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RESEARCH ARTICLE

Adoption of Industry 4.0 Technology in Resources Administration on Construction Projects

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ABSTRACT

Construction industry has tremendous impact on creating housing facility for the masses. There are issues that surround allocation and distribution of resources. The study investigated the challenges involved in the adoption of Industry 4.0 technology for manpower resources management in construction firms operating in Lagos State, Nigeria. The study aims to identify and analyse the specific hurdles that hinder the successful integration of Industry 4.0 technologies in the construction industry. Through a mixed-methods approach encompassing a literature review, qualitative interviews, and surveys, this research aims to uncover key challenges, and their impact, and propose strategies to overcome them. The findings will provide valuable insights to enhance the adoption and effective utilization of Industry 4.0 technologies in construction resources management, particularly in the context of the study.

1. INTRODUCTION

Construction industry has been lacking when it comes to technology, while other manufacturing, producing, and various industries were grabbing and utilizing the benefits of technology in their respective fields. However, it has been noticed as an issue that the adoption of industry 4.0 is rather slow and the attitude toward embracing its concept is poor or pushed aside. Although, the industry does have challenges that would be contributing to the prolonged incorporation of industry 4.0. A reason for its lack of implementation could be due to the huge capital investment needed. Construction projects are extremely costly with the implementation of these new technologies' costs would rise tremendously. With the range of advanced technologies involved, monetary capacity is important which involves the instalment and maintenance of the various technology, hence raising costs more. To be able to make use of these additional new technologies, skilled professional workers are needed to be able to handle and run them. New sets of training and skill acquisition would be needed by professionals to make use of these technologies. Also, the adoption of Industry 4.0 would mean accepting change from the norms to a new system different from what the industry was used to. Some construction firms may not be open to adopting the new systems of Industry 4.0 and rather

chose to stick to old ways. Moreover, one major problem is that people fear it may bring about a loss of jobs, especially when it comes to physical and manual jobs (Aigbavboa, et Al, 2020).

Currently, new innovative technologies have been added to the industry. Some of the technologies which are already seen are robotics, 3D printing, Machine learning, Artificial Intelligence (AI), Building Information Modelling (BIM), etc. Therefore, this study aims to create awareness about the need to adopt Industry 4.0 into the construction industry and to perform a review of construction firms who are or not already implementing industry 4.0 into the ethics with an emphasis on particularity to construction manpower resources management. Also, to figure out and analyse the possible roadblocks and issues slowing down its adoption into the industry. It is expected to see a greater and more receptive attitude towards Industry 4.0 and the addition of its technologies in the industry.

The construction Industry is one of the oldest industries to be set up that has stood for centuries and more to come (Jones, 2022). It is known to largely contribute to the employment of people in a nation. It gives career opportunities to both local and international persons in search of jobs. Career options like Contract Administrators, Site Managers, Project Managers, Project

Engineers, Estimators, Architectural, Building, Surveying Technicians, etc. The industry of

construction is well known for its huge machinery, loud noise production, and bringing complex designs of a building or structure to life. InAdekoya (2017),Ademuyiwa (2019),Adepetun (2019),Adetunmbi, Fadipe-Joseph & Ayeni (2020). For years, the construction industry has dawdled. The modes and systems adopted in the industry of construction several. It involves traditional methods, prefabrication methods, lean methods, modular methods, new innovative inventions like 3D printing, etc. In Nigeria, the construction industry is still fixated mostly on traditional methods. Although, construction firms are adopting the means of lean construction to eliminate all forms of waste usually produced during construction. The rest of the world is embracing The Fourth Industrial Revolution or Industry 4.0 to improve their modes of manufacturing activities, societal patterns, and technology(Adeyemo 2018,Agbataekwe 2015).

