BAYERO UNIVERSITY, KANO, KANO STATE, NIGERIA

Proceedings of the Academic Conference of Sub-Sahara African Academic Research Publications on African Potentials for Sustainable Development in the 21st Century: Multi-disciplinary Approach Vol. 29 No. 3 on the 29th December, 2023

PROCEEDINGS

ON THE

AFRICAN POTENTIALS FOR SUSTAINABLE DEVELOPMENT IN THE 21ST CENTURY: MULTI-DISCIPLINARY APPROACH

THEME

UNLOCKING SUB-SAHHARA AFRICAN POTENTIALS FOR SUSTAINABLE DEVELOPMENT IN 21ST CENTURY: MULTI-DISCIPLINARY APPROACH.

DATE:

DECEMBER, 29TH 2023

VENUE:

BAYERO UNIVERSITY, KANO, KANO STATE, NIGERIA, WEST-AFRICA.

PROCEEDINGS

ON THE AFRICAN POTENTIALS FOR SUSTAINABLE DEVELOPMENT IN THE 21ST CENTURY: MULTI-DISCIPLINARY APPROACH

THEME
UNLOCKING SUB-SAHHARA AFRICAN POTENTIALS FOR SUSTAINABLE DEVELOPMENT IN 21ST CENTURY: MULTI-DISCIPLINARY APPROACH.

SUB THEME:

- Pure and Applied Science
- Medical and Pharmaceutical Sciences
- Engineering
- Environmental
- Humanities and Social Sciences
- Management Science & Entrepreneurship

BUK KANO-2023
BAYERO UNIVERSITY, KANO, KANO STATE, NIGERIA
Proceedings of the Academic Conference of Sub-Sahara African Academic Research Publications on African Potentials for Sustainable Development in the 21st Century: Multi-disciplinary Approach Vol. 29 No. 3, 29th December, 2023

APPRAISING THE BENEFITS AND CHALLENGES OF IMPLEMENTING ARTIFICIAL INTELLIGENCE IN THE NIGERIAN CONSTRUCTION INDUSTRY.

NKOLLO, O. W.; & SAIDU, I.
Department of Quantity Surveying, Federal University of Technology, Minna, Nigeria

ABSTRACT
The construction industry is currently experiencing a transformation from traditional, hierarchically organised construction sites to digital and more autonomous ones. A shift is taking place, and the development of digital is advancing so fast that the industry struggles to keep up. In view of this, the study was aimed at appraising the benefits and challenges of implementing artificial intelligence in the Nigerian construction industry. The study adopted a mixed-methods research design that combined both quantitative and qualitative research approaches. The research population for the quantitative data was the 255 construction firms registered with the Abuja Business Directory. Out of which, a sample size of 150 was obtained. While the population for the qualitative data were construction professionals domiciled in Abuja, using the simple random sampling method, the collected data from the questionnaire were analysed using the mean item score (RII), and the qualitative analysis was done using interviews and analysis carried out using deductive analysis. The study revealed that 46.7% of the sampled professionals were not aware of the implementation of AI in industry. The findings revealed the most important benefit of artificial intelligence (AI) implementation in the construction industry is "job creation" (MIS = 4.55). The findings revealed the most significant challenges faced in the implementation of artificial intelligence (AI) in the construction industry: "AI technologies require high initial costs to obtain accurate data" (MIS = 4.60). It was therefore concluded that the application of AI tools would significantly improve practices on construction sites in Abuja. There is therefore a need for construction firms to embrace the use of AI tools to improve the safety performance and practices of their employees. It was recommended that the majority of construction professionals have insufficient knowledge about the use of AI tools at building sites. Consequently, it is necessary to arrange seminars, workshops, and conferences to enlighten these experts about the advantages of using AI tools on construction sites.

Keywords: *Assessment, Artificial Intelligence, Construction Industry, Implementation*

Introduction

The construction sector has a crucial role in improving the economy of countries (Vorakulpipat *et al.*, 2010). However, rapid advances in digital technology are redefining the world today (De Almeida *et al.*, 2016). The construction industry is currently experiencing transformation from traditional, hierarchically organized construction sites to digital and more autonomous ones. A shift is taking place, and the development of the digital is advancing so fast that the industry struggles to keep up (Harty *et al.*, 2015). Although the construction industry is claimed to be digitized and with a low productivity development compared to other industries, however, the right implementation of digitization will increase efficiency of the building process (Barbosa et al., 2017). Thus, more advance technology such as Artificial Intelligence (AI) is now entering the industry (Schia et al., 2019). This is confirmed by Mohamed et al. (2021) that the world is embracing the rise of use of Artificial Intelligence (AI) as a fundamental shift in the construction industry.

Artificial Intelligence (AI) has been studied for decades and is still one of the most challenging subjects in digital computer (Robinson, 2018). Artificial Intelligence (AI) models have evidenced their capacity to solve dynamic, uncertain and complex tasks (Yaseen et al., 2020). However, according to Robinson (2018), AI is taking the world by storm, considering the application of its innovative uses across all industry segments. AI makes it possible for machines to learn from experience, adjust to new inputs and perform human-like tasks. Examples are computers learning to play chess or Jeopardy using AI, for intelligent assistants (Siri; Alexa) or for self-driving cars (Prieto, 2019). AI can automate several operations and increase the efficiency of the building process (Salehi and Burgueño, 2018). AI could help to enhance the project quality within the project duration, cost and design by emerging the latest technology in the construction industry (Mohamed, *et al.*, 2021).

The adoption of AI techniques has helped to enhance automated and provide better competitive advantages as compared to conventional approaches (Chien *et al.*, 2020). The subfields of AI such as machine learning, natural language processing, robotics, computer vision, optimisation, automated planning and scheduling, have been applied to tackle complex problems and support decision-making for real-world problems (Rao *et al.*, 2021).

Thus, according to Ezeokoli *et al.* (2019), the application of digital technologies skills and its transformation in the study area is still at foundation level. However, 63% of construction professionals are satisfied with their firm's readiness to digital transformation. This affirms the study of Bolton (2018), who confirms the implementation of AI as a digital transformation.

It is evident that this AI revolution has led to significant process improvements, cost-efficiency, reduced production times, improved safety and helped to achieve firms' sustainability goals (Ajayi *et al.*, 2020). However, the construction industry is yet to reap significant benefit from AI despite its existing challenges (Abioye *et al.*, 2021). Hence, this study focuses on appraising the benefits and challenges of implementing artificial intelligence in the Nigerian construction industry.

LITERATURE REVIEW

Benefits of Artificial Intelligence (AI) Implementation in the Construction Industry

There is a range of opportunities that new technologies bring to a construction project. It gives companies a competitive advantage by lowering costs and increasing efficiency. Adaptive manufacturing is a growing concept that introduces flexible machines capable of customizing part productions and enabling new cost-effective building methods (Delgago *et al.*, 2019). This new method leads to the potential modification of jobs by combining planning, design, and construction tasks. It is critical that users acknowledge the benefits and performance enhancement that AI may bring to a construction site to adopt new technologies into their projects effectively (Pillai *et al.*, 2020).

