Barriers to the Application of Artificial Intelligence Tools in Construction Project Monitoring and Supervision in Enugu State, Nigeria

by

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Abstract

The study identified the barriers to the application of artificial intelligence tools in construction project monitoring and supervision in Enugu State, Nigeria. The study adopted a descriptive survey. The study was carried out in the capital city of Enugu State, Nigeria. The population for the study was 250 which were made up of 95 building construction managers and 155 building construction site supervisors. The entire population was used as the sample size because it was manageable for the study. Structured questionnaire was developed by the researchers and used for data collection. The items were based on a rating scale Strongly Agree (SA), Agree (A), Undecided (UD), Disagree (D), Strongly Disagree (SD) with values of 5, 4, 3, 2, and 1 respectively. The instruments were face validated by three experts from the Department of Industrial Technical Education, University of Nigeria, Nsukka. The experts made some inputs that were integrated to improve the final copy of the instrument. Reliability of the study was determined using Cronbach Alpha. The instrument had a reliability coefficient of 0.78. Mean was used to answer the research questions while t-test will be used to test the hypothesis at a level of significance 0.05. The study recommends that it is necessary to arrange seminars, workshops, and conferences to enlighten these experts about the advantages of using AI tools on construction sites.

Keywords: Building Construction, Artificial Intelligence, Project Monitoring, and Project Supervision.

Introduction

The construction industry is a major contributor to the world economy. Construction industries have unique characteristics which also involves significant resources, making construction management and supervision often challenging and almost insurmountable for the human mind (Johnson & Babu, 2020). Construction project monitoring and supervision are distinct but related processes aimed at ensuring a project's successful completion. Monitoring is the act of observing and tracking project progress, while supervision involves actively guiding and overseeing the work to ensure adherence to plans and standards. According to Güngör, (2020), construction project monitoring involves tracking project progress, identifying potential problems, and assessing performance against planned schedules and budgets. Construction project monitoring also involves collecting data, analyzing project performance, and reporting on progress to stakeholders. On the other hand, Osunsanmi, Aigbavboa and Oke, (2018)described construction project supervision as the ability to guide and oversee the construction process, ensuring quality, safety, and compliance with project specifications. Construction project supervision also involves providing on-site guidance to contractors, inspecting work for quality, ensuring adherence to safety regulations, and coordinating with various stakeholders. The key responsibilities of construction project monitoring and supervision include: ensuring adherence to approved plans and specifications, monitoring the quality of work performed, ensuring compliance with safety regulations and best practices, managing project budgets and schedules, and coordinating with architects, engineers, contractors, and suppliers (Ajayi et al.,2020). Generally, projects worldwide consistently face issues related to delays, cost

overruns, rework, and low customer satisfaction. To address these challenges, the construction industry in the current era is increasingly leaning towards the use of industry 4.0 technology (Abioye et al., 2021). Innovations such as Digital Twin (DT), Building Information Modelling (BIM), Internet of Things (IoT), Smart Vision (SV) and Artificial Intelligence (AI), are rapidly advancing in the present era.

The application of Artificial Intelligence (AI) construction project monitoring and supervision is growing because of its ability to provide solutions in uncertain and complex situations.AI is the ability of a machine to mimic human behavior intelligently through the use of algorithms to solve difficult problems (Robinson, 2018). One of the main objectives of AI is to train machines to reason, plan, and process, perceive, move and manipulate things like humans, with a view to solving complex organizational or day-to-day challenges (Rao, Gaddam, Kurni& Saritha, 2021). AI consists of intelligent systems that use structured or unstructured data, to learn and imitate human behavior thereby making informed decisions (Salehi& Burgueño, 2018).AI is the generation of human-like intelligence that can learn; reason, plan, perceive, or process natural language in order to collate and organize information for use in an organization, or to perform a routine human task.AI has wide applicability in all sectors, and in construction project monitoring and supervision, it has been found to produce positive outcomes for social, environmental, and economic sustainability (Delgado et al. 2019). It also creates convenience, improves productivity, and adds value to a system (Eber, 2020). AI is also well suited for the construction industry because of the uniqueness and inherent complexities of the industry. For instance, projects in the industry are one-off, construction products are immobile, multiple stakeholders and regulatory agencies are involved, and work packages are fragmented. These features of the industry make the management of projects difficult and almost overwhelming to thehuman mind, and this limits the performance of the industry.Ikuabe, Aghimien, Aigbavboa and Oke, (2020) noted that many projects worldwide, in Nigeria and Enugu State still experience delays, cost overruns, rework, and low customer satisfaction, which negatively affect the performance of the construction industry globally. The use of AI in construction project monitoring and supervision can enhance the efficiency of construction processes and reduce waste and safety concerns. It can also improve the planning, design, monitoring process, and maintenance of construction facilities (Eber, 2020), thereby enhancing the overall performance and competitiveness of the industry.

