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Implementation of Artificial Intelligence (AI) Technologies for Construction Project Management

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Abstract
The potentials of artificial intelligence (AI) at revolutionizing construction project management processes are enormous, considering the trend of technological advancement experienced across the globe. Hence, the need to investigate the implementation of AI in the Nigeria construction industry with focus on the level of adoption and, the challenges and benefits. Purposive sampling technique was used to collect data through a survey conducted on 337 construction professionals in Benin City. Analysis was done using percentages, mean item score and standard deviation. Findings revealed that "Internet of Things (IoT) (MIS = 3.49)", "Sensors (MIS = 3.39)" and "Drones MIS = 3.38" ranked first, second and third among the AI tools adopted and frequently used for construction project management processes in Nigeria. The least ranked tools are "Struction site (MIS = 2.28)", "IESVE (MIS = 2.20)" and "Conga (MIS = 2.14)". Results further revealed challenges like "Resistance to Change, Skill Shortage and Risk of Job Displacement" to have ranked first with (MIS=4.07). Also, the benefits accruing to AI technologies implementation are "Quality Control (MIS=4.07)", "Increased efficiency and productivity (MIS=4.05)" and "Faster project delivery" ranked third with (MIS=4.03). The study concluded that the extent of adoption of AI technologies for project management is still low despite the huge benefits available. However, there is the need to devise means to mitigate the challenges thwarting AI implementation. It was recommended that construction companies and technology providers should collaborate and invest in robust AI infrastructure tailored to the unique needs and challenges of professionals in Benin City.

Keywords: *Artificial intelligence, construction industry, construction professionals, project management, technologies.*

1.0 Introduction

The construction industry plays a crucial role in the economic development of any country. It is responsible for the creation of infrastructure that supports various sectors such as residential, commercial, industrial, and transportation. However, the construction industry is faced with many challenges that have hindered its growth and led to extremely low productivity levels when compared with other industries such as manufacturing (Wang, 2019). The construction industry is one of the least digitized industries in the world and most stakeholders acknowledge the age-long culture of resistance to change (Abioye, et al., 2021). The lack of digitization and excessively manual nature of the industry makes project management more complex and unnecessarily tedious. Low level of digital expertise and technology adoption within the construction industry has also been linked to cost inefficiencies, project delays, poor quality performance, uninformed decision-making and poor performance in terms of productivity, health and safety (Owolabi, 2019).

Artificial Intelligence (AI), is currently revolutionizing industries such as manufacturing, retail, and telecommunications but there is paucity of AI transformation in construction project management (Waqar et al., 2023). The uniqueness and inherent complexities of the construction industry require the use of this AI technology to improve its processes and enhance overall competitiveness and performance. The continuous rapid advancement in this technology is changing almost every aspect of organisational and managerial activities (Boje *et al.*, 2020). The fast-growing discipline of AI gets more and more attention from practitioners (Bughin, *et al.*, 2019; Ransbotham, *et al.*, 2017) and academia (Iansiti and Lakhani, 2020; Raisch and Krakowski, 2020) in different fields of management, and is expected to disrupt the field of project management as well (Lahmann et al., 2018; Auth, 2019; Parsi, 2019; PMI, 2019; Wang, 2019).

AI technologies can facilitate real-time collaboration and communication among project stakeholders, improving coordination and decision-making. They can also enable the use of digital twins, virtual replicas of physical assets, to simulate and optimize construction processes, identify potential design flaws, and enhance project visualization (Ransbotham, et al., 2017). Artificial intelligence in construction aims to provide insights into state-of-the-art AI technologies, their potential applications, and their implications for project management processes. It lays the foundation for further research and the development of guidelines and best practices for integrating AI into construction project management processes, ultimately improving project outcomes and driving innovation in the industry (Waqar et al., 2023). However, the successful application of Industry-specific AI technologies in construction project management requires a deep understanding of the unique challenges, as well as considerations of ethical, legal, and social implications. It is crucial to investigate and explore the level of implementation of AI technologies in project management in order to harness its benefits while addressing the challenges and ensuring responsible and ethical adoption. These challenges can be attributed to the lack of effective project management practices and the limited adoption of innovative technologies such as Artificial Intelligence (Waqar, et al., 2023). However, the implementation of AI technologies for construction project management still remains underexplored. Hence, the research focuses on embracing the implementation of AI technologies by construction professionals with a view to enhancing project management practices in Nigeria. This was achieved by examining the level of adoption and frequency of use, and investigating the challenges and benefits of AI implementation for construction project management in Edo State, Nigeria. The outcome of this research is expected to inform stakeholders, guide future research endeavours, and contribute to embrace and implement AI technologies in construction project management practices.