1. **Waste Management and Resources:** The amount of resource waste is growing rapidly on a yearly basis due to rapid development (Schonbeck *et al.*, 2019). Companies are becoming more waste aware and are implementing proactive data-driven approaches that minimize waste through analytics (Eber, 2020). Waste analytics is dependent on different sources of data, such as building design, material properties, and construction strategies. AI technologies are needed to turn information into relevant waste management strategies. These strategies include the optimization of offsite construction, material selection, reuse and recovery, waste-efficient procurement, deconstruction, and flexibility (Ajayi *et al.*, 2020).
2. **Estimation and Scheduling:** AI application models are important to accurately forecast construction costs and project timeline. Projects that do not have accurate costs and time estimation have large financial implications (Aparicio *et al.*, 2020).
3. **Construction Site Analytics:** Construction sites constantly transform and incorporate new technologies to become smarter working environments. IoT sensors and other digital technologies are becoming more apparent on sites to generate valuation data. A large volume of data is generated from construction sites and is mostly unstructured. The use of AI can structure the data generated and analyse the data to optimize site performance in all key areas such as planning, design, safety, quality, scheduling, and costs (Lin *et al.*, 2021).
4. **Job Creation:** Based on the literature review, construction jobs that require low to medium education are at a higher risk of becoming redundant. This is evident as, by 2030, 38–45% of these jobs will be completed by automated analytics or robotics (Araujo *et al.*, 2018).
5. **Supply Chain Management:** There are common supply chain management (SCM) issues evident in the construction industry. The SCM is a costly and complex process, and the lack of specific performance measurement frameworks, organization trust, and communication channels risks its success (Oyedele, 2017).
6. **Health and Safety:** Advanced analytics can reduce the risk of workplace accidents by using predictive analytics. The construction industry records a significant number of injuries compared to other industries (Winge *et al.*, 2019) and others.

SN	Benefits	Sources
7	Aim for Better Design Quality	Ellis, (2022); George and Newton, (2022).
8	Enhance Job Site Safety	Ellis, (2022); George and Newton, (2022).
9	Risk Assessment and Risk Reduction	Ellis, (2022); George and Newton, (2022).
10	Can be used in predicting building material properties	Doroshenko, (2020)
11	Are used to detect seismic signals caused by soil vibrations and earthquakes.	Doroshenko, (2020)

12	Construction Equipment Detection and Tracking	Boesch, (2023)
13	Managing and Maintaining Assets with Computer Vision	Boesch, (2023)
14	Controlling Quality with Automation	Boesch, (2023)
15	Analysing and Optimizing Processes	Wu et al., (2022)
16	Tracking and optimizing processes	Wu et al., (2022)
17	Help classify clauses as requirements or nonrequirements or as distinct categories (e.g., construction, design, operation, and maintenance).	Wu et al., (2022)
18	Help in predicting and classifying safety risks based on risk levels or types (such as environmental, financial, and political) is possible.	Wu et al., (2022)
19	Help in scheduling and Cost Management	Wu et al., (2022)
20	Help to evaluate incident severity, prioritise O&M actions, and provide advice for future infrastructure project	Wu et al., (2022)

Challenges Faced in the Implementation of Artificial Intelligence (AI) in the Construction Industry

The construction industry is behind manufacturing and transportation to adopt AI, as it is still in the initial conceptual phase of development (Bigham *et al.*, 2021). Technology challenges vary, depending on the project's size, labour and capital intensity, industry sector, technologies used for projects, and the types of firms that use the technology (Hager *et al*, 2016). According to Mohammadpour *et al.* (2018), a significant barrier for businesses to embrace AI is the complexity of tasks performed by analytics. This is potentially caused by the higher variability and volatility of construction sites and the urban environment. AI requires large amounts of data to train algorithms and identify patterns in which only a limited number of people can interpret data from these platforms, resulting in limited economies of scale, impeding innovation and digitalization (Paoletti *et al.*, 2016; Ribeiro *et al.*, 2016).

1. **Cultural Issues:** 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 (Nagendra *et al.*, 2018). 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 (Pan *et al.*, 2021; Hardie *et al.*, 2005). Therefore, it would be beneficial to take advantage of technologies such as blockchain to improve trust and transparency (Zavadskas *et al.*, 2010).
2. **Security:** 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 (Hasegawa *et al.*, 2006).
3. **Higher Initial Costs:** The benefits that AI may bring to a construction site are indisputable. However, AI technologies require high initial costs to obtain accurate data. This may be unaffordable for most subcontractors and small firms that make up most of the construction industry. The high upfront costs require a considerable financial commitment for R&D and application purposes, and these investments will be at increased risk and taking this risk in a highly competitive market. Small to medium-sized business firms cannot invest in system-level technology and thus cannot benefit from technological breakthroughs (Afzal *et al.*, 2017). In addition, there is a high cost of owning and using these AI technologies as they are not fully developed and need investment constantly to keep up to date with the advancement of the technology (Ali *et al.*, 2019). Therefore, it is imperative that firms determine the cost saving that AI may bring to a project and decide whether it is feasible. As AI in construction continues to expand and becomes more prevalent in construction, the process is expected to lower and become more affordable for smaller businesses.

involves professionals who are of different fields. The descriptive analysis was employed to analyze the data using descriptive tools which include: mean item score (MIS) and ranking methods.

Results and Discussion

Demographic Characteristics

Table 1 shows the demographic characteristics of respondents. As regards the professional background of the respondents, 48.0% were quantity surveyors with a majority, followed by engineers with 20.0%, architects with 13.3%, and builders with 8.6%, while others, such as safety officers, had a minority with 6.6%. The major professions in the Nigerian construction industry are well represented.

As regards educational qualification, 41.3% have a bachelor degree, 33.3% have a master degree, 18.6% have a Higher National Diploma (HND), 5.3% have a National Diploma, and 1.5% have a doctorate qualification. It was revealed that the respondents are adequately educated to provide meaningful information for this research.

For the professional qualifications, 40.0% of the respondents were MNIQS/QSRBN members, 22.0% had other professional qualifications such as HSE, MNITP/TOPREC, 16.6% were MNIOB/CORBON members, 11.4% were MNSE/COREN members, and 10.0% were MNIA/ARCON members.

In the case of years of experience, 3.3% of the respondents have above 20 years of working experience, 17.3% have 1–5 years of working experience, 20.7% have 11–15 years, 22.0% have 6–10 years of working experience, and 36.7% have working experience of 16–20 years. This implies that the respondents are well-equipped to provide valuable information for this research.

Regarding the level of awareness of the implementation of AI in industry, the majority (46.7%) were aware, 30.7% were moderately aware, and 12.7% were not aware, while the minority that constituted 9.9% were highly aware.

