Adoption of Artificial Intelligence in Building Industry: the Professional's Perspectives on Three-Dimensional Concrete Printer

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Abstract

This study, "Adoption of Artificial Intelligence in the Building Industry: The Professional's Perspectives on Three – Dimensional Concrete Printer, "was conducted to determine how well – informed the Nigerian construction industry is about artificial intelligence and three – dimensional concrete printers. According to Niksasetal .(2007), a lack of appropriate digital skills and technology adoption in the construction industry is linked to cost inefficiencies, project delays, subpar quality performance, poorly informed decision - making, and subpar productivity, health, and safety performance. The construction sector must embrace digitization and better technology, as has been clear in recent years as a result of several issues, including, among others, a lack of skilled labour. Artificial intelligence is the science and engineering of creating intelligent devices, particularly intelligent computer programs. By depositing materials instages according to a computer model, three – dimensional concrete printing is a technique used to produce real objects. A side from cost savings, shorter construction times, and a decrease in accidents and waste, three – dimensional concrete printing has many advantages for the construction industry. This study's main goals are to identify potential applications for AI in the building industry, gauge how much building professionals are aware of it, how they use it, and how they perceive it — particularly in the context of 3D concrete printers — as well as how readily they accept AI's potential to replace human labour in the sector. In the study, the stake holders and professionals in the building industry in Lagos State were manually surveyed as part of the descriptive and inferential statistical data collection. All professionals were given two hundred and fifteen (215) surveys, and two hundred and three (203) responses were fully returned, or 94.4 percent of the total. The statistical software SPSS was used to examine these responses. In contrast to the three – dimensional concrete printer (3DCP), the results indicate a high level of awareness of artificial intelligence. Three – dimensional concrete printers have the potential to raise *housing quality in Nigeria's construction industry, even though few specialists are familiar with them. Conclusions and recommendations were derived from the findings, such as the fact that a three – dimensional concrete printer will benefit the construction sector, help reduce waste, and speed up the completion of building projects. To keep up with counterparts in the Western world, a further suggestion is made that a comprehensive and ongoing study of evolving technology is encouraged. Additionally, the government should promote AI and encourage the inclusion of knowledge about it in primary, secondary, and tertiary institution curricula.*

Introduction

The traditional, hierarchically managed construction sites are currently being replaced with digital, more autonomous ones in the construction sector. There is a digital revolution happening, and because digital technology is developing so quickly, the market finds it difficult to keep up (Harty etal. 2015). This article, which examines the application of artificial intelligence (AI), is a ground breaking piece of work. Artificial intelligence (AI) implementation is an issue that hasn't been thoroughly studied, particularly in the construction sector. According to Salehi and Burgueo (2018), artificial intelligence (AI) can automate several tasks and improve the effectiveness of the construction process. This is in line with the lean mind set, which places a strong emphasis on cutting waste and maximizing value (Ballard & Howell, 2003).

Since the turn of the last century, artificial intelligence (AI) has been a popular concept. Artificial intelligence (AI) concepts have been well embraced and developed following our current understanding of natural intelligence, but frequently, as the human mind has been better understood, artificial attempts to keep up have fallen short. Ancient concepts have been revived and are currently reaching heights that genuinely seem to be able to compete with the human brain thanks to the anticipated development in computing power. Astonishing heights are revealed by the complexity of the outcome, which hasn't changed much from the core notions (Wolfgang, 2020).

Technology acceptance and utilization in the international business environment saw a significant transition with the start of the current millennium. Organizations' business strategies are influenced by technology, thus executives must view it as both a crucial component of business and a topic of concern for the entire company (Omotayo, 2015). Research has revealed that the Nigerian built environment is sluggish to adapt technology, which results in a high percentage of failed and abandoned public projects. Technology utilization for effective planning and coordination toward enhanced business performance is crucial to companies. In a recent study, it was discovered that Nigerian building professionals were behind their peers in the US, UK, and South Africa by 5 years in terms of awareness of and use of building information modelling (BIM) technology (Hamma-Adama etal., 2018). Strong impediments to the use of BIM technology in Nigeria include a lack of infrastructure and specialized knowledge (Hamma-Adama etal., 2018). People who matter in an organization must support the adoption of technology even though it is crucial for corporate success and connections. The stakeholders in Nigeria's built environments, according to Ojelabi, Afolabi, Oyeyipo, Tunji-