1.1 Overview of the Construction Industry

Construction industry is one of the most important economic sectors across the world (Ransbotham et al., 2017). The spending in construction represents between 9% and 15% of GDP in most countries, and up to half of the nation's investment can be allocated to the built environment. Despite its huge economic importance, the construction industry is filled with inefficiencies (Owolabi, 2019). Productivity in many other sectors has increased in the last five (5) decades, however, reverse is the case for construction industry in developing nations (Owolabi, 2019). The construction industry's growth is significantly hindered by the various complicated difficulties such as cost and time overruns, health and safety, productivity, and labour shortages (Ransbotham et al., 2017). Furthermore, the industry is among the least computerized sectors in the world, making it difficult to address the problems it's currently facing (Waqar et al., 2023).

Abioye et al. (2021) described among the computerized gargets to include AI as a digital technology that is currently reshaping industries such as manufacturing, retail, and telecommunications industries in such a way that it makes input of labour, time, energy, workforce little and makes the output of work more efficient and effective for projects delivery. AI has various fields such as machine learning; knowledge-based systems, computer vision, robotics, and optimization to boost profitability, efficiency, safety, and security (Owolabi, 2019). It was further noted that while several benefits accrue to AI applications, the construction industry still faces various AI-related problems and this tends not to bring out the best in project management from inception to closing.

1.2 Artificial Intelligence (AI)

The term "Artificial Intelligence" (AI) was introduced in the 1950s with the seminal works of Alan Turing (Turing, 1950) and John McCarthy and colleagues (McCarthy, 2006), concerning replicating human intelligence by using computer programs. Since then, AI has experienced fluctuations in the level of interest by scholars and practitioners (Haenlein and Kaplan, 2019), which is also demonstrated in the various definitions that were suggested. Some definitions focused on rational reasoning and acting. Charniak and McDermott (1985) described AI as *"the study of mental faculties through the use of computational models"*, while Winston (1993) also defined AI as *"the study of the computations that make it possible to perceive, reason, and act"*. Other definitions emphasized behavioural and human performance. For example, Kurzweil et al. (1990) defined AI as "the art of creating machines that perform functions that require intelligence when performed by people. Artificial intelligence (AI) is primarily concerned with comprehending and carrying out intelligent tasks such as thinking, acquiring new abilities, and adapting to new contexts and challenges. AI is thus considered a branch of science and engineering that focuses on simulating a wide range of issues and functions in the field of human intellect (Haenlein, and Kaplan, 2019). Building an effective AI model is challenging, and to solve these challenges in today's industrial revolution, the various analytical, functional, interactive, textural and visual AI functions must be employed as indicated in Table 1 (Haenlein, and Kaplan, 2019; Sarker, 2022).