Table 1: Demographics Characteristics of Respondents

Variables		Frequency	Percentage (%)
Profession	Architect	20	13.3
	Builder	13	8.6
	Engineer	30	20.0
	Estate Surveyor	05	3.5
	Quantity Surveyor	72	48.0
	Others	10	6.6
	Total	**150**	**100.00**
Highest academic qualification	ND	8	5.3
	HND	28	18.6
	BSc/BTech	62	41.3
	MSc/MTech	50	33.3
	PhD	2	1.5
	Total	**150**	**100.00**
professional qualification	MNIA/ARCON	15	10.0
	MNIOB/CORBON	25	16.6
	MNSE/COREN	17	11.4
	MNIQS/QSRBN	60	40.0
	Others	33	22.0
	Total	**150**	**100.00**
Years of Experience	1 – 5 years	26	17.3
	6 – 10 years	33	22.0
	11 – 15 years	31	20.7
	16 – 20 years	55	36.7
	Above 20 years	5	3.3
	Total	**150**	**100.00**
Level Awareness of the implementation AI	Not aware	70	46.7
	Moderately Aware	46	30.7
	Aware	19	12.7
	Highly Aware	15	9.9
	Total	**150**	**100.00**

Results and Discussion on benefits of Artificial Intelligence (AI) Implementation in the Construction Industry

Table 2 Presents the result of the benefits of artificial intelligence (AI) implementation in the construction industry

Table 2: Results of Benefits of Artificial Intelligence (AI) Implementation in the Construction Industry

CODE	Safety Practices	MIS	RANK	DECISION
B3	Job Creation	4.55	1st	Very -Important
B1	Health and Safety	4.40	2nd	Very -Important
B2	Supply Chain Management	4.30	2nd	Very -Important
B4	Construction Site Analytics	4.25	4th	Very -Important
B5	Estimation and Scheduling	4.15	5th	Very -Important
B6	Waste Management and Resources	4.10	6th	Important
B7	Aim for Better Design Quality	4.00	7th	Important
B8	Enhance Job Site Safety	3.95	8th	Important
B9	Risk Assessment and Risk Reduction	3.90	9th	Important
B10	Can be used in predicting building material properties	3.90	9th	Important
B11	Are used to detect seismic signals caused by soil vibrations and earthquakes.	3.85	11th	Important
B12	Construction Equipment Detection and Tracking	3.80	12th	Important
B13	Managing and Maintaining Assets with Computer Vision	3.79	13th	Important
B14	Controlling Quality with Automation	3.75	14th	Important
B15	Analysing and Optimizing Processes	3.74	15th	Important
B16	Tracking and optimizing processes	3.73	16th	Important
B17	Help classify clauses as requirements or nonrequirements or as distinct categories (e.g., construction, design, operation, and maintenance).	3.70	17th	Important
B18	Help in predicting and classifying safety risks based on risk levels or types (such as environmental, financial, and political) is possible.	3.68	18th	Important
B19	Help in scheduling and Cost Management	3.65	19th	Important
B20	Help to evaluate incident severity, prioritise O&M actions, and provide advice for future infrastructure project	3.60	20th	Important
	Average MIS	*3.94*		*Important*

Table 2 reveals twenty (20) identified benefits of artificial intelligence (AI) implementation in the construction industry, which are all very important, with MIS ranging from 4.55 to 3.60. The most important benefit is "job creation" (MIS = 4.55), while the least important one is "Help to evaluate incident severity, prioritise O&M actions, and provide advice for future infrastructure project" (MIS = 3.60). The average MIS value shown is 3.94. This also reveals that all the identified benefits of artificial intelligence (AI) implementation in the construction industry are very important. This is in tandem with past studies from Delgago *et al.*, 2019; Pillai *et al.*, 2020; Schonbeck *et al.*, 2019; and Eber, 2020, which identified the benefits of artificial intelligence (AI) implementation to include: waste management and resources; estimation and scheduling; and job creation. Furthermore, AI has the possibility to resolve organisational trust and communication issues that have hindered the use of SCM in recent years. AI can detect potential issues and ensure efficient delivery by managing the entire supply chain (Ajayi *et al.*, 2017).

Results and Discussion on Challenges faced in the implementation of artificial intelligence (AI) in the construction industry

Table 3 gives a summary of the MIS results of the challenges faced in the implementation of artificial intelligence (AI) in the construction industry.

Table 3: Results of Challenges faced in the implementation of artificial intelligence (AI) in the construction industry

CODE	Challenges faced in the implementation of artificial intelligence (AI) in the construction industry	MIS	RANK	DECISION
C4	AI technologies require high initial costs to obtain accurate data	4.60	1st	Very Significant
C1	Traditional methods are prioritized over un-trusted technologies due to the risk associated with construction, as mistakes can lead to high financial implications	4.50	2nd	Very Significant
C7	The construction industry has created standards that make it difficult to share information between companies due to intellectual property issues	4.35	3rd	Significant

C2	Despite the improvement in AI security, it can still be targeted by cyber criminals.	4.20	4th	Significant
C5	The development of construction robots is technologically challenging due to the constantly changing environment of the construction process.	4.15	5th	Significant
C3	The work process is complex, non-repetitive, and depends on the weather, labour, and local building regulations	4.05	6th	Significant
C6	There is a solid institutional barrier in the construction industry, as technology may replace workers, resulting in higher unemployment rates	4.00	7th	Significant
C9	Negative social impact	3.99	8th	Significant
C8	Big data handling	3.95	9th	Significant
C10	Powerful computers and reliable internet access	3.90	10th	Significant
C11	Lack of talent	3.87	11th	Significant
C15	Learning from streaming data, dealing with high-dimensional data, scalability of models and distributed computing.	3.85	12th	Significant
C20	AI applications are highly specialized and need constant algorithms training to identify patterns.	3.80	13th	Significant
C18	The fragmented nature of the construction industry may result in data scarcity.	3.78	14th	Significant
C17	AI platforms need investment constantly to keep data up to date.	3.75	15th	Significant
C12	Implementation of AI requires businesses to move away from traditional ideas.	3.73	16th	Significant
C14	High impact on traditional skills and may impact job availability.	3.70	17th	Significant
C16	Non-standardization of a construction project makes it difficult to implement AI.	3.69	18th	Significant
C13	Ethical, moral, and legal issues that are yet to be addressed by the government or institutional bodies.	3.65	19th	Significant
C19	Multi-point responsibility between stakeholders may reduce accountability.	3.63	20th	Significant
	Average MIS	***3.94***		***Significant***

Table 3 reveals twenty (20) main challenges faced in the implementation of artificial intelligence (AI) in the construction industry. The two challenges are very significant. These range from "AI technologies require high initial costs to obtain accurate data" (MIS = 4.60) to "There is a solid institutional barrier in the construction industry, as technology may replace workers, resulting in higher unemployment rates" (MIS = 4.00). The remaining eighteen challenges are also significant. On average, all the identified challenges faced in the implementation of artificial intelligence (AI) in the construction industry (average MIS = 3.63) This finding, as supported by Ali *et al.* (2019), affirms that there is a high cost of owning and using these AI technologies, as they are not fully developed and require constant investment to keep up with the advancement of the technology. Consequently, non-standardisation hinders automation and robotics efficiency as it is difficult to control, and it also challenges maintaining these technologies in an unstructured environment (Taillandier *et al.*, 2015).