Olayeni, and Adewale (2018), have not demonstrated a high level of readiness to adopt and integrate technological platforms for developing commercial and socialties. According to the findings of Ojelabi etal., stakeholders' involvement and commitment are crucial in the decision – making process that results in the adoption of technology.

With the development of technology in recent years, particularly in developed nations, academic study on 3D printing has intensified. In underdeveloped nations like Nigeria, the technology is still very young. Therefore, there is a critical need to address the under representation of research that is particularly interested in the effects that 3D printing can have in a variety of sectors in developing nations like Nigeria. This study addresses this issue by concentrating its examination on the uses of the technology, benefits that may be derived from the implementation of the technology, and a variety of sectors where 3D printing can present Nigeria with significant opportunities (Raji, 2017).

In comparison to other sectors, including manufacturing, the construction industry has numerous difficulties that have stifled its expansion and resulted in incredibly low productivity levels (Chui & Francisco, 2017). The fact is that the construction sector is one of the least digitalized in the world, and the majority of stakeholder groups admit the long – standing resistance to change in the culture (Young et.al., 2021). Delgado & Oyedele (2021 (a); Bello et.al., 2021) state that the lack of digitization and the industry's excessively manual nature make project management more difficult and unnecessarily laborious. According to Niks et.al. (2007), the lack of adequate digital expertise and technology adoption within the construction industry has also been linked to cost inefficiencies, project delays, subpar performance, ill – informed decision - making, and subpar productivity, health, and safety results. With the challenges of current labour shortages, the COVID- 19 pandemic, and the requirement to provide sustainable infrastructure, it has recently become clear that the construction industry must embrace digitization and swiftly improve technological capacity (Delgado and Oyedele, 2021). The study's goals in this context are to pin point potential applications for AI in building construction, measure how much building professionals are aware of, using, and perceiving AI, particularly 3D concrete printers, and assess whether AI will replace human labour in the construction industry entirely or in part. While describing the advantages of AI in construction, the study emphasizes the importance of technological innovation for industry professionals.

Literature Review

Artificial intelligence (AI), a key component of digital technology, has recently made a substantial contribution to raising industry productivity and enhancing corporate operations (Chui & Francisco, 2017). In comparison to traditional methods, the adoption of AI techniques has improved automation and provided better competitive advantages (Chien et.al., 2020). Various AI subfields, including machine learning, natural language processing, robotics, computer vision, optimization, automated planning, and scheduling (Rao et.al., 2021), have been used to solve complex problems and aid decision – making for practical issues. For instance, the introduction of Industry 4.0, also referred to as Industry 4.0, in the manufacturing sector is focused on automation, data – driven technologies, and the use of cutting –edge AI approaches (Yao et.al. 2017). This revolution has resulted in large process improvements, cost efficiency, shortened manufacturing times, increased safety, and assisted enterprises in achieving their sustainability goals (Ganiyu et.al., 2020; Ajayi et.al.,2020). The challenges facing the construction sector, however, have prevented it from utilizing AI to any greatextent.