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Table 1: Artificial Intelligence (AI) tools and functions

S/N	AI Tools	Functions
1.	Auto-Desk Fusion 360	Auto-Desk Fusion 360 is a 3D-based modelling software, capable of modelling, simulation, and documentation. It is used for Parametric modelling, Mesh Modelling, and Surface Modelling, is also used for extremely realistic renders, also used in Topology and shape optimization.
2.	OptiStruct	OptiStruct is a finite element analysis software tool which was developed by Altair Engineering. OptiStruct assists engineers in conducting detailed structural analysis, topology optimization, sizing and shape optimization which enables the evenly distribution of loads in a building.
3.	CES Selector	CES Selector is a software developed by Granta Design and it is used to select best materials for a construction project, optimization of building materials, provides insights into material database, helps in materials comparisons so that the best can be selected for a project.
4.	Procore	Procore is a cloud-based construction management software designed to streamline various aspects of construction project management. Procore provides tools for project planning, scheduling and management. Procore has tools for financial reporting, cost tracking, and budgeting.
5.	Oracle Primavera	Oracle Primavera is an application package for enterprise project portfolio management that is meant to assist enterprises in managing complex and diverse project portfolios. Primavera allows users to develop complete project plans and schedules, including job dependencies, and resource allocation.
6.	Auto-Desk BIM 360	Autodesk BIM 360 is an Autodesk cloud-based construction project management software platform. Building Information Modeling (BIM) is an abbreviation for Building Information Modeling, and BIM 360 is intended to promote collaboration, expedite workflows, and improve project outcomes in the construction and architecture industries.
7.	IESVE	The Integrated Environmental Solutions Virtual Environment (IESVE) is a software platform used in the architecture, engineering, and construction (AEC) industry for building performance study and simulation. IESVE is used to run sophisticated energy simulations for buildings, assisting in the prediction and optimization of energy usage and costs.
8.	Virtual Reality	Virtual Reality is used by architects, engineers, and designers to generate immersive 3D models and walkthroughs of architectural designs. By viewing the construction processes and spotting potential cost-saving possibilities or obstacles, Virtual Reality can help with more accurate cost estimation.
9.	Acumen Fuse	Acumen Fuse is a Deltek Acumen software application used in project management and scheduling for a variety of industries, including construction, engineering, and aerospace. It is intended to study and evaluate project schedules for accuracy, risk, and adherence to industry standards.
10.	P6 Scheduler	P6 Scheduler is widely used in the construction, engineering, and other industries for project management and scheduling. P6 Scheduler is well-known for its powerful capabilities in project planning, management, and execution, particularly for big and complicated projects.
11.	CostOS	CostOS is a construction estimating software developed by Exactal. It was developed to help construction professionals including contractors, estimators, and quantity surveyors accurately estimate project costs. CostOS has a number of tools and features that help to speed up the estimate process and increase cost estimation accuracy.
12.	Cleopatra	Cleopatra Enterprise, also known as "Cleopatra," is a software program for managing project costs that was designed by Cost Engineering Consultancy. It is aimed at helping companies in a variety of industries, including manufacturing, engineering, oil and gas, construction, and cost management.
13.	OpenSpace	The digital platform called OpenSpace was created specifically for real estate and the construction industries. 360-degree cameras and artificial intelligence (AI) are used to record and document the development of construction projects. OpenSpace's visual tracking and documentation features are its main selling points.

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Table 1: Artificial Intelligence (AI) tools and functions (Cont'd)