Conclusion And Recommendation

It is evident that this AI revolution has led to significant process improvements, cost-efficiency, reduced production times, improved safety, and helped to achieve firms' sustainability goals. However, the construction industry is yet to reap significant benefits from AI, despite its existing challenges. In view of this, the study assessed the implementation of artificial intelligence (AI) in the Nigerian construction industry with a view to enhancing AI employment in the construction industry. One hundred and fifty-six (156) questionnaires were administered to the research population, and one hundred and fifty (150) were retrieved, representing a response rate of 96%. The use of descriptive statistical techniques was employed for the analysis of the data. Findings from the data analyses carried out in the study led to the conclusions made in this section. Regarding the level of awareness of the implementation of AI in industry, the majority of the respondents were not aware.

The study revealed that the most important benefit is "job creation, while the least important one is "waste management and resources. The study revealed seven (7) main challenges faced in the implementation of artificial

intelligence (AI) in the construction industry. These range from "AI technologies require high initial costs to obtain accurate data" to "There is a solid institutional barrier in the construction industry, as technology may replace workers, resulting in higher unemployment rates." It can therefore be concluded that the application of AI tools would significantly improve practices on construction sites in Abuja. There is therefore a need for construction firms to embrace the use of AI tools to improve the safety performance and practices of their employees. It is recommended that the majority of construction professionals have insufficient knowledge about the use of AI tools at building sites. Consequently, it is necessary to arrange seminars, workshops, and conferences to enlighten these experts about the advantages of using AI tools on construction sites.

References

Abioye, S. O., Oyedele, L.O., Akanbi, L., Ajayi, A., Delgado, J. M. D., Bilal, M., Akinde, O. O., & Ahmed, A. (2021). Artificial intelligence in the construction industry: A review of present status, opportunities and future challenges. *Journal of Building Engineering 44 (2021) 103299*. https://doi.org/10.1016/j.jobe.2021.103299

Afzal, F., Yunfei, S., Nazir, M., & Bhatti, S.M. (2019). A review of artificial intelligence-based risk assessment methods for capturing complexity-risk interdependencies. *International Journal of Managing Projects in Business*. 14, 300-328.

Ajayi, A., Oyedele, L., Akinade, O., Bilal, M., Owolabi, H., Akanbi, L., & Delgado, J. M. D. (2020). Optimised big data analytics for health and safety hazards prediction in power infrastructure operations. Saf. Sci. 125 (2020), 104656.

Ali, T. H., Akhund, M. A., Memon, N. A., Memon, A. H., Imad, H. U., & Khahro, S. H. (2019). *Application of Artifical Intelligence in Construction Waste Management*. In: 2019 8th International Conference on Industrial Technology and Management (ICITM) (pp. 50-55). IEEE.

Araújo, C., Henriques, P. R., & Martini, R. G. (2018). Virtual Learning Spaces Creation Based on the Systematic Population of an Ontology. *Journal of Information Systems Engineering & Management*, 3(1), 07.

Aparicio, A., Ferriol-Galmés, M., Suárez-Varela, J., & Barlet-Ros, P. (2020). Applying graph-based deep learning to realistic network scenarios. *arXiv preprint arXiv:2010.06686*.

Barbosa, F., Woetzel, J., Mischke, J., Ribeirinho, M. J., Sridhar, M., Pearsons, M., Bertram, N., & Brown, S. (2017). "Reinventing construction: A route to higher productivity." *Reinventing construction: A route to higher productivity*, <https://www.mckinsey.com/~/media/mckinsey/industries/capital%20projects%20and%20infrastructure/our%20insights/reinventing%20construction%20through%20a%20productivity%20revolution/mgi-reinventing-construction-executivesummary. ashx> (Retrieved on February. 8, 2019).

Bello, S.A., Oyedele, L.O. , Akinade, O.O. , Bilal, M. , Delgado, J.M.D., Akanbi, L.A., Ajayi, A.O., Owolabi, H.A., (2021). Cloud computing in the construction industry: use cases, benefits, and challenges. Autom. ConStruct., 122 (2021), Article 103441.

Bigham, G. F., Adamtey, S., Onsarigo, L., & Jha, N. (2021). Artificial intelligence for construction safety: Mitigation of the risk of fall. In: Proceedings of SAI Intelligent Systems Conference (pp. 1024-1037). Springer, Cha

Bolton, C., Machová, V., Kovacova, M., & Valaskova, K. (2018). "The power of human machine collaboration: Artificial Intelligence, Business automation, and the smart economy." *Economics, Management and Financial Markets*, 13(4), 51-56.

Cai, S., Ma, Z., Skibniewski, M., Guo, J., & Yun, L. (2018). *Application of automation and robotics technology in high-rise building construction: an overview*. In: ISARC. Proceedings of the International Symposium on Automation and Robotics in Construction (Vol. 35, pp. 1-8). IAARC Publications.

Chien, C. D. -P. S., Huh, W., Jang, Y., & Morrison, J. (2020). Artificial intelligence in manufacturing and logistics systems: algorithms, applications, and case studies, *Publication Cover Int. J. Prod. Res.* 58 (9) 2730–2731.

Choi, M., & Francisco, S. (2017). Artificial Intelligence the Next Digital frontier? s.L,McKinsey and Company Global Institute, 2017.

De Almeida, P. R, Bühler, M., Gerbert, P., Castagnino, S., Rothballer, C., (Eds)., & Geneva, (2016). Shaping the future of construction: A breakthrough in mindset and technology, industry agenda prepared in collaboration with The Boston Consulting Group, *World Economic Forum; 2016*. Available: www.weforum.org.

Delgado, J. A., Short Jr, N. M., Roberts, D. P., & Vandenberg, B. (2019). Big data analysis for sustainable agriculture on a geospatial cloud framework. *Frontiers in Sustainable Food Systems*, 3, 54

Delgado, J.M.D., & Oyedele, L., (2021). Deep learning with small datasets: using autoencoders to address limited datasets in construction management, Appl. Soft Comput. 112 (2021), 107836.

Doroshenko, A. (2020). Applying Artificial Neural Networks In Construction. https://doi.org/10.1051/e3sconf/20

Eber W., Oesterreich T.D., & Teuteberg F. (2020). Potentials of artificial intelligence in construction management: organization technology management in construction. Organization Technology Management in Construction, 12 (1), 2218-2233.

Ellis, G. (2022). How Machine Learning Is Making Construction More Human. https://constructionblog.autodesk.com/machine-learning-construction/ Date accessed: 27.06.2023

Ezeokoli F. O., Onyia, C. I., & Bert-Okonkwor. C. B. N., (2019). State of Readiness of Nigerian Construction Industry towards Digital Transformation: The Construction Professionals' Perception. *Journal of Engineering Research and Reports* 4(2): 1-11, 2019; Article no.JERR.47343.