Researchers have written articles about using AI and its subfields to address problems unique to the construction industry during the last few decades. For instance, machine learning has been used to optimize supply chain and logistical processes, monitor safety, estimate costs, and predict risks, among other things (Khobragade et.al., 2018; Ajayi et.al., 2020). Robotics has been used for site monitoring and performance evaluation, off – site assembly, and the administration of building supplies, plants, and machinery (Chu et.al., 2010). Despite these advantages, the construction industry is among the least digitalized in the world and has had a difficult time implementing AI other digital Conclusions and recommendations were derived from the findings, such as the fact that a three – dimensional concrete printer will benefit the construction sector, help reduce waste, and speed up the completion of building projects. To keep up with counterparts in the Western world, a further suggestion is made that a comprehensive and ongoing study of evolving technology is encouraged. Additionally, the government should promote AI and encourage the inclusion of knowledge about it in primary, secondary, and tertiary institution curricula. Technologies in a way that will be useful. Some obstacles are preventing the wide spread use of AI, including cultural hurdles, high start up costs for implementing AI – based solutions, lack of trust, security concerns, a talent shortage, limited computer capacity, and poor internet access. There are some murky regions in the study trend regarding AI applications, potential future opportunities, and adoption constraints in the construction business.

The most typical building material utilized worldwide is concrete. The global concrete building sector is facing many difficulties. This includes the hefty price. Shaping is one of these, according to a recent study by the Boral Innovation Factory (Austin & Khoshnevis, 1988). In Sydney, shaping accounts for almost 75% of all building expenses. According to recent studies by the Boral Innovation Factory (Austin & Khoshnevis, 1988), the shape is responsible for over 75% of all building expenses in Sydney. Concrete structures all around the world may have this trait. The substantial waste generated in the construction industry is another issue. The building business generates more trash as a result of shaped form because they are all eventually discarded. Everyday, 3D printing technology is employed in a variety of industries including manufacturing, health and safety, aviation, construction and architecture, military applications, textiles, nutrition, and training. In light of all these applications, the construction industry is still exploring 3D printing. The advantages of 3D printing for the construction sector should not be understated because it reduces the number of variables in a project, including design, materials, costs, and time. Charles (Chuck) Hull created a three – dimensional object utilizing numerical data for the first time in 1984 (Nadarajah, 2018). After being converted to STL (stereolithography) format, the virtual 3D template is delivered to the 3D printer (Bos et.al., 2016).

Layer by layer, a concrete object is built via three – dimensional (3D) printing. Rapid prototyping used to be the name for it. The items become lighter because of the 3D printing technology's sparing use of material, which also makes it possible to create components with many applications. Surprising research by Boset.al. (2016) revealed that the building industry is responsible for creating roughly 80% of all garbage worldwide. The typical method of pouring concrete into the form work, however, limits architects' structural freedom of design for a variety of geometries unless the cost of specially made form work is very high. Rectilinear shapes not only prevent architectural innovation, but they also have worse structural integrity than curvilinear ones due to the intensity of their stresses. Another difficulty is the construction's slow pace (i.e., the protracted and challenging leadtime). Additionally, there are several stages involved in the construction of concrete, such as material processing, transportation, and on – site production.

In Australia, an average of 35 construction workers suffer significant injuries per day, according to the Safe Work Australia survey (Camacho et.al., 2018). More than a quarter of fatalities in buildings are caused by height falls (Camacho et.al., 2018). Considering that Australia has some of the latest safety standards in the world for construction sites. Not least among all these issues is the contemporary construction industry's serious sustainability issues. In general, the materials and methods used in construction today are not environmentally friendly. According to Campbell et.al. (2011), the entire construction process — including on – site manufacture, material transportation, installation and assembly, and building — creates a significant amount of carbone missions. Concrete made with regular Portland cement (OPC) is not sustainable for the environment. OPC is produced in a way that is both energy and carbon – intensive (Cesaretti et.al., 2014). The same problems might be resolved by utilizing 3D printing technology for concrete buildings. The construction industry has recently embraced 3D printing technology more widely. In the past, a variety of 3D approaches have been investigated. This study reviews the present status of 3D concrete printing technology.

Materials and Methodology

A structured questionnaire was adopted and distributed by hand to the construction professionals and stakeholders in the industry in Lagos State. Three aspects of the questionnaire bordered on the demographic characteristics of the respondents, their profession and experience, and their perceptions, awareness, benefits, and adoption of artificial intelligence in building construction, especially 3D concrete printing.