In spite of the value-adding potentials of AI, its application in the construction project monitoring and supervision in Enugu State is still limited (Ezeokoli Onyia& Bert-Okonkwor, 2019). Lack of awareness and misconception of the concept of AI has been identified as one of the limitations to its use, especially in the construction project monitoring and supervision(Adegoke, 2022). For instance, Ikuabe et al., (2020) noted that only one-third of the people who come in contact with AI realize that they are actually using it. Hence, understanding of the artificial intelligence tools and the barriers to the application of AI tools will provide useful insights into the state of AI applications in the construction project monitoring and supervision in Enugu State, Nigeria.

Statement of the Problem

AI has wide applicability in all sectors. In construction project monitoring and supervision, it has been found to produce positive outcomes for social, environmental, and economic sustainability. It also creates convenience, improves productivity, and adds value to a system. AI is also well suited for the

construction industry because of the uniqueness and inherent complexities of the industry as projects in the industry are one-off, construction products are immobile, multiple stakeholders and regulatory agencies are involved, and work packages are fragmented. These features of the industry make the management of projects difficult and almost overwhelming to the human mind, and this limits the performance of the industry.

Studies revealed that many projects worldwide, in Nigeria and Enugu State still experience delays, cost overruns, rework, and low customer satisfaction, which negatively affect the performance of the construction industry globally. The use of AI in construction project monitoring and supervision can enhance the efficiency of construction processes and reduce waste and safety concerns. It can also improve the planning, design, monitoring process, and maintenance of construction facilities, thereby enhancing the overall performance and competitiveness of the industry. However, in spite of the value-adding potentials of AI, its application in the construction project monitoring and supervision in Enugu State is still limited. Lack of awareness and misconception of the concept of AI has been identified as one of the limitations to its use, especially in the construction project monitoring and supervision. Studies reveal that only one-third of the people who come in contact with AI realize that they are actually using it. The understanding of the artificial intelligence tools and the barriers to the application of AI could provide useful insights into the state of AI applications in the construction project monitoring and supervision in Enugu State, Nigeria.

Purpose of the study

The overall objective of the study is to identify the barriers to the application of artificial intelligence tools in construction project monitoring and supervision in Enugu State, Nigeria. There were two specific Objectives that guided this study which are:

1. To identify the artificial intelligence tools that could be applied for construction project monitoring and supervision in Enugu State, Nigeria.
2. To identify the barriers to the application ofartificial intelligence tools in construction project monitoring and supervision in Enugu State, Nigeria.

Research Questions

The following research questions are posed to guide the study

1. What are the artificial intelligence tools that could be applied for construction project monitoring and supervision in Enugu State, Nigeria?
2. What are the barriers to the application of artificial intelligence tools in construction project monitoring and supervision in Enugu State, Nigeria?

Hypothesis

The following hypothesis guided the study:

1. There is no mean difference between the responses of building construction managers and building construction site supervisors on the artificial intelligence tools that could be applied for construction project monitoring and supervision in Enugu State, Nigeria.
2. There is no mean difference between the responses of building construction managers and building construction site supervisors on the barriers to the application of artificial intelligence tools in construction project monitoring and supervision in Enugu State, Nigeria.

Methodology

The study adopted a descriptive survey. The study was conducted in the Capital city of Enugu State (or Enugu metropolis town). The population for the study is 250 which were made up of 95Building Construction Managers and 155Building Construction Site Supervisors. Since the numbers of the respondents are not too large,

the entire population was used because it was manageable for the study. Structured questionnaire was developed by the researchers and used for data collection. The questionnaire was divided into two groups, Section A and Section B. Section A contains items that sought demographic information from the Building Construction Managers and Building Construction Site Supervisors. Section B consists of a total of 20 items, Cluster A sought the artificial intelligence tools that could be applied for construction project monitoring and supervision in Enugu State, Nigeria while Cluster B sought the barriers to the application of artificial intelligence in construction project monitoring and supervision in Enugu State, Nigeria. The items were based on a rating scale Strongly Agree (SA), Agree (A), Undecided (UD), Disagree (D), Strongly Disagree (SD) with values of 5,4, 3, 2, and 1 respectively. The instruments were face validated by three experts from the Department of Industrial Technical Education, University of Nigeria, Nsukka. The experts made some inputs that were integrated to improve the final copy of the instrument.