S/N	AI Tools	Functions
14.	Struction Site	The technological platform StructionSite was created specifically for the construction sector. Through the use of 360-degree cameras and software solutions, it specializes in the documentation of construction sites and project management. To improve project documentation and communication, StructionSite focuses primarily on collecting and maintaining visual data.
15.	ContractWorks	ContractWorks is a contract management software platform created to help construction organizations to effectively manage and track their contracts throughout the contract lifecycle. ContractWorks maintains a centralized location for all contracts, making it simple to access, organize, and search for contract documents.
16.	Conga	Conga is a software company that offers document generation, contract lifecycle management, and digital transformation solutions. These products are intended to assist enterprises in streamlining document-related procedures, increasing productivity, and improving customer experiences.
17.	Robotic Bricklayer e.g., SAM100	A robotic bricklayer, also known as a bricklaying robot or a bricklaying machine, is a type of construction automation technology that automates the process of laying bricks or other masonry materials in building projects. Robotics and automation are used in these machines to improve the efficiency and precision of bricklaying processes.
18.	Robotic Excavators e.g., Volvo ECR25	Robotic excavators, also known as autonomous excavators or robot excavators, are pieces of heavy construction equipment that operate automatically or semi-autonomously, without the need for direct human intervention. These machines are outfitted with cutting-edge technologies and sensors that allow them to conduct excavation and earthmoving jobs with pinpoint accuracy and efficiency.
19.	Robotic Pavers	Robotic pavers, also known as autonomous or robot pavers, are specialized construction robots outfitted with automation technologies and sensors to automate the process of spreading asphalt or concrete pavement in road building and paving operations. These machines can conduct repetitive paving activities with accuracy and efficiency.
20.	Autonomous Compactors	Autonomous compactors, also known as self-driving or robotic compactors, are specialized construction machines equipped with automation technologies and sensors that automate the compacting of soil, asphalt, or other materials in construction and road-building operations.
21.	Internet of Things (IoT)	The Internet of Things (IoT) is a network of physical objects or "things" equipped with sensors, software, and connectivity that enable them to collect and share data with other devices and systems via the internet.
22.	Drones	Drones are commonly utilized in the construction industry for site surveying and mapping. They can build precise 3D models and topographic maps of construction sites rapidly and accurately. This information assists project planning by allowing contractors to detect prospective problems and plan accordingly.
23.	Sensors	Sensors are critical in the construction industry as they provide real-time data and enable automation and control operations. These sensors monitor many aspects of building projects to ensure safety, efficiency, and accuracy. On building sites, sensors monitor environmental conditions. Temperature, humidity, air quality, and noise levels are all monitored by sensors. Sensor contributes to workers safety and environmental compliance.

Source: Synthesis of previous studies

1.3 Challenges of Artificial Intelligence (AI) Technologies

Bughin, et al. (2019) averred that artificial intelligence (AI) has caused a significant increase in revenue and a reduction in costs, especially among users who have adopted AI in multiple business activities. Cubric (2020) further noted that to realize the unprecedented potential of AI for economic growth, it is important to understand the drivers and barriers to the adoption and implementation of these technologies in the

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construction and project management domain. Several sources as indicated in Table 2 have confirmed there are barriers to the adoption and implementation of AI (Abioye et al., 2021; Babic, 2021; Singh and Singh, 2023).

Table 2: Challenges of implementing AI technologies

S/N	Barriers to Implementation	Authors
1	Resistance to Change	Babic (2021)
2	Skill Shortage	Abioye et al. (2021)
3	Risk of Job Displacement	Chattopadhyay (2022)
4	Regulatory Compliance	Chattopadhyay (2022)
5	Infrastructure Limitations	Singh and Singh (2020)
6	High Initial Cost	Chattopadhyay (2022)
7	Data Privacy and Security Concerns	Corbett (2023)
8	Compatibility with Existing Systems	Abioye et al. (2021)
9	Limited Awareness and Education	Cubric (2020)
10	Ethical Considerations	Abioye et al. (2021)
11	Data Availability and Quality	Singh and Singh (2020)
12	Reliability and Accuracy	Babic (2021)
13	Limited Customization	Corbett (2023)

Source: Synthesis of previous studies

1.4 Benefits of Artificial Intelligence (AI) Technologies

Artificial intelligence (AI) is a powerful technology with a range of capabilities, which are beginning to become apparent in all industries in recent times (Kulkarni, 2017). Artificial intelligence (AI) is certain to be one of the inquiries in managing projects as it will aid in higher and faster productivity and efficiency. Highlighted in Table 3 are some of the benefits offered by artificial intelligence (AI).