A total of two hundred and fifteen (215) screened and validated questionnaires were distributed to the professionals in their offices: one questionnaire per respondent. A total of two hundred and three (203) out of two hundred and fifteen questionnaires were retrieved (94.4%), and twelve were not retrieved due to some logistical reasons that kept the respondents away. Hence, the two hundred and three (203) questionnaires were properly attended to, indicating a good understanding of the items by the professionals and standardization of the questionnaire items. A five – point scale ranging from most to least used is 'most beneficial', 'beneficial', 'slightly beneficial', 'not beneficial," 'veryaware', 'aware," 'slightly aware', 'not aware at all, 'yes' or 'no,"as the case may be. This rating scale followed the Likert rating scale (1 to 5). The lowest rating was 1, while the highest was 5.

Two types of statistical analysis were used: descriptive and inferential. The descriptive aspect included frequency distribution, percentages, standard deviation, and graphical presentations of the data.

Mean quality scores using Statistics Package for Social Sciences (SPSS) were adopted to analyse the primary data collected from the questionnaires, which were framed as multiple - selection, closed - ended, and open – ended questions, and appropriate choice options were selected by the respondents.

Results and Discussions

The result of the descriptive data collected reveals in Table 1 below that the gender distribution of men was higher than that of females.

Table 1. Gender Distribution of respondents

	Frequency	Percent	Cumulative Percent
Male	153	75.4	75.4
Female	50	24.6	100.0
Total	203	100.0	

From Table 1 above, males were in the majority with 153 (75.4%) of the respondents, while females were only 50 (24.6%). This follows a general trend in the construction industry, where males are predominant.

The perception of the average person in developing countries is that such a profession is for men. The professions of the various respondents assessed are shown in Table 2.

Table 2: Role or Profession of Respondent in the Construction Industry

	Frequency	Percent	Valid Percent	Cumulative Percent
Architect	13	6.4	6.4	6.4
Builder	63	31.0	31.0	37.4
Engineer	78	38.4	38.4	75.9
Quantity Surveyor	16	7.9	7.9	83.7
Estate Management	21	10.3	10.3	94.1
Others	12	5.9	5.9	100.0
Total	203	100.0	100.0	

Source: Fieldwork, 2022

Table 2 above shows the ascending order of the number of roles of respondents as 13 (6.4%), 63(31.0%), 78(38.4%), 16(7.9%), 21(10.3%) and 12(5.9%) being architects, builders, engineers, quantity surveyors, estate managers, and others, respectively.

The organization and core activities of the respondents are displayed in Table 3, as shown.

Table 3: Organisation of Employment of Respondent

	Frequency	Percent	Valid Percent	Cumulative Percent
Consulting Firm	15	7.4	7.4	7.4
Contracting Firm	70	34.5	34.5	41.9
Properties Firm	20	9.9	9.9	51.7
Government Agency	83	40.9	40.9	92.6
Others	15	7.4	7.4	100.0
Total	203	100.0	100.0	

Source: Field Work, 2022

The table 3 above shows that respondents from government agencies were the highest, with 83(40.9%), followed by contracting firms (70(34.5%)), property firms (20(9.9%), consulting firms, and others, with each of the two having 15(7.4%).

The large sample size from the government agency may sound logical considering the size of the governmental organization and the need to ensure quality service delivery in terms of construction as well as monitoring construction works throughout the state. Being the most populous state in Nigeria, the increasing demand for construction, especially residential and industrial buildings as well as road works, would require more building professionals.

It is expected that the level of experience or practice will reveal exposures and limitations. Hence, table 4 lists the years of experience.

Table4:Respondents'YearsofProfessionalExperienceintheConstructionIndustry

	Frequency	Percent	Valid Percent	Cumulative Percent
5 Years & below	25	12.3	12.3	12.3
6 – 10 Years	48	23.6	23.6	36.0
11 – 15 Years	38	18.7	18.7	54.7
16 – 20 Years	70	34.5	34.5	89.2
21 Years & Above	22	10.8	10.8	100.0
Total	203	100.0	100.0	

Source: Field Work 2022

Table 4 above shows that the minimum job experience of the professionals in this study was in the range of % years and below with a frequency of 25(12.3%) respondents, and the maximum was in the range of 21 years and above with a frequency of 22(10.8%) respondents. 16 – 20 years formed the majority of 70(34.5%) of the respondents, and 21 years and above were the least of 22(10.8%). It shows that the respondents were not fresh graduates or job seekers, but those who had the required job experience to have knowledge of artificial intelligence and its applications in the construction industry. The competence and professional expertise with which the respondents are affiliated are outlined in Table 5 below.