Gamil, Y., A. Abdullah, M., Abd Rahman, I., & Asad, M. M. (2020). Internet of things in construction industry revolution 4.0: Recent trends and challenges in the Malaysian context. Journal of Engineering, Design and Technology, 18(5), 1091–1102. https://doi.org/10.1108/JEDT-06-2019-0164

George J. Newton. (2022). 3 Ways Machine Learning Can Be Useful in Construction. https://www.probuilder.com/blog/ways-machine-learning-can-benefitconstruction-industry Date accessed: 27.06.2023

Glenn, D. I. (2013). Determining Sample size. Institute of Food and Agricultural Sciences (IFAS), University of Florida, Gainesville, FL 32611. Retrieved on June 3rd 2013 from edis.ifas.ufl.edu/pdffiles/PD/PD00600.pdf

Harty, J., Kouider, T., & Paterson, G. (2015). *Getting to Grips with BIM*. Routledge, London; New York.

Hager, I., Golonka, A., & Putanowicz, R. (2016). 3D printing of buildings and building components as the future of sustainable construction? *Procedia Engineering*, 151, 292-299.

Hardie, M., Miller, G., Manley, K., & McFallan, S. (2005). Experience with the management of technological innovations within the Australian construction industry. In: Technology Management.

Hasegawa, Y. (2006). Construction automation and robotics in the 21st century. In: 23rd International Symposium on Automation and Robotics in Construction.

Mohamed, M., Ahmad, A., & Mohamad, D. (2021). The implementation of artificial intelligence (AI) in the Malaysia construction industry. *AIP Conference Proceedings*. Vol. 2339.

Muhammadpour, A., Karas, İ., & Asadi, S. (2019). *Artificial intelligence techniques to support design and construction*. In ISARC. Proceedings of the International Symposium on Automation and Robotics in Construction, 36, 1282-1289.

Naser, M. Z. (2019). AI-based cognitive framework for evaluating response of concrete structures in extreme conditions. Engineering Applications of Artificial Intelligence, 81, 437-449.

Nagendra, S., & Rafi, N. (2018). Application of artificial intelligence in construction management. International Journal of Research in Engineering, Science, Management, 1, 1-3.

Patil, G. (2019). Applications of artificial intelligence in construction management. International Journal of Research in Engineering, IT & Social Sciences, 3, 21-28.

4. **Project Uniqueness:** Another challenge for the construction industry to implement AI technologies is that nearly every project is unique. The work process is complex, non-repetitive, and depends on the weather, labour, and local building regulations (Poh *et al.*, 2018). Consequently, non=standardization hinders automation and robotics efficiency, as it is difficult to control, and it also challenges maintaining these technologies in an unstructured environment (Taillandier *et al.*, 2015).
5. **Robotics:** The development of construction robots is technologically challenging due to the constantly changing environment of the construction process. Furthermore, these robots need to be robust, flexible, highly mobile, and versatile (Patil, 2019). As construction sites are an unstructured environment, robots must be reprogrammed according to conditions at each site when they move around the site (Han *et al.*, 2011). To overcome this challenge, the repetitive planning, design, and construction of buildings are needed to provide an organized operating and structured environment (Shukla *et al.*, 2019).
6. **Institutional Barrier:** There is a solid institutional barrier in the construction industry, as technology may replace workers, resulting in higher unemployment rates. Nevertheless, construction robotics can take a significant amount of time to set up and need constant monitoring by skilled workers (Ca *et al.*, 2018). Therefore, for an efficient transition to incorporate robotics on a construction site and become more ordinary, a new construction profession with a strong background with specific training in robotics, algorithms, and software needs to be created (Xin *et al.*, 2022).
7. **Information Sharing:** The construction industry has created standards that make it difficult to share information between companies due to intellectual property issues (Xin *et al.*, 2022). These companies have no framework to follow, and there is no guidance on implementing these technologies on sites (Mohammadpour *et al.*, 2018). There is also a concern about the security, reliable storage, efficiency, and interpretation of big data on sites (Na *et al.*, 2022).
8. **Negative Social Impact:** With the development of emerging AI technologies, society has significantly changed norms, dramatically transforming how construction industry stakeholders learn, work, communicate and use information. (Gamil *et al.*, 2020).
9. **Big Data Handling:** The complexity and lack of understanding of big data make it difficult for organizations to extract data required for specific functions. The selection of data is, therefore, inaccurate because it is extracted from big data; therefore, results or outputs may be incorrect due to the accuracy of the selection. Big data is, therefore, a complex and challenging issue. (Gamil *et al.*, 2020).
10. **Powerful Computers and Reliable Internet Access:** There is a lack of power, telecommunications, and internet connectivity at most construction sites. This is a severe problem for construction sites whose operations heavily depend on power supplies and internet connectivity, such as robots and site monitoring systems (Abioye *et al.*, 2021).
11. **Lack of Talent:** As a result of the many challenges facing the construction industry, it is challenging to find AI engineers with experience in the sector. AI engineers with the needed skills are currently in short supply (Chui and Fransico, 2017).
12. Learning from streaming data, dealing with high-dimensional data, scalability of models and distributed computing (Chein *et al.*, 2020).
13. The fragmented nature of the construction industry may result in data scarcity (Bello *et al.*, 2021).
14. AI platforms need investment constantly to keep data up to date (Young *et al.*, 2021).
15. Implementation of AI requires businesses to move away from traditional ideas (Delgado *et al.*, 2021).
16. Non-standardization of a construction project makes it difficult to implement AI (Bello *et al.*, 2021)
17. High impact on traditional skills and may impact job availability (bello et al., 2021).
18. Ethical, moral, and legal issues that are yet to be addressed by the government or institutional bodies (Young *et al.*, 2021).
19. Multi-point responsibility between stakeholders may reduce accountability (Delgado *et al.*, 2021)
20. AI applications are highly specialized and need constant algorithms training to identify patterns (Chui and Fransico, 2017).

METHODOLOGY

This research was adopted quantitative approach, that is both quantitative approach in the form of a well-structured questionnaire survey which will be assess professional's perceptions on the implementation of artificial intelligence (AI) in the Nigerian construction industry. The sample size of the study therefore amounted to 156 based on Glenn (2013) equation. Furthermore, to determine the sample size of AI professionals, census was used. For the questionnaire, the researcher adopted the stratified simple random technique. This is because the research

Pan, W., Chen, L., & Zhan, W. (2021). PESTEL analysis of construction productivity enhancement strategies: A case study of three economies. *Journal of Management in Engineering*, *37*(1), 05018013.

Paoletti, I., & Elza, M. (2016). Adaptive manufacturing: a new perspective for construction industry. In: Back to 4.0: rethinking the digital construction industry (pp. 341-350).

Pillai, R., DeBolt, C., & Sivathanu, B. (2020). Adoption of AI-based chatbots for hospitality and tourism. *International Journal of Contemporary Hospitality Management*, *32*(10), 3199-3226.