Table 3: Benefits of AI technologies

S/N	Benefits of AI Technologies	Authors
1	Quality Control	Kulkarni (2017)
2	Increased efficiency and productivity	Mistri (2015)
3	Faster project delivery	Yaseen (2021)
4	Site and material management	Kulkarni (2017)
5	Streamlined Communication	Mammen et al. (2016)
6	Improved Project Planning	Yaseen (2021)
7	Better data collection and predictive analysis	Baker et al. (2020); Yaseen (2020)
8	Surveillance and mapping	Mammen et al. (2016)
9	Competitive Advantage	Hatoum (2020)
10	Improved project monitoring and progress tracking	Ditria et al. (2022)
11	Real-Time Monitoring	Mammen et al. (2016)
12	Better safety and risk management	Arabshahi et al. (2021)
13	Sustainable Practices	Arabshahi et al. (2021)
14	Enhances precision and accuracy	Hatoum (2020)
15	Cost Reduction	Hatoum (2020)

Source: Synthesis of previous studies

2.0 Materials and Methods

This study's major focus group consists of construction professionals in Benin City, Edo State. They include experts like; Architects, Builders, Engineers, and Quantity Surveyors who work on and manage projects for numerous firms operating in Benin City. As shown in Table 1, 2 and 3 the variables were obtained from previous studies and it was further edited to prevent duplications. A questionnaire containing the variables as well as request for demographic data of the respondents was sent to construction professionals in Benin City, Edo State. Respondents were first asked to indicate their level of adoption of the prevailing AI technologies on a Likert scale of 1-5, where 1 = Very low, 2 =Low, 3 = Average, 4 = High, 5 = Very high, the frequencies of use of the numerous AI technologies were grouped into always (>80%), often (>60≤80%), average (>40≤60%), sometimes (>20≤40%), and seldom (≤20%), and also to assess the important of the challenges and benefits of implementing AI technologies on a Likert scale of 1-Not significant at all, 2-Insignificant, 3-Neutral, 4-Significant, 5-Very significant. The study further set a boundary mean score value of 3.50 based on the Likert scale of 5 as established in previous studies (Okorie and Olanrewaju, 2019;

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Olanrewaju et al., 2020). The levels of awareness of AI technologies were analysed using mean item score (MS) based on the respondents' views. Mean item score was calculated for each variable as follows:

$$ms = \frac{(n1 * 5) + (n2 * 4) + (n3 * 3) + (n4 * 2) + (n5 * 1)}{N}$$

Where:
n1 = the percentage of respondents who choose "Very low,"
n2 = the percentage of respondents who chose "Low,"
n3 = the percentage of respondents who chose "Average,"
n4 = the percentage of respondents who chose "High,"
n5 = the percentage of respondents who chose "Very high,"
MS = mean score and
N = total number of respondents

Purposive sampling was used to target 337 professionals (Table 4) from the general population who are currently engaged in construction and project management activities in the study area, and are up-to-date with their financial membership in their various associations. This was necessary to ensure appropriateness and representativeness of data collected for the purpose of analysis.

Table 4: Target population and sample size

S/N	Professionals	Population	Sample Size	Percentage (%)
1	Architects	183	65	19.28
2	Builders	46	22	6.53
3	Engineers	600	194	57.57
4	Quantity Surveyors	132	56	16.62
	Total	961	337	100.00

Source: Nigerian Institute of Architects, Nigerian Institute of Builders, Nigerian Society of Engineers, Nigerian Institute of Quantity Surveyors, Edo State Chapter, (2025)

Data were examined and analysed using Statistical Package for Social Sciences version 20 (SPSS 20). The analysis was based on 261 suitably filled copies of the questionnaire returned, out of the 337 copies sent out, representing 77.45% as shown in Table 5. Quantitative data was gathered and analysed to meet the study's objectives.

Table 5: Questionnaire response rate

Questionnaire	Questionnaires Administered	Percentage (%)	Questionnaires Retrieved	Percentage (%)
Self-administered	91	27.00	75	28.74
Google Forms	246	73.00	186	71.26
Total	337	100.00	261	100.00

3.0 Results and Discussion

Background information of respondents revealed most of them were Engineers (n = 107, 41%). It was also shown in Table 6 that all the respondents are graduates, while most of the respondents are members of their respective professional bodies. Similarly, the respondents have construction work experience of >11 years (n= 124, 47.5%). The research further explores the roles of construction professionals in managing projects with (n = 69, 26.2%) being project team members. The data in Table 6 implies that the respondents were qualified and adjudged knowledgeable enough to provide reliable opinions to the subject matter of the study.