Table 5: Registered Professional Association of Respondents

	Frequency	Percent	Valid Percent	Cumulative Percent
NIA	13	6.4	6.4	6.4
NIOB	63	31.0	31.0	37.4
NSE	78	38.4	38.4	75.9
NIQS	16	7.9	7.9	83.7
NIEVS	21	10.3	10.3	94.1
Others	12	5.9	5.9	100.0
Total	203	100.0	100.0	

Source: Field Work 2022

Shown in Table 5 above are the registered professional bodies to which the respondents belong. This is evidence that the respondents were not quacks or dead – end practitioners. Members of the Nigerian Institute of Architects (NIA) were 13(6.4%). 63(31%), 78(38.4%), 16(and.9%), 21(10.3), and 12(5.9%) of the respondents were members of the Nigerian Institute of Builders (NIOB), the Nigerian Society of Engineers (NSE), the Nigerian Institute of Quantity Surveyors (NIQS), the Nigerian Institute of Estate Values and Surveyors (NIEVS), and others, respectively. The result of the first objective on the level of awareness of artificial intelligence among construction stakeholders and the professionals tested is shown in Table 6 below.

Table6:Respondents'AwarenessofArtificialIntelligenceInConstruction

	Frequency	Percent	ValidPercent	Cumulative Percent
Not Aware	2	1.0	1.0	1.0
Slightly Aware	47	23.2	23.2	24.1
Not Sure	14	6.9	6.9	31.0
Aware	112	55.2	55.2	86.2
Very Aware	28	13.8	13.8	100.0
Total	203	100.0	100.0	

Source: Field Work, 2022

The table below (table 7) reveals the result of the second objective on the readiness of respondents to adopt artificial intelligence as analyzed.

Table7:Readiness of Respondents' Construction Industry In Adopting Artificial Intelligence

	Frequency	Percent	Valid Percent	Cumulative Percent
Not Ready At All	4	2.0	2.0	2.0
Slightly Ready	34	16.7	16.7	18.7
Not Sure	34	16.7	16.7	35.5
Ready	124	61.1	61.1	96.6
Very Ready	7	3.4	3.4	100.0
Total	203	100.0	100.0	

Source; Field Work,2022

Table 7 above reveals that only 7(3.4%) respondents were from organizations that zealously adopted AI inthisstudy. 124(61.1%) ordinarily adopted it, and 34(16.7%) were not sure of their organization's adoption of AI. 34(16.7%) organizations scarcely adopted it, while 4(2%) organizations did not at all adopt AI.

Objective 3 results in Table 8 below represent the respondent's perspective on the benefits of artificial intelligence in various aspects of construction work.

Table 8: Respondents' Response to the Benefits of Artificial Intelligence in Construction

Varia ble	**Likert's Rating Scale(x)**	**Frequency *(f)***	**Percen-tage (%)**	***fx***	**Mean**	**Variance^2**	**Standard deviation**
(i)	**Supervising building projects**						
N.B	1	0	0	0	3.212	0.285	0.53
S.B	2	12	5.9	24			
B	3	136	67.0	408			
M.B	4	55	27.1	220			
TOTAL		203	100.0	652			
(ii)	**Monitoring site safety**						
N.B	1	2	1.0	2.0	3.355	0.422	0.65
S.B	2	13	6.4	26.0			
B	3	99	48.8	297.0			
M.B	4	89	43.8	356.0			
TOTAL		203	100.0	681.0			

