate thousands of project scenarios and suggest the most efficient execution paths. Yet, these recommendations still require human project managers to assess feasibility based on local labour conditions, regulatory requirements, and client expectations [27]. This collaboration results in faster decision-making and better resource utilisation without sacrificing the nuanced considerations that only a human expert can bring [28].

METHOD OF STUDY

A total of 200 valid responses were collected from professionals in the Nigerian construction industry, comprising Project Managers (30%), Quantity Surveyors (25%), Civil Engineers (30%), and Construction Executives (15%). The majority of respondents (64%) possessed over 5 years of professional experience, reflecting a well-informed sample capable of providing insight into the integration of Artificial Intelligence (AI) in project management. The survey comprised five thematic dimensions: (1) AI awareness and adoption, (2) perceived benefits, (3) perceived challenges, (4) organizational readiness, and (5) impact of AI on project success. Responses were rated on a five-point Likert scale ranging from Strongly Disagree (1) to Strongly Agree (5). Descriptive statistical tools such as mean and standard deviation were used to analyse. In addition, several sets of inferential statistics: Correlation Analysis, Regression Analysis, and Analysis of Variance (ANOVA), were used to analyse the data in line with the five thematic dimensions.

DATA PRESENTATION AND ANALYSIS

Table 1 shows the description of statistics.

Descriptive Statistics

Interpretation

The descriptive analysis indicates that most respondents recognize AI as a transformative force in project management. The relatively high mean for AI Awareness ($M=4.12$) and Perceived Benefits ($M=4.25$) suggests growing acceptance of AI tools such as predictive analytics, automation, and machine learning for project scheduling, cost control, and risk assessment. However, the moderate mean for Perceived Challenges ($M=3.58$) reveals that issues such as data security, cost of adoption, and limited technical expertise remain significant barriers. Organizational Readiness ($M=3.76$) shows cautious optimism, implying that many firms are preparing for digital integration but lack comprehensive frameworks for implementation.

Inferential Statistics

Table 2 shows the correlation between AI adoption and project success.

Correlation Analysis

Interpretation

The Pearson correlation coefficient ($r=0.72$, $p<0.01$) indicates a strong, positive, and statistically significant relationship between AI adoption and project success. This implies that projects utilizing AI-supported tools tend to achieve better outcomes in cost efficiency, timeliness, and stakeholder satisfaction. The result supports existing research emphasizing that digital technologies enhance performance in project management environments.

Table 1. Descriptive statistics of key variables.

Variable	Mean (M)	Standard deviation (SD)	Interpretation
AI Awareness and Adoption	4.12	0.71	High awareness and moderate adoption across firms
Perceived Benefits of AI	4.25	0.64	Respondents agree that AI improves project efficiency and decision-making
Perceived Challenges of AI	3.58	0.82	Moderate level of concern regarding skills gap and data privacy
Organizational Readiness	3.76	0.79	Reasonable readiness, though some structural limitations persist
Impact of AI on Project Success	4.31	0.68	Strong positive perception of AI's role in achieving project objectives

Table 2. Correlation between AI adoption and project success.

Variables	r	p-Value	Significance
AI Adoption vs. Project Success	0.72	0.000	Significant (p<0.01)

Table 3. Linear regression model predicting project efficiency.

Predictor variable	β (Beta)	t-value	p-value	Decision
AI Adoption	0.63	9.41	0	Significant
Organizational Readiness	0.28	4.52	0.001	Significant
Perceived Challenges	-0.17	-2.83	0.005	Significant (negative effect)
$R^2=0.64$, $F(3,196)=115.23$, $p<0.001$				

Table 4. ANOVA Results on AI perception across professional groups.

Source	SS	df	MS	F	p-value	Decision
Between Groups	6.82	3	2.27	4.15	0.007	Significant
Within Groups	107.41	196	0.55			
Total	114.23	199				

Regression analysis

Regression analysis is shown in Table 3, which shows the Linear Regression model predicting project efficiency.

Interpretation

The regression results demonstrate that AI adoption and organizational readiness significantly predict project efficiency, jointly explaining 64% of the variance ($R^2=0.64$). Specifically, AI adoption ($\beta=0.63$, $p<0.001$) has the strongest positive influence, while perceived challenges exert a mild but significant negative effect ($\beta=-0.17$). This suggests that increasing AI utilization and strengthening institutional readiness can meaningfully enhance project outcomes in Nigeria's construction sector.

Anova test

Table 4 shows the ANOVA results on AI perception across professional groups.