Reliability of the study was determined using Cronbach Alpha, the instruments were trial tested on 10 Building Construction Managers and 15 Building Construction Site Supervisors in Awka, Anambra State which were not part of the population but share similar characteristics. The instrument had a reliability coefficient of 0.78. The data was collected by administering the questionnaire directly on the respondents by the researchers and five researcher assistants. A data analysis was carried out using SPSS 22.0 as statistical package. The statistical tools employed were, Cronbach alpha, Mean and t-test. Mean was used to answer the research questions while t-test will be used to test the hypothesis at a level of significance 0.05. Any item with mean value of 3.50 and above implies Agree while any item with a mean below 3.50 was considered not Disagree. For the test of significance, the probability (p) value was used in comparison with the alpha value of .05, and at other relevant levels. If any item has a probability value greater than .05 ($P>0.05$) it will be concluded that there is no significant difference in the mean responses of the respondents.

RESULTS

Table 1

Mean and t-test analysis of building construction managers and building construction site supervisors on the artificial intelligence tools that could be applied for construction project monitoring and supervision N=250

S/N	Items Statements	Construction Managers		Site Supervisors					
		X	SD	X	SD	Decision	t-cal	Sig	H_0
1	Drones equipped with cameras and sensors can capture aerial views of the construction site, providing a bird's-eye perspective on progress.	3.66	0.87	3.88	0.77	Agree	0.82	0.69	NS
2	AI algorithms can analyze the captured images via Image Recognition tools to identify completed tasks, track the progress of specific elements, and detect deviations from the project schedule.	3.63	0.75	3.63	0.71	Agree	0.85	0.10	NS
3	AI-powered robots can assist with tasks such as material handling, welding, and concrete pouring, improving efficiency and reducing labor costs.	3.67	0.87	3.60	0.81	Agree	0.81	0.99	NS
4	Wearable Technology and Sensor devices worn by construction workers can monitor their safety and health, including detecting falls, near misses, and exposure to hazardous materials.	3.71	0.81	3.73	0.82	Agree	0.85	0.56	NS
5	Data Analysis and Reporting tools/systems can generate real-time reports on project progress, allowing for informed decision-making and prompt adjustments.	3.84	0.86	3.63	0.82	Agree	0.82	0.06	NS
6	AI algorithms can analyze data from Real-time Alerts devices to provide immediate alerts to supervisors about potential safety hazards, enabling swift intervention.	4.53	0.71	4.02	0.74	Agree	0.83	0.32	NS
7	AI can analyze historical accident data and identify patterns via Predictive Analytics tools to predict potential safety risks, allowing for preventative measures.	3.82	0.81	3.79	0.77	Agree	0.83	0.08	NS
8	AI can be used to predict project outcomes, identify potential risks, and analyze the impact of different scenarios on the project timeline and budget via Machine Learning Algorithms tools.	4.56	1.07	4.51	1.01	Agree	0.89	0.08	NS
9	Via early warning systems, AI can provide early warnings about potential issues, such as delays, material shortages, or changes in weather conditions, allowing for proactive adjustments.	3.66	0.87	3.62	0.83	Agree	0.83	0.10	NS
10	Throughresource optimization tools, AI can help optimize resource allocation, reduce material waste, and improve the overall efficiency of the construction process.	3.63	0.75	3.62	0.72	Agree	1.83	0.11	NS
	Cluster	**3.67**	**0.77**	**3.67**	**0.76**		**1.88**	**0.16**	

Note; X = Grand Mean, SD= Standard Deviation, H_0 = null hypothesis, NS = not significant, SA = strongly agree, A = agree, U= undecided, D = disagree, SD = strongly disagree

Data presented in Table 1 show Mean and t-test analysis of building construction managers and building construction site supervisors on the artificial intelligence tools that could be applied for construction project monitoring and supervision in Enugu State,

Nigeria. The table revealed that all the items had their mean values which are above the cut-off point of 3.50.This implies that the respondents agreed that the items are artificial intelligence tools that could be applied for construction project monitoring and supervision. Table 1 also shows that all the 10 items had their significant value to be greater than .05 (P>0.05). This indicated that, there was no significant difference between the mean responses of building construction managers and building construction site supervisors on the artificial intelligence tools that could be applied for construction project monitoring and supervision in Enugu State, Nigeria, therefore the hypothesis which stated that there is no significant difference in the mean responses of building construction managers and building construction site supervisors on the artificial intelligence tools that could be applied for construction project monitoring and supervision in Enugu State, Nigeria was accepted.