(iii)	**Estimating project cost**						
N.B	1	0.0	0.0	0.0	3.448	0.336	0.58
S.B	2	9.0	4.4	18.0			
B	3	94.0	46.3	282.0			
M.B	4	100.0	49.3	400.0			
TOTAL		203.0	100.0	700.0			
(iv)	**Estimating project time**						
N.B	1	2.0	1.0	2.0	3.345	0.433	0.66
S.B	2	15.0	7.9	30.0			
B	3	97.0	47.3	291.0			
M.B	4	89.0	43.8	356.0			
TOTAL		203.0	100.0	679.0			
(v)	**Planning project**						
N.B	1	0.0	0.0	0.0	3.473	0.358	0.598
S.B	2	11.0	5.4	22.0			
B	3	85.0	41.9	255.0			
M.B	4	107.0	52.7	428.0			
TOTAL		203.0	100.0	705.0			
(vi)	**Identifying risk**						
N.B	1	2.0	1.0	2.0	3.463	0.455	0.675
S.B	2	15.0	7.4	30.0			
B	3	73.0	36.0	219.0			
M.B	4	113.0	55.6	452.0			
TOTAL		203.0	100.0	703.0			
(vii)	**Designing**						
N.B	1	2.0	1.0	2.0	3.478	0.378	0.614
S.B	2	7.0	3.4	14.0			
B	3	86.0	42.4	258.0			

M.B	4	108.0	53.2	432.0			
TOTAL		203.0	100.0	706.0			
(viii)Partialreplacementoflabour							
N.B	1	7.0	3.5	7.0	2.67	0.536	0.732
S.B	2	78.0	38.4	156.0			
B	3	93.0	45.8	279.0			
M.B	4	25.0	12.3	100.0			
TOTAL	TOTAL	203.0	100.0	542.0			

Source; Field Work, 2022

Table 8 above shows the respondent's responses on the benefits of artificial intelligence in construction. The"N.B." (Not Beneficial), "S.B." (Slightly Beneficial), "B." (Beneficial) and "M.B." (Most Beneficial) The percentages, means, and standard deviations of the responses were computed against each benefit using the Statistical Package for Social Sciences (SPSS version 20).

The values of the means being higher than the rated scores for ‘not beneficial’ and ‘slightly beneficial’ showed that the AI was generally beneficial. The lower values of the means than the rated score for ‘most beneficial’ showed AI was not ‘most beneficial’ but rather ‘beneficial’

The standard deviations showed the degree to which the scores varied from the sample means. The low values of the standard deviations showed that the scores were very close to the sample mean, and since the samples were characteristic representatives of the population, the means could stand for the population as well.

The respondent’s level of awareness of 3D concrete printers was also measured, as shown in Table 9 below.

Table 9: Respondents’ Awareness of 3D Concrete Printer.

Variable	Likert” Rating Scale *(x)*	Frequency	*Percentage*	*Fx*	Mean	Variance	**Standard Deviation**
N..A	1	52	25.60	52.0	2.153	0.843	**0.918**
S.A	2	88	43.35	176.0			
A	3	43	21.18	129.0			
V.A	4	20	9.85	80.0			
TOTAL		203	100.00	437.0			

Source: Field Work, 2022

It can be seen from Table 9 above that 52(25.6%) respondents were not aware of 3D concrete printers. Eighty – eight (88)(43.35%) were slightly aware, forty – three (43)(21.18%) were ordinarily aware, and only 20(9.85%) respondents were aware of 3D concrete printers. The mean (2.153) being higher than the Likert's ratings for 'Not Aware' (N.A.) and 'Slightly Aware' (S.A.) indicates that the level of awareness was higher than those two variables. The mean being lower than the ratings for 'Aware' (A) and 'Very Aware' (V.A) shows that the awareness level of the respondents was lower than each of them. Generally, therefore, the awareness level of the respondents about 3D concrete printers as seen in this study was very low.