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Table 6: Background information of respondents

Categories	Description	Frequency	Percentage (%)
Profession	Architects	51	19.7
	Builder	30	11.5
	Engineer	107	41.0
	Quantity surveyors	73	27.9
	Total	261	100
Highest Academic Qualification	PhD	24	9.0
	MSc	57	22.0
	PGD	13	5.0
	BSc/B.Tech.	104	40.0
	HND	63	24.0
	Total	261	100
Professional Qualification	Probationer	25	9.8
	NIOB	31	11.8
	NIA	51	19.7
	NIQS	56	21.3
	NSE	98	37.7
	Total	261	100
Years of Experience	20 years and above	4	1.6
	16 – 20 years	17	6.6
	11 – 15 years	124	47.5
	5 – 10 years	52	19.7
	Less than 5 years	64	24.6
	Total	261	100
Position/Role	Project management officer	25	9.8
	Project manager	51	19.7
	Site manager	56	21.3
	Other	60	23
	Project team member	69	26.2
	Total	261	100
Type of Projects Handled	Institutional	9	3.3
	Industrial	34	13.1
	Civil	34	13.1
	Residential	51	19.7
	> 2 listed above	133	50.8
	Total	261	100

3.1 Level of Adoption and Frequency of Use of AI Technologies

The results on Table 7 show the respondents level of adoption and frequency of use of AI tools in the construction industry. "Drones (MIS = 3.49)" ranked first among the AI tools adopted and always used for construction project management processes in Nigeria. "Sensors and Internet of Things (IoT)" ranked second and third with MIS = 3.39 and 3.38 while "Robotic pavers and Robotic excavators" ranked 4th and 5th on the adoption of AI tools with MIS = 3.36 and 3.31 respectively. Among the least ranked AI technologies are Struction site (MIS = 2.28), IESVE (MIS = 2.20) and Conga (MIS = 2.14). On the frequency of use of AI technologies, it was observed that Internet of Things was rated among the AI technologies as always in use in the construction industry, followed by Sensors, Drones and Robotic Pavers which is often used by construction professionals. The once seldom used are Acumen Fuse, Struction Site and IESVE.

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Table 7: Artificial Intelligence (AI) technologies

AI Technologies	Level of Adoption		Level of Use		Scale
	MIS	Rank	F	%	
Internet of Things (IoT)	3.49	1	261	100	ALWAYS
Sensors	3.39	2	200	77	OFTEN
Drones	3.38	3	198	76	OFTEN
Robotic Pavers	3.36	4	180	69	OFTEN
Robotic Excavators e.g., Volvo ECR25	3.31	5	150	57	AVERAGE
Autonomous Compactors	3.29	6	140	54	AVERAGE
Robotic Bricklayer e.g., SAM100	3.26	7	130	50	AVERAGE
Virtual Reality	2.91	8	125	48	AVERAGE
Auto-Desk Fusion 360	2.90	9	115	44	AVERAGE
Auto-Desk BIM 360	2.70	10	90	34	SOMETIMES
Cost OS	2.51	11	85	33	SOMETIMES
P6 Scheduler	2.42	12	85	33	SOMETIMES
Oracle Primavera	2.40	13	78	30	SOMETIMES
Cleopatra	2.39	14	78	30	SOMETIMES
OpenSpace	2.39	15	70	27	SOMETIMES
Procore	2.36	16	70	27	SOMETIMES
CES Selector	2.36	17	65	25	SOMETIMES
OptiStruct	2.36	18	60	23	SOMETIMES
ContractWorks	2.34	19	58	22	SOMETIMES
Acumen Fuse	2.30	20	50	19	SELDOM
Struction Site	2.28	21	40	15	SELDOM
Integrated Environmental Solutions Virtual Environment software (IESVE)	2.20	22	36	14	SELDOM
Conga	2.14	23	35	13	SELDOM

3.2 Challenges of Implementing AI Technologies for Construction Project Management

From Table 8, it can be deduced that the three most significant challenges thwarting the implementation of AI technologies are Resistance to Change, Skill Shortage, and Risk of Job Displacement with mean scores of 4.07 while the least are Data availability and quality, Reliability and accuracy and Limited customization with mean scores 3.87, 3.87 and 3.70 respectively.