Industry 4.0 is unique, zeroing in rather on how new and existing apparatuses can be utilized in imaginative ways. Industry 4.0 is described by shrewd assembling, and execution of Cyber-Physical Systems (CPS) for creation, i.e., inserted actuators and sensors, organizations of microcomputers, and connecting the machines to the worth chain. Advanced innovations and techniques are meaningfully having an impact on the way we oversee building destinations. A very long time ahead will see a change in innovation and across ventures considering expanding interconnectivity and brilliant robotization. It has been named Industry 4.0, or the fourth modern upheaval, and upskilling for development experts is vital (Bolpagni, 2022, Lekan, Clinton, Stella, Moses, Biodun 2022 and Lekan, Aigbavboa, Emetere 2023).

2.0 Review of Relevant Concepts

2.1 Industry 4.0 Technologies

According to Adekoya (2017), questions about if Nigerian local manufacturers are set for the change of adopting Industry 4.0 need to be addressed in lieu of healthy competitive advantage. (Adekoya, 2017) talks about how the utilization of advanced mechanics in Nigerian assembling traces back to when robots were introduced in vehicle plants. From that point forward they have become ordinary in certain ventures, taking on jobs that could already just be completed by human laborers. As of now, neighbourhood gathering plants send the utilization of robots for certain cycles, while the Nigerian concrete industry currently conveys the utilization of robots to deal with a piece of its cycles to guarantee legitimate adjustment of its machines, so items satisfy managed guidelines. ndustry 4.0 refers to the current trend of automation and data exchange in manufacturing technologies. The adoption of innovations, research has shown that the rate of adoption is largely determined by how individuals perceive the characteristics of the innovation and Akindipe, Oluwagbemi & Adesina (2020), Akinnusi (2019) and Rogers (1995), identified five attributes that influence the rate of adoption. These include the relative advantage which is the degree to which an innovation is seen as being better than the existing technology and compatibility which explains the degree to which an innovation is understood as being consistent with existing values, past experiences, and needs of potential adopters. Also, (Roger, 1995) talked about complexity showing the degree to which an

innovation is viewed as being difficult to understand or use, and trialability as an innovation that can be tested or experimented with before adoption. Lastly, observability which shows the results of innovation is visible to others. Additionally, Carter et al., (2001), Lekan, Clinton, Stella, Moses, Biodun (2022); Lekan, Aigbavboa, Emetere (2023). However, Obaju, Fagbenle, Amusan (2022), Faith, Olabosipo, Amusan (2022),Oni, Amusan, Owolabi, Akinbile (2019) suggested that the adoption of innovation is often a bottom-up process, meaning that the individual employees who will be affected by the innovation should be involved in the decision-making process and provided with appropriate training and support to ensure successful adoption.

2.2 Challenges with The Adoption of Industry 4.0 In Nigeria

The adoption of Industry 4.0 in Nigeria faces numerous challenges and issues that are unique to the country. The country having infrastructure deficit remains a significant hindrance to the adoption of Industry 4.0 in Nigeria, particularly in the areas of power supply, poor internet connectivity, and transportation (Akindipe, Oluwagbemi & Adesina 2020, Akinnusi 2019). This is important because the effectiveit originated in the Ger employment of Industry 4.0 would require a reliable and robust infrastructure, which the country is seen to be lacking. According to (Akindipe et al., 2020), the low level of digital literacy among the Nigerian workforce poses a significant challenge to the adoption rate of the industry which means they do not have the necessary skills to operate and maintain the new technologies required. Moreover, a huge gap of lack of skilled workers available with the necessary technical expertise is a significant challenge (Abdullahi et al., 2021) which shows Nigerian organizations will or are struggling to find qualified personnel to operate the new technology, and the high cost of implementing the technologies of the new industrial era, particularly for small and medium-sized businesses (Akinwale, Adeyemo & Agbaje 2020,Bai, Liu & Liu 2020 and Bryan 2018),

As posited in Cao, Li & Li (2020) and Carson (2021),the cost of acquiring the necessary hardware, software, and system to implement industry 4.0 can be restrictive, mostly those with limited financial resources. There is a cultural resistance to change in Nigerian organizations, which makes it difficult to adopt new technologies and innovations and this could be the unimaginativeness of the individuals which enables them to be resistant. Nigerian organizations should create an environment that stirs up innovation and testing to conquer this prevailing cultural refusal to change. Also, with security and privacy concerns and alerts in the country, data security, and confidentiality pose a threat in Nigeria, in particular, the light of the highly increasing threats of cyber-attacks this is supported in Cao, Li & Li (2020),Carson (2021) and Omotayo et al., 2021). Also, more companies should ensure that they have with adequate security measures in order to shield away threats, whereas Amusan et al., (2021) talks about the insufficient amount of support from the Nigerian government side in terms of her policies and incentives to promote the industry's adoption and making this a challenge for most Nigerian organizations.