In the above table, the distribution of the awareness level amongst the respondent professionals is shown. 3 architects, 18 builders, 16 engineers, 3 quantity surveyors, 6 estate managers, and 6 others, all adding up to 52 respondents, were not aware of 3D concrete printers. The 88 respondents who were slightly aware were 7 architects, 29 builders, 31 engineers, 7 quantity surveyors, 10 estate managers, and 4 'others'. The 43 who were aware were made up of an architect, 10 builders, 21 engineers, 4 quantity surveyors, 5 estate managers, and 2 'others'. The 20 who were 'very aware' were 2 architects, 6 builders, 10 engineers, and 2 quantity surveyors. None from estate management or'others' were very aware.

Table 10 below is aimed at comparing the level of AI and 3DCP awareness among construction professionals.

Table10: AI - 3D concrete Printer awareness comparison table.

Professionals	Awareness of AI							Awareness of 3D concrete printer						
	N.A	S.A	N.S	A	V.A	Total	%	N.A	S.A	N.S	A	V.A	Total	%
Architects	3	1	0	7	2	13	6.42	3	7	0	1	2	13	6.42
Builder	0	14	10	34	5	63	31.03	18	29	0	10	6	63	31.03
Engineer	1	17	1	47	12	78	38.42	16	31	0	21	10	78	38.42
Q/Surveyor	0	3	0	8	5	16	7.88	3	7	0	4	2	16	7.88
EstateMgt.	1	5	2	11	2	21	10.35	6	10	0	5	0	21	10.35
Others	0	5	0	5	2	12	5.90	6	4	0	2	0	12	5.90
TOTAL	5	45	13	112	28	203	100.00	52	88	0	43	20	203	100.00
%	2.46	22.16	6.41	55.17	13.80	100.00		25.60	43.30	0	21.20	9.90	100.00	

Source: Field Work, 2022

The degree of awareness of the respondent professionals about AI and its 3D concrete printer is shown by the figures in Table 10 above. For example, a total of five respondents not aware of AI were made up of three architects, an engineer, and an estate manager.

It is evident from table 10 above that 5(2.46%) respondents were not aware of AI, while 52(25.6%) were not aware of a 3D concrete printer. This showed that not all respondents who were aware of AI were aware of 3D concrete printers, although they may be aware of other subfields of AI. 45(22.16%) were slightly aware of AI, while 88(43.3%) had a slight knowledge of 3D concrete printers. 13(6.41%) weren't sure of AI, while 'not sure' (NS) was not in a 3D concrete printer. 112(55.17) respondents were aware of AI, while 43(21.2%) were aware of a 3D concrete printer. 28 respondents were very aware of AI, while 20 were aware of a 3D concrete printer.

This research work and consequently the low level of awareness among professionals would result in wastage of materials and money, increased contract costs, increased pollution, construction project delays, and increased human error. Hence, regular training encouraged by the government at schools and professional workshops is necessary to pass on appropriate holistic knowledge of all subfields of AI to professionals in public and private organizations, especially now that the world is going digital and growing digital.

Conclusion and Recommendations

This study focuses on the application of artificial intelligence, especially 3D awareness and usage among some sample – sized professionals and stakeholders in their construction industries. The outcome of the tested objectives shows that awareness and adoption of AI in its subfields, especially 3D concrete printing, were unpronounced and exploited. Also, partial knowledge of AI and its subfields in construction resulted in its adoption and promotion. Partial knowledge will not do.

This study concludes that there are numerous impacts on productivity and efficiency achievable through adequately exploiting sustainable technology. Hence, the study is a contribution to knowledge on artificial intelligence (AI), especially its 3D concrete printer subfield and its awareness and adoption in building construction. It is avaluable source of information on the current usage of AI and how to promote it from its present low state of adoption in a building that makes it comparable and competitive among industries.

Recommendation

The study recommends that further research be carried out, focusing on all aspects of AI in construction. Such research studies should be frequent as technology advances rapidly so that we will be able to keep pace with our counterparts in the Western world. Furthermore, the promotion of the aspect of AI requires immediate attention by the government to include it in the curriculums of education in primary, secondary, and tertiary institutions of learning for a holistic appropriation.

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