Poh, C. Q., Ubeynarayana, C. U., & Goh, Y. M. (2018). Safety leading indicators for construction sites: A machine learning approach. *Automation in construction*, *93*, 375-386.

Prieto, B. (2019). Impacts of Artificial Intelligence on Management of Large Complex Projects. *PM World Journal*, Vol. VIII, Issue V, June.

Rao, T., Gaddam, A., Kurni, M., & Saritha, K. (2021). Reliance on artificial intelligence, machine learning and deep learning in the Era of industry 4.0, in:

Smart Healthcare System Design: Security and Privacy Aspects. s.L., Wiley.

Ribeirinho, M., Mischke, J., Strube, G., Sjodin, E., Blanco, J., Palter, R., Biorck, J., Rockhill,

D., & Andersson, T. (2020). The next normal in construction. https://www.mckinsey.com/~/media/McKinsey/Industries/Capital%20Projects%20and%20Infrastructure/Our%20Insights/The%20next%20normal%20in%20construction/The-next-normalin-construction.pdf.

Robinson, R. N., (2018). Artificial Intelligence: Its Importance, Challenges and Applications in Nigeria. *Direct Research Journal of Engineering and Information Technology*. Vol.5(5), pp.36-41, December 2018. ISSN 2354-4155

Salehi, H., & Burgueño, R. (2018). "Emerging artificial intelligence methods in structural engineering." *Engineering Structures*, 171, 170–189.

Schia, M.H., Trollsås, B.C., Fyhn, H., & Lædre, O. (2019). "The Introduction of AI in the Construction Industry and its Impact on Human Behavior" In: *Proc. 27th Annual Conference of the International. Group for Lean Construction (IGLC)*, Dublin, Ireland, pp. 903-914.

Schonbeck P. (2020). Quantitative review of construction 4.0 technology presence in construction project research. Buildings. 10(12):237. DOI: 10.3390/buildings10120237

Shukla, A. K., Janmaijaya, M., Abraham, A., & Muhuri, P. K. (2019). Engineering applications of artificial intelligence: a bibliometric analysis of 30 years (1988–2018). Engineering Applications of Artificial Intelligence, 85, 517-532

Taillandier, F., Taillandier, P., Tepeh, E., Breysse, D., Mehdizadeh, R., & Khartabil, F. (2015). A multiagent model to manage risks in construction project (SMACC). Automation in Construction, 58, 1-18

Vorakulpipat, C., Rezgui, Y., & Hopfe, C.J., (2010). Value creating construction virtual teams: A case study in the construction sector. *Automated. Construction. 2010*, 19, 142–147. International Federation of Robotics (2017). The Impact of Robots on Productivity, Employment and Jobs. *A Positioning Paper by the International Federation of Robotics*.

Wu, C., Li, X., Guo, Y., Wang, J., Ren, Z., Wang, M., & Yang, Z. (2022). Natural language processing for smart construction: Current status and future directions. In Automation in Construction (Vol. 134). Elsevier B.V. https://doi.org/10.1016/j.autcon.2021.104059

Xin, X., Tu, Y., Stojanovic, V., Wang, H., Shi, K., He, S., & Pan, T. (2022). Online reinforcement learning multiplayer non-zero sum games of continuous-time Markov jump linear systems. Applied Mathematics and Computation, 412, 126537.

Yaseen, Z. M., Ali, Z. H., Salih, S. Q., &Al-Ansari, N., (2020). Prediction of Risk Delay in Construction Projects Using a Hybrid Artificial Intelligence Model. *Sustainability 2020*, 12, 1514; doi:10.3390/su12041514.

Young, D., Panthi, K., & Noor, O. (2021). Challenges involved in adopting BIM on the construction jobsite, EPiC Series in Built Environment 2 (2021) 302-310.

Zavadskas, E. K. (2010). Automation and robotics in construction: International research and achievements. Automation in Construction, 19(3), 286-290

BUK KANO-2023
BAYERO UNIVERSITY, KANO, KANO STATE, NIGERIA
Proceedings of the Academic Conference of Sub-Sahara African Academic Research Publications on African Potentials for Sustainable Development in the 21st Century: Multi-disciplinary Approach Vol. 29 No. 3, 29th December, 2023

APPRAISING THE BENEFITS AND CHALLENGES OF IMPLEMENTING ARTIFICIAL INTELLIGENCE IN THE NIGERIAN CONSTRUCTION INDUSTRY.

NKOLLO, O. W.; & SAIDU, I.
Department of Quantity Surveying, Federal University of Technology, Minna, Nigeria

ABSTRACT
The construction industry is currently experiencing a transformation from traditional, hierarchically organised construction sites to digital and more autonomous ones. A shift is taking place, and the development of digital is advancing so fast that the industry struggles to keep up. In view of this, the study was aimed at appraising the benefits and challenges of implementing artificial intelligence in the Nigerian construction industry. The study adopted a mixed-methods research design that combined both quantitative and qualitative research approaches. The research population for the quantitative data was the 255 construction firms registered with the Abuja Business Directory. Out of which, a sample size of 150 was obtained. While the population for the qualitative data were construction professionals domiciled in Abuja, using the simple random sampling method, the collected data from the questionnaire were analysed using the mean item score (RII), and the qualitative analysis was done using interviews and analysis carried out using deductive analysis. The study revealed that 46.7% of the sampled professionals were not aware of the implementation of AI in industry. The findings revealed the most important benefit of artificial intelligence (AI) implementation in the construction industry is "job creation" (MIS = 4.55). The findings revealed the most significant challenges faced in the implementation of artificial intelligence (AI) in the construction industry: "AI technologies require high initial costs to obtain accurate data" (MIS = 4.60). It was therefore concluded that the application of AI tools would significantly improve practices on construction sites in Abuja. There is therefore a need for construction firms to embrace the use of AI tools to improve the safety performance and practices of their employees. It was recommended that the majority of construction professionals have insufficient knowledge about the use of AI tools at building sites. Consequently, it is necessary to arrange seminars, workshops, and conferences to enlighten these experts about the advantages of using AI tools on construction sites.

Keywords: *Assessment, Artificial Intelligence, Construction Industry, Implementation*

Introduction

The construction sector has a crucial role in improving the economy of countries (Vorakulpipat *et al.*, 2010). However, rapid advances in digital technology are redefining the world today (De Almeida *et al.*, 2016). The construction industry is currently experiencing transformation from traditional, hierarchically organized construction sites to digital and more autonomous ones. A shift is taking place, and the development of the digital is advancing so fast that the industry struggles to keep up (Harty *et al.*, 2015). Although the construction industry is claimed to be digitized and with a low productivity development compared to other industries, however, the right implementation of digitization will increase efficiency of the building process (Barbosa et al., 2017). Thus, more advance technology such as Artificial Intelligence (AI) is now entering the industry (Schia et al., 2019). This is confirmed by Mohamed et al. (2021) that the world is embracing the rise of use of Artificial Intelligence (AI) as a fundamental shift in the construction industry.