2.3 Managing Human Resources in Construction Industry

The role of Human Resources Management has evolved over the years, from being simply administrative to becoming more strategic in nature. As such, the duties of HRM have become more varied and complex, with a focus on achieving organisational goals and objectives through the effective management of the workforce. One major duty of the human resources manager is recruitment and selection, and this involves attracting and identifying the right candidates for the job, evaluating their skills and competencies, and selecting the best fit for the organisation. The role of the human resource manager is to find, develop and retain the right talent for the organisation (Chen, Zhang & Wang 2019),Chen, Zhang & Wang (2019)and Chen, Liu, Du, Gao & Lee (2021).

Another important duty of HRM is to provide training and development opportunities for employees. This involves identifying areas for improvement, developing training programs, and ensuring that employees have the necessary skills and knowledge to perform their jobs effectively. Training and development are key functions of human resource manager as it helps employees acquire new skills and knowledge that can help them grow and improve their performance (Deloitte, 2021). Human resources management is also responsible for managing the performance of employees. This involves setting performance objectives, providing feedback, and conducting performance appraisals. Performance management is critical to the success of any organization as it ensures that employees are aligned with organizational goals and objectives this is supported in Chen, Zhang & Wang

(2019),Chen, Zhang & Wang (2019),and Chen, Liu, Du, Gao & Lee (2021),Chiarello, D'Antonio & Panarello (2018).

Also, Human resources management, or HRM is responsible for managing employee compensation and benefits, including salaries, bonuses, and other incentives. This involves developing and implementing compensation and benefits policies and ensuring that employees are fairly compensated for their work. Compensation is not just about pay, it is about attracting and retaining the best talent for the organization. HRM is also responsible for managing employee relations, including handling employee grievances, and ensuring that the workplace is free from discrimination and harassment. This involves developing policies and procedures that promote fairness and respect in the workplace, the idea was supported in Coursera (2020), Dattijo (2022),Deloitte (2019),Ehab (2022), Enoch (2020),

2.4 Industry 4.0 Technologies Application in Firms.

Concerning the management of manpower, regardless of the ascent of robots, they are yet overseen by people. As per industry watchers, fabricating a superior assembling area with increased and computer-generated reality, mechanical technology and information investigation utilizing shrewd gear normally brings up a significant issue, or the question will Industry 4.0 manpower resemble? However, WEF questions if there will in any case be a requirement for individuals, who can oversee new tasks, deal with the robots, program them, and keep up with them (Adekoya, 2017). The research domain include the following: to carry out a situation analysis of the extent of adoption of Industry 4.0 technology on selected sites in Lagos State; to study the factors that influence the effective adoption of Industry 4.0 technology; to study the challenges involved in the adoption of Industry 4.0 technology in construction resources management of manpower and to study the critical success factor that influences the adoption of industry 4.0 for resources management of manpower on sites (Aguenza, Patil & Medikonda 2012,Aigbavboa, Thwala & Kikwasi 2020). Technology has become an integral part of the construction industry, and its application can lead to better outcomes, improved efficiency, and enhanced safety on construction sites. Technology is said to be the essence of people utilizing science-based understanding to answer applied challenges (Coursera 2020, Dattijo 2022,Deloitte 2019,Ehab 2022). In the current age of today, technology is found to be in all fields and used by both professionals and individuals. Industry 4.0 technologies are smart technologies, which entail them to be automated, versatile, and useful. In order words, these technologies can be used by construction firms in the management of their manpower, reduce costs, and improve safety, quality on construction sites and be more efficient (Jha, 2020). With the introduction of Industry 4.0 technologies, the construction industry is undergoing a paradigm shift toward automation and digitisation. Previously, the industry was known for its labour-intensive nature. Enhanced safety on construction sites is one of the most significant advantages of technology in the construction industry. According to Deilotte (2019), the construction industry is widely acknowledged as one of the most dangerous in the world due to its high rate of accidents and fatalities. However, the industry can achieve safer and more effective work practices by utilising IoT, AI, augmented reality, and robotics.