Table 2

Mean and t-test analysis of the building construction managers and building construction site supervisors on the barriers to the application of artificial intelligence tools in construction project monitoring and supervision N = 250

S/N	Items Statements	Construction Managers		Site Supervisors					
		X	SD	X	SD	Decision	t-cal	Sig	H_0
1	Higher Initial Costs leading to expensive implementation.	3.78	0.59	3.71	0.52	Agree	0.53	0.55	NS
2	Ethical, moral, and legal issues that are yet to be addressed by the government or institutional bodies.	4.28	0.81	4.21	0.72	Agree	0.51	0.30	NS
3	Difficulties in adapting to change	3.72	0.60	3.75	0.62	Agree	0.58	0.31	NS
4	Limited availability of the right digital skills and capabilities in AI.	3.52	0.62	3.55	0.66	Agree	0.59	0.47	NS
5	Shortage of trained personnel in AI	3.57	0.88	3.54	0.82	Agree	0.50	0.86	NS
6	Lack of awareness on adoption of AI in Construction	3.79	0.76	3.73	0.72	Agree	0.51	0.08	NS
7	Resistance to technology by stakeholders leading to Fear of employees losing job.	4.26	0.76	4. 20	0.73	Agree	0.53	0.32	NS
8	Training and Knowledge Barrier.	4.92	0.82	4.83	0.83	Agree	0.53	0.46	NS
9	Intellectual property protection and security issues.	4.86	0.75	4.83	0.76	Agree	0.51	0.31	NS
10	Maintenance and repair costs	4.60	0.69	4.63	0.61	Agree	0.58	0.10	NS
	Cluster	**4.78**	**0.76**	**4.71**	**0.72**		**0.52**	**0.44**	

Note; X = Grand Mean, SD= Standard deviation, H_0 = Null Hypothesis, NS = not significant, SA = strongly agree, A = Agree, U= undecided, D = disagree, SD = strongly disagree

Table 2 shows the Mean and t-test analysis of the building construction managers and building construction site supervisors on the barriers to the application of artificial intelligence tools in construction project monitoring and supervision in Enugu State, Nigeria. Data presented in Table 2 shows that all the items had their mean values above the cut-off point of 3.50, which implies that the respondents agreed that the items are the barriers to the application of artificial intelligence in construction project monitoring and supervision. Table 2 also shows that all the 10 items had their significant value to be greater than .05 (P>0.05). This indicated that, there was no significant difference between

the mean responses of building construction managers and building construction site supervisors on the barriers to the application of artificial intelligence tools in construction project monitoring and, therefore the hypothesis which stated that there is no significant difference in the mean responses of building construction managers and building construction site supervisors on the barriers to the application of artificial intelligence tools in construction project monitoring and supervision in Enugu State, Nigeria was accepted.

Discussion of Findings

The data presented in Table 1 revealed the artificial intelligence tools that could be applied for construction project monitoring and supervision in Enugu State, Nigeria. The findings are in line with Olurufemi, (2023) who supported by saying that subfields of AI such as machine learning, natural language processing, robotics, computer vision, optimization, automated planning and scheduling, have been applied to tackle complex problems and support decision making for real-world problem. Also, Egwim et al.,(2021) stated that construction sites constantly transform and incorporate new technologies to become smarter working environments. Internet of things (IoT) sensors and other AI tools are becoming more apparent on sites to generate valuation data. The use of AI can structure the data generated and analyze the data to optimize site performance in all key areas such as planning, design, safety, quality, scheduling, and costs

The result in Table 2 revealed the barriers to the application of artificial intelligence tools in construction project monitoring and supervision in Enugu State, Nigeria. This is in line with Yang et al., (2023) who stated that construction sites are constantly changing and require AI to learn and adapt to these new environments. Traditional methods are prioritized over un-trusted technologies due to the risk associated with construction, as mistakes can lead to high financial implications. The disjointed nature of the construction industry makes it difficult to change. Successful transition from traditional to future models requires compatible design, management, labour practices, and site operation practices. Consequently, as construction is performed and requires multi-point responsibility from different project disciplines, individual organizations control construction phases. It is difficult for AI technologies to be effective without these disciplines sharing common interests throughout the project cycle. Schonbeck (2020) also stated that despite the improvement in AI security, it can still be targeted by cyber criminals. This is a critical issue, as it can have financial implications and comprise the safety of construction works. For example, a computer vision system can be hacked to mislabel a construction worker working at height. Construction companies will need to implement machine learning (ML) techniques that reduce the exposure of high-level sensitive data

Conclusion

The study identified barriers to the application of artificial intelligence tools in construction project monitoring and supervision in Enugu State, Nigeria. The study identified some of the artificial intelligence tools that could be applied for construction project monitoring and supervision and barriers to the application of artificial intelligence in construction project monitoring and supervision in Enugu State, Nigeria.

Recommendations

From the results, discussions and conclusions made. The following recommendations are made:

1. The majority of construction professionals in Enugu State have insufficient knowledge about the use of AI tools for construction project monitoring and supervision. It is necessary to arrange seminars, workshops, and conferences to

enlighten these experts about the advantages of using AI tools on construction sites.

2. There is need for government and private sector collaboration in the Nigerian construction industry as this will help reduce the high cost associated with adoption of AI in construction project monitoring and supervision.

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