Table 8: Challenges of implementing AI **technologies**

Challenges	MIS	Rank
Resistance to Change	4.07	1
Skill Shortage	4.07	1
Risk of Job Displacement	4.07	1
Regulatory Compliance	4.00	2
Infrastructure Limitations	3.97	3
High Initial Cost	3.95	4
Data Privacy and Security Concerns	3.93	5
Compatibility with Existing Systems	3.93	5
Limited Awareness and Education	3.91	6
Ethical Considerations	3.89	7
Data Availability and Quality	3.87	8
Reliability and Accuracy	3.87	8
Limited Customization	3.70	9

3.3 Benefits of Implementing AI Technologies

Table 9 contains the responses regarding the benefits of implementing AI technologies in construction project management practices in Edo State. Ranking 1st, 2nd and 3rd on the list are Quality Control, Increased efficiency and productivity and Faster project delivery with mean item score of 4.07, 4.05 and 4.05 respectively while the least benefits of the implementing AI technology for construction project management practices are Sustainable Practices, Enhances precision and accuracy and Cost Reduction with mean item scores of 3.87, 3.85 and 3.84 respectively.

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Table 9: Benefits of implementing AI technologies

Benefits	MIS	Rank
Quality Control	4.07	1
Increased efficiency and productivity	4.05	2
Faster project delivery	4.05	2
Site and material management	4.05	2
Streamlined Communication	4.03	3
Improved Project Planning	4.02	4
Better data collection and predictive analysis	4.02	4
Surveillance and mapping	3.98	5
Competitive Advantage	3.98	5
Improved project monitoring and progress tracking	3.97	6
Real-Time Monitoring	3.93	7
Better safety and risk management	3.90	8
Sustainable Practices	3.87	9
Enhances precision and accuracy	3.85	10
Cost Reduction	3.84	11

3.4 Discussion

It was observed in Table 7 that Internet of Things (IoT) and Sensors and Drone AI technologies ranked high in level of awareness and use among professionals in the construction industry. This is not surprising as projects require connectivity, computing capability and the ability to share data and information in real-time. In today's world, we almost cannot do without the internet. IoT is a system in which objects in the physical world can be connected by sensors, this validates (Ashton 2009). Internet of Things has become a popular term for describing scenarios in which Internet connectivity and computing capability extend to a variety of objects, devices, sensors, and everyday items. This was followed by sensors and drones as a result of the need to embrace digitization, remote working and rapidly improve technological capacity, especially with challenges of existing labor shortages. An example is the case of lockdown in many countries during the COVID-19 pandemic. Such improvements can be made possible when Artificial intelligence technologies are well adopted and implemented according to (Abioye et al., 2021). Despite the fact that these AI technologies ranked high, the mean values did go above the set boundary of 3.50 based on the Likert scale of 5 as established. Hence, revealed a low level of adoption among professionals for construction project management. This was in alignment with the studies of Okorie and Olanrewaju (2019) and Olanrewaju et al. (2020) which noted a very low response.

The least ranked tools the respondents know and couldn't make use of are Conga, IESVE, Struction site and Acumen Fuse which are mostly AI-enhanced construction project management software. This is due to lack of awareness and adequate skill/training for this software. The study of Ezeabasili, et al. (2021) corroborates findings in this study noting that failure in construction project delivery can be attributed to many risk events such as lack of latest technology trends, lack of experience and skill among construction professionals, inadequate budgeting, materials wastage and a list of others in construction processes. These problems could be addressed if AI technologies were adopted. Although the respondents indicated a relatively high level of understanding and knowledge of what AI tools are, they still showed a relatively average level of awareness of the listed AI technologies tailored for construction processes and a low level of use of these AI technologies.