One of such technology is the Internet of Things (IoT), which can be used to monitor workers productivity and safety on construction sites as well as track the location and movement of workers and equipment for better coordination and scheduling. By monitoring the health of workers, the conditions of the surrounding environment, and the utilization of equipment, Internet of Things (IoT) technology can be utilized to enhance construction site safety. For instance, IoT sensors can be introduced on development hardware to screen their utilization, identify blames, and send cautions to upkeep groups for sure fire fix (Coursera 2020, Dattijo 2022,Deloitte 2019,Ehab 2022 and Enoch 2020,Wang et al., 2021). This technology can also be used to track where workers and equipment are, which helps with scheduling and coordination and reduces the chance of collisions or accidents. Artificial Intelligence (AI) is another technology that can be used, allowing construction firms to analyse data from various sources, such as worker schedules, weather forecasts, and equipment usage, to optimize resource allocation and predict labor demand. Computerised reasoning (AI) is one more innovation that can be utilized in the development business to further develop security.

3.0 RESEARCH METHODOLOGY

As presented in Mc-Combes et al, (2022), research method was described as section that describes actual work carried out in term of tool and procedure used, this view was also expressed in Mishra et al., (2017). In this study the challenges and issues involved in the adoption of Industry 4.0 in construction firms for the management of manpower on construction sites was investigated. This chapter constitutes the research work methodology that was acquired for this research.

3.2 Research Design

McCombes et al., (2022) submitted that research design could be described as method used in carrying out a research,the design of population frame, population size, choice of tools for analysis are all embodiment of a research design.It includes the choice of sampling technique, sourcing of data,m calibration of data collection instrument, pilot study among others The method of data collection incorporated for this research work would be a questionnaire. This would be well designed and given to specifically selected construction companies and in return requesting information from their responses. The use of questionnaires as a research design is to describe the perceptions, manners, and assessments of construction professionals and their experiences. The research design of this study is a quantitative descriptive method and was chosen to enable the researcher to gather specific details of the subjects of concern.

3.3 Research Method

The research method being embraced for the concentration of this study is qualitative research. In literature review, qualitative means going in depth with typically descriptive information.

3.4 Population Of Study

Population frame of construction companies legally registered with Lagos State Ministry of Works. This consists of 4 small scale to large-scale construction companies in Lagos State with twenty (20) Local Government Areas, according to the national population census counting in 2006. Entailing of governmental and non-governmental companies and would be handed over to actors in construction sites and firms. The population frame of 100 respondents from construction firms in Lagos state was used in this study.

3.5 Sample Size

This study is addressed to a total of 100 construction professional respondent. A sample size of 80 using the sample size template below by Krejcie & Morgan, 1970 was adopted for this study and it includes professionals such as Architects, Builders, Quantity Surveyors, HSE, Structural Engineers, Project Managers etc. A total of eighty (80) questionnaires were distributed as part of this research.

3.6 Data Collection

To address research questions or objectives, a research project's data collection refers to the methodical process of acquiring pertinent and trustworthy information or data. It makes use of a variety of techniques, including surveys, interviews, observations, experiments, and the gathering of pre-existing data from secondary sources. Data gathering guarantees that researchers have access to reliable and correct information for analysis and conclusion-making. Data collection must be meticulously planned and ethically carried out to guarantee data quality, participant anonymity, and adherence to research guidelines.

3.6.1 Questionnaire

A well calibrated questionnaire was used to collate opinion of the respondents and were later analyzed.

3.6.2 Tools For Data Analysis

The tools used to perform data analysis in this research are SPSS, Spearman Ranking, Simple Percentage, Mean Item Score, and Relative Agreement Index.