Interpretation

The ANOVA results ($F(3,196)=4.15$, $p=0.007$) indicate a statistically significant difference in perceptions of AI across professional groups. Post hoc analysis reveals that Project Managers and Construction Executives exhibit higher optimism toward AI applications compared to Engineers and Quantity Surveyors. This variation may stem from differences in exposure to AI tools and the nature of their decision-making responsibilities.

DISCUSSION OF FINDINGS

The findings affirm that AI adoption significantly enhances project management performance, aligning with global research trends that underscore AI's capacity to improve accuracy, optimize resource allocation, and minimize risk. Nevertheless, challenges such as limited technical expertise, ethical concerns, and interoperability constraints persist, echoing earlier studies that caution against overreliance on technology without adequate human oversight.

Organizational readiness emerges as a critical mediating factor in ensuring sustainable integration of AI. Firms that invest in digital training, change management, and infrastructure stand to gain the most from AI deployment. Overall, the analysis supports a synergistic framework in which human expertise complements AI capabilities, ensuring that technology serves as an enabler rather than a replacement for human decision-making. Project managers must therefore be trained not only in using AI tools but also in understanding their limitations and ethical implications. Furthermore, new roles such as AI integration specialists or data-savvy project analysts are emerging to bridge the gap between technical AI outputs and strategic project goals. These roles support project managers in interpreting and applying AI-driven insights effectively.

CONCLUSION

Artificial Intelligence has transformative potential for project management, based on its capacity to enhance efficiency and support data-driven decision-making. However, human expertise in leadership, ethics, and innovation remains indispensable. The integration of AI and human skills offers a powerful model for navigating complex projects. The integration of AI into project management is not a temporary trend; it signals a fundamental evolution in how projects are conceived, executed, and evaluated. This transition will be marked not by obsolescence, but by the elevation of human roles to focus on those aspects of work that machines cannot replicate: empathy, vision, and leadership. Ultimately, the future of project management will not be about replacing people with machines; it will be about creating a collaborative environment where humans and AI tools complement one another. In this augmented landscape, projects will benefit from both the precision of machines and the insight of human judgment, enabling faster innovation, reduced risk, and greater stakeholder satisfaction. This study has explored the intersection of AI capabilities with human expertise, arguing for a synergistic model that combines the strengths of both. Through analysis of AI applications, enduring human roles, and the future of hybrid management, the study presents a forward-looking view on how to navigate the evolving landscape of project management.

Nonetheless, as organisations begin to integrate AI into project management, they are likely to face several key challenges that must be addressed to ensure successful adoption and long-term sustainability:

- *Overreliance on technology:* One major risk lies in excessive dependence on AI systems. Although AI can efficiently analyse data and generate recommendations, its effectiveness is limited by the quality of the data it processes. Inaccurate, biased, or outdated data can produce misleading insights and poor decisions if not balanced by human judgment. Therefore, project managers must maintain a critical, evaluative approach, using AI as a support tool rather than a substitute for professional reasoning and experience.
- *Ethical and privacy concerns:* AI applications often require access to sensitive project and personnel data, raising concerns about privacy, consent, and ethical use of information. Furthermore, AI algorithms can inadvertently reinforce existing biases if not properly designed and monitored. To mitigate these risks, organisations must establish transparent AI governance frameworks that promote accountability, fairness, and ethical data handling throughout the project lifecycle.
- *Skills gap and workforce readiness:* A significant challenge lies in the shortage of AI-related competencies among project management professionals. Many practitioners lack familiarity with concepts such as machine learning, data analytics, and algorithmic bias. Consequently, organisations must invest in structured training and capacity-building initiatives to enhance workforce readiness. Continuous professional development can be achieved through

participation in workshops, seminars, webinars, and conferences focused on AI applications in construction and project management. Pursuing AI-related professional certifications, particularly those linked to quantity surveying, data analytics, or AI-driven project management, can further strengthen technical competence and industry credibility.

- *Organisational resistance to change*: AI adoption often necessitates a fundamental transformation in organisational culture. Established workflows may need reconfiguration, and some employees may resist changes due to fear of redundancy or uncertainty about new technologies. Effective change management strategies, emphasizing transparent communication, stakeholder engagement, and phased implementation, are vital to fostering acceptance and ensuring a smooth transition.
- *Integration and interoperability challenges*: In many cases, AI tools are introduced as isolated systems that fail to integrate with existing project management or enterprise resource planning software. Such fragmentation limits efficiency and can lead to duplication of efforts. To maximize value, organisations should adopt a holistic digital transformation strategy that ensures seamless interoperability between AI solutions and broader organisational processes.

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