The construction industry is one of the least digitized industries in the world and most stakeholders acknowledge the age-long culture of resistance to change (Abioye et al., 2021). The absence of adequate digital expertise and technological adoption within the construction industry has also been linked to cost inefficiencies, project delays, poor quality performance, uninformed decision-making and poor performance in terms of productivity, health and safety. The literature highlights several benefits and advantages of implementing AI technologies for construction processes these include increased efficiency and productivity surveillance and mapping, project monitoring and tracking, site and material management, enhanced precision and accuracy by automating construction site processes and safety and risk management (Kulkarni and Padmanabham 2017; Hatoum, 2020; Ditria et al., 2022)

The findings from the present study align with these recommendations as indicated by the high mean item scores assigned to these benefits in the survey. Artificial intelligence (AI) technology has in recent times aided in the pre-construction stage (planning, designing, scheduling), construction stage (construction processes) and post-construction stage of construction project management. AI technology can examine project specs, building codes, and historical data (Abioye et al, 2021). Consequently, the survey results validate

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the literature's recommendations that the management of construction projects gets insight and support into possible outcomes through the implementation of Artificial intelligence (AI) technologies as it helps to boost decision-making quality (Alshaikhi, 2016) for construction project management practice.

4.0 Conclusion

The study assessed the level of awareness, determined the frequency of use and investigated the challenges and benefits associated with the implementation AI technologies within construction project management in Benin City. It was observed from the findings in Table 7 that the most aware AI technologies are Internet of Things (IoT), Sensors and Drones in the decreasing order of magnitude. Furthermore, Internet of Things (IoT), Sensors, Drones and Robotic Pavers are the AI technologies always and often in use in most construction sectors in the studied area. However, Table 8 shows that the challenges for implementing AI technologies include, Resistance to Change, Skill Shortage and Risk of Job Displacement. And the benefits associated with implementing the AI technologies include, Quality Control, Increased efficiency and productivity, Faster project delivery. Based on the findings, the research study sheds light on critical insights regarding the current landscape of AI adoption within the construction sector in Benin City. Despite the promising potential and benefits of AI technologies to revolutionize project management processes, the study reveals several significant challenges that hinder widespread implementation. Key findings from the survey indicate a pervasive low awareness level of AI technologies, industry resistance, and a notable lack of innovation and acceptance of technological trends among construction stakeholders in Benin City. These findings underscore the urgent need for targeted interventions to facilitate the adoption and integration of AI solutions effectively.

5.0 Recommendations

In light of the analysis conducted in this study several recommendations emerge to further enhance the integration of AI technologies in construction project management within Benin City. Stakeholders, including government bodies, construction companies, and technology providers, should collaborate to invest in robust AI infrastructure tailored to the unique needs and challenges of the construction industry in Benin City. This investment should encompass both hardware and software solutions necessary for seamless AI integration. Recognizing the pivotal role of human capital in AI implementation, concerted efforts should be made to provide training and capacity-building programs for construction professionals in Benin City. These programs should focus on equipping individuals with the necessary skills and knowledge to effectively leverage AI technologies in project management processes. Establishing platforms for collaboration and knowledge sharing among stakeholders is essential to foster innovation and accelerate AI adoption in the construction sector. Forums, workshops, and networking events should be organized to facilitate the exchange of best practices, lessons learned, and innovative ideas about AI implementation. Policymakers should work in tandem with industry stakeholders to develop a regulatory framework and standards governing the ethical and responsible use of AI technologies in construction project management. Clear guidelines should be established to address concerns related to data privacy, security, and algorithmic bias, ensuring that AI technologies are deployed in a manner that aligns with societal values and norms. By adhering to these recommendations, stakeholders can navigate the complexities associated with AI implementation and unlock the full potential of AI technologies to revolutionize construction project management practices in Benin City. Embracing a collaborative, inclusive, and forward-thinking approach is paramount to realizing sustainable development goals and driving positive change in the construction industry.

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