Relative Agreement Index was (RAI) were used to describe the fulfilment of judgment of the respondents. The formular is: Realitive (R).Agreement(A). Index(I)= 5SA + 4A + 3A + 2D + 1N/5(SA+A+SD+D+N)

Mean Item Score (M.I.S) was used in analysing the information gathered during the Research field survey. The formula is:

3.7 Sampling Techniques

To choose respondents from various professionals in the construction industry, a random sampling technique was employed. We acquired lists of organisations from websites and conducted personal interviews with professionals. Additionally, we administered the questionnaires during site visits.

4.2.1 Respondent Gender

Table 4.1 Results of Respondents' Gender

S/N	GENDER	FREQUENCY	PERCENTAGE
I	MALE	59	72.8
II	FEMALE	22	27.2
	TOTAL	81	100.0

Table 4.1 shows that (59) 72.8% of the sampled respondents are male and (22) 27.2% of the respondents are female. From the field survey of eighty-one (81) respondents that replied to the questionnaires, the greatest percentage number is 72.8% of which are male respondents, and the lowest percentage number is 27.2% of which are female respondents.

4.2.2 Respondents' Educational Qualification

Table 4.2 Results of Respondents' Gender

S/N	QUALIFICATION	FREQUENCY	PERCENTAGE
I	W.A.S.C.E	43	53.1
II	OND/ NCE	18	22.2
III	B.SC	20	24.7
	TOTAL	81	100.0

Table 4.2 shows that (43) 53.1% of the respondents have W.A.S.C.E qualifications has the greatest ranking, (18) 22.2% of respondents have OND/ NCE qualifications have the lowest ranking and (20) 24.7% of the respondents have B.SC. qualifications have the second-ranking. While (0) 0% of respondents have M.Sc. and PhD qualifications. From the data obtained, a total of 81 professional respondents.

4.2.3 Respondents' Profession

Table 4.3 Results of the profession of respondents

S/N	PROFESSION	FREQUENCY	PERCENTAGE
I	Builder	61	75.3
II	Structural Engineer	6	7.4
III	Quantity Surveyor	4	4.9
IV	Architect	4	4.9
V	Project Manager	4	4.9
VI	HSE	2	2.5
	Total	81	100.0

Table 4.3 shows that (61) 75.3% of the respondents are Builders have the highest ranking, (6) 7.4% of respondents are Structural Engineers have the second ranking, (4) 4.9% of the respondents are Quantity Surveyors, Architects, and Project Managers each respectively and stand as 3rd position and (2) 2.5% of the respondents are HSE personnel. The data collected shows a total of 81 respondents.

4.2.4 Respondents' Company Category

Table 4.4 Results of the profession of respondents

S/N	SCALE	FREQUENCY	PERCENTAGE
I	Medium scale (<100)	68	84.0
II	Small scale (<50)	10	12.3
III	Large scale (>100)	3	3.7
	Total	81	100.0

Table 4.4 shows that (68) 84.0% of the respondents are from medium-scale companies have the greatest ranking, (10) 12.3% of respondents are from small-scale companies have the second

ranking, (3) 3.7% of the respondents are from large-scale companies have the third ranking and (0) 0% are others. The data collected shows a total of 81 respondents.

4.2.5 Situation Analysis Of The Extent Of Adoption Of Industry 4.0 Technology On Selected Sites In Lagos State

Table 4.5 Situation analysis of the extent of adoption of Industry 4.0 technology on selected sites in Lagos state

S/N	SITUATION ANALYSIS OF THE EXTENT OF ADOPTION OF INDUSTRY 4.0 TECHNOLOGY ON SELECTED SITES IN LAGOS STATE	RAI	STANDARD DEVIATION	MEAN	RANK
I	Industry 4.0 has enhanced productivity on site.	4.4815	0.52705	0.8963	1st
II	Industry 4.0 technology has been implemented on this site.	4.4568	0.50123	0.8914	2nd
III	Industry 4.0 has been effectively integrated