Artificial Intelligence (AI) has been studied for decades and is still one of the most challenging subjects in digital computer (Robinson, 2018). Artificial Intelligence (AI) models have evidenced their capacity to solve dynamic, uncertain and complex tasks (Yaseen et al., 2020). However, according to Robinson (2018), AI is taking the world by storm, considering the application of its innovative uses across all industry segments. AI makes it possible for machines to learn from experience, adjust to new inputs and perform human-like tasks. Examples are computers learning to play chess or Jeopardy using AI, for intelligent assistants (Siri; Alexa) or for self-driving cars (Prieto, 2019). AI can automate several operations and increase the efficiency of the building process (Salehi and Burgueño, 2018). AI could help to enhance the project quality within the project duration, cost and design by emerging the latest technology in the construction industry (Mohamed, *et al.*, 2021).

The adoption of AI techniques has helped to enhance automated and provide better competitive advantages as compared to conventional approaches (Chien *et al.*, 2020). The subfields of AI such as machine learning, natural language processing, robotics, computer vision, optimisation, automated planning and scheduling, have been applied to tackle complex problems and support decision-making for real-world problems (Rao *et al.*, 2021).

Thus, according to Ezeokoli *et al.* (2019), the application of digital technologies skills and its transformation in the study area is still at foundation level. However, 63% of construction professionals are satisfied with their firm's readiness to digital transformation. This affirms the study of Bolton (2018), who confirms the implementation of AI as a digital transformation.

It is evident that this AI revolution has led to significant process improvements, cost-efficiency, reduced production times, improved safety and helped to achieve firms' sustainability goals (Ajayi *et al.*, 2020). However, the construction industry is yet to reap significant benefit from AI despite its existing challenges (Abioye *et al.*, 2021). Hence, this study focuses on appraising the benefits and challenges of implementing artificial intelligence in the Nigerian construction industry.

LITERATURE REVIEW

Benefits of Artificial Intelligence (AI) Implementation in the Construction Industry

There is a range of opportunities that new technologies bring to a construction project. It gives companies a competitive advantage by lowering costs and increasing efficiency. Adaptive manufacturing is a growing concept that introduces flexible machines capable of customizing part productions and enabling new cost-effective building methods (Delgago *et al.*, 2019). This new method leads to the potential modification of jobs by combining planning, design, and construction tasks. It is critical that users acknowledge the benefits and performance enhancement that AI may bring to a construction site to adopt new technologies into their projects effectively (Pillai *et al.*, 2020).

1. **Waste Management and Resources:** The amount of resource waste is growing rapidly on a yearly basis due to rapid development (Schonbeck *et al.*, 2019). Companies are becoming more waste aware and are implementing proactive data-driven approaches that minimize waste through analytics (Eber, 2020). Waste analytics is dependent on different sources of data, such as building design, material properties, and construction strategies. AI technologies are needed to turn information into relevant waste management strategies. These strategies include the optimization of offsite construction, material selection, reuse and recovery, waste-efficient procurement, deconstruction, and flexibility (Ajayi *et al.*, 2020).
2. **Estimation and Scheduling:** AI application models are important to accurately forecast construction costs and project timeline. Projects that do not have accurate costs and time estimation have large financial implications (Aparicio *et al.*, 2020).
3. **Construction Site Analytics:** Construction sites constantly transform and incorporate new technologies to become smarter working environments. IoT sensors and other digital technologies are becoming more apparent on sites to generate valuation data. A large volume of data is generated from construction sites and is mostly unstructured. The use of AI can structure the data generated and analyse the data to optimize site performance in all key areas such as planning, design, safety, quality, scheduling, and costs (Lin *et al.*, 2021).
4. **Job Creation:** Based on the literature review, construction jobs that require low to medium education are at a higher risk of becoming redundant. This is evident as, by 2030, 38–45% of these jobs will be completed by automated analytics or robotics (Araujo *et al.*, 2018).
5. **Supply Chain Management:** There are common supply chain management (SCM) issues evident in the construction industry. The SCM is a costly and complex process, and the lack of specific performance measurement frameworks, organization trust, and communication channels risks its success (Oyedele, 2017).
6. **Health and Safety:** Advanced analytics can reduce the risk of workplace accidents by using predictive analytics. The construction industry records a significant number of injuries compared to other industries (Winge *et al.*, 2019) and others.

SN	Benefits	Sources
7	Aim for Better Design Quality	Ellis, (2022); George and Newton, (2022).
8	Enhance Job Site Safety	Ellis, (2022); George and Newton, (2022).
9	Risk Assessment and Risk Reduction	Ellis, (2022); George and Newton, (2022).
10	Can be used in predicting building material properties	Doroshenko, (2020)
11	Are used to detect seismic signals caused by soil vibrations and earthquakes.	Doroshenko, (2020)

12	Construction Equipment Detection and Tracking	Boesch, (2023)
13	Managing and Maintaining Assets with Computer Vision	Boesch, (2023)
14	Controlling Quality with Automation	Boesch, (2023)
15	Analysing and Optimizing Processes	Wu et al., (2022)
16	Tracking and optimizing processes	Wu et al., (2022)
17	Help classify clauses as requirements or nonrequirements or as distinct categories (e.g., construction, design, operation, and maintenance).	Wu et al., (2022)
18	Help in predicting and classifying safety risks based on risk levels or types (such as environmental, financial, and political) is possible.	Wu et al., (2022)
19	Help in scheduling and Cost Management	Wu et al., (2022)
20	Help to evaluate incident severity, prioritise O&M actions, and provide advice for future infrastructure project	Wu et al., (2022)

Challenges Faced in the Implementation of Artificial Intelligence (AI) in the Construction Industry

The construction industry is behind manufacturing and transportation to adopt AI, as it is still in the initial conceptual phase of development (Bigham *et al.*, 2021). Technology challenges vary, depending on the project's size, labour and capital intensity, industry sector, technologies used for projects, and the types of firms that use the technology (Hager *et al*, 2016). According to Mohammadpour *et al.* (2018), a significant barrier for businesses to embrace AI is the complexity of tasks performed by analytics. This is potentially caused by the higher variability and volatility of construction sites and the urban environment. AI requires large amounts of data to train algorithms and identify patterns in which only a limited number of people can interpret data from these platforms, resulting in limited economies of scale, impeding innovation and digitalization (Paoletti *et al.*, 2016; Ribeiro *et al.*, 2016).

1. **Cultural Issues:** 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 (Nagendra *et al.*, 2018). 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 (Pan *et al.*, 2021; Hardie *et al.*, 2005). Therefore, it would be beneficial to take advantage of technologies such as blockchain to improve trust and transparency (Zavadskas *et al.*, 2010).
2. **Security:** 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 (Hasegawa *et al.*, 2006).
3. **Higher Initial Costs:** The benefits that AI may bring to a construction site are indisputable. However, AI technologies require high initial costs to obtain accurate data. This may be unaffordable for most subcontractors and small firms that make up most of the construction industry. The high upfront costs require a considerable financial commitment for R&D and application purposes, and these investments will be at increased risk and taking this risk in a highly competitive market. Small to medium-sized business firms cannot invest in system-level technology and thus cannot benefit from technological breakthroughs (Afzal *et al.*, 2017). In addition, there is a high cost of owning and using these AI technologies as they are not fully developed and need investment constantly to keep up to date with the advancement of the technology (Ali *et al.*, 2019). Therefore, it is imperative that firms determine the cost saving that AI may bring to a project and decide whether it is feasible. As AI in construction continues to expand and becomes more prevalent in construction, the process is expected to lower and become more affordable for smaller businesses.

Results and Discussion on benefits of Artificial Intelligence (AI) Implementation in the Construction Industry

Table 2 Presents the result of the benefits of artificial intelligence (AI) implementation in the construction industry

Table 2: Results of Benefits of Artificial Intelligence (AI) Implementation in the Construction Industry

CODE	Safety Practices	MIS	RANK	DECISION
B3	Job Creation	4.55	1st	Very -Important
B1	Health and Safety	4.40	2nd	Very -Important
B2	Supply Chain Management	4.30	2nd	Very -Important
B4	Construction Site Analytics	4.25	4th	Very -Important
B5	Estimation and Scheduling	4.15	5th	Very -Important
B6	Waste Management and Resources	4.10	6th	Important
B7	Aim for Better Design Quality	4.00	7th	Important
B8	Enhance Job Site Safety	3.95	8th	Important
B9	Risk Assessment and Risk Reduction	3.90	9th	Important
B10	Can be used in predicting building material properties	3.90	9th	Important
B11	Are used to detect seismic signals caused by soil vibrations and earthquakes.	3.85	11th	Important
B12	Construction Equipment Detection and Tracking	3.80	12th	Important
B13	Managing and Maintaining Assets with Computer Vision	3.79	13th	Important
B14	Controlling Quality with Automation	3.75	14th	Important
B15	Analysing and Optimizing Processes	3.74	15th	Important
B16	Tracking and optimizing processes	3.73	16th	Important
B17	Help classify clauses as requirements or nonrequirements or as distinct categories (e.g., construction, design, operation, and maintenance).	3.70	17th	Important
B18	Help in predicting and classifying safety risks based on risk levels or types (such as environmental, financial, and political) is possible.	3.68	18th	Important
B19	Help in scheduling and Cost Management	3.65	19th	Important
B20	Help to evaluate incident severity, prioritise O&M actions, and provide advice for future infrastructure project	3.60	20th	Important
	Average MIS	*3.94*		*Important*

Table 2 reveals twenty (20) identified benefits of artificial intelligence (AI) implementation in the construction industry, which are all very important, with MIS ranging from 4.55 to 3.60. The most important benefit is "job creation" (MIS = 4.55), while the least important one is "Help to evaluate incident severity, prioritise O&M actions, and provide advice for future infrastructure project" (MIS = 3.60). The average MIS value shown is 3.94. This also reveals that all the identified benefits of artificial intelligence (AI) implementation in the construction industry are very important. This is in tandem with past studies from Delgago *et al.*, 2019; Pillai *et al.*, 2020; Schonbeck *et al.*, 2019; and Eber, 2020, which identified the benefits of artificial intelligence (AI) implementation to include: waste management and resources; estimation and scheduling; and job creation. Furthermore, AI has the possibility to resolve organisational trust and communication issues that have hindered the use of SCM in recent years. AI can detect potential issues and ensure efficient delivery by managing the entire supply chain (Ajayi *et al.*, 2017).

Results and Discussion on Challenges faced in the implementation of artificial intelligence (AI) in the construction industry

Table 3 gives a summary of the MIS results of the challenges faced in the implementation of artificial intelligence (AI) in the construction industry.

Table 3: Results of Challenges faced in the implementation of artificial intelligence (AI) in the construction industry

CODE	Challenges faced in the implementation of artificial intelligence (AI) in the construction industry	MIS	RANK	DECISION
C4	AI technologies require high initial costs to obtain accurate data	4.60	1st	Very Significant
C1	Traditional methods are prioritized over un-trusted technologies due to the risk associated with construction, as mistakes can lead to high financial implications	4.50	2nd	Very Significant
C7	The construction industry has created standards that make it difficult to share information between companies due to intellectual property issues	4.35	3rd	Significant

involves professionals who are of different fields. The descriptive analysis was employed to analyze the data using descriptive tools which include: mean item score (MIS) and ranking methods.

Results and Discussion

Demographic Characteristics

Table 1 shows the demographic characteristics of respondents. As regards the professional background of the respondents, 48.0% were quantity surveyors with a majority, followed by engineers with 20.0%, architects with 13.3%, and builders with 8.6%, while others, such as safety officers, had a minority with 6.6%. The major professions in the Nigerian construction industry are well represented.

As regards educational qualification, 41.3% have a bachelor degree, 33.3% have a master degree, 18.6% have a Higher National Diploma (HND), 5.3% have a National Diploma, and 1.5% have a doctorate qualification. It was revealed that the respondents are adequately educated to provide meaningful information for this research.

For the professional qualifications, 40.0% of the respondents were MNIQS/QSRBN members, 22.0% had other professional qualifications such as HSE, MNITP/TOPREC, 16.6% were MNIOB/CORBON members, 11.4% were MNSE/COREN members, and 10.0% were MNIA/ARCON members.

In the case of years of experience, 3.3% of the respondents have above 20 years of working experience, 17.3% have 1–5 years of working experience, 20.7% have 11–15 years, 22.0% have 6–10 years of working experience, and 36.7% have working experience of 16–20 years. This implies that the respondents are well-equipped to provide valuable information for this research.

Regarding the level of awareness of the implementation of AI in industry, the majority (46.7%) were aware, 30.7% were moderately aware, and 12.7% were not aware, while the minority that constituted 9.9% were highly aware.

Table 1: Demographics Characteristics of Respondents

Variables		Frequency	Percentage (%)
Profession	Architect	20	13.3
	Builder	13	8.6
	Engineer	30	20.0
	Estate Surveyor	05	3.5
	Quantity Surveyor	72	48.0
	Others	10	6.6
	Total	**150**	**100.00**
Highest academic qualification	ND	8	5.3
	HND	28	18.6
	BSc/BTech	62	41.3
	MSc/MTech	50	33.3
	PhD	2	1.5
	Total	**150**	**100.00**
professional qualification	MNIA/ARCON	15	10.0
	MNIOB/CORBON	25	16.6
	MNSE/COREN	17	11.4
	MNIQS/QSRBN	60	40.0
	Others	33	22.0
	Total	**150**	**100.00**
Years of Experience	1 – 5 years	26	17.3
	6 – 10 years	33	22.0
	11 – 15 years	31	20.7
	16 – 20 years	55	36.7
	Above 20 years	5	3.3
	Total	**150**	**100.00**
Level Awareness of the implementation AI	Not aware	70	46.7
	Moderately Aware	46	30.7
	Aware	19	12.7
	Highly Aware	15	9.9
	Total	**150**	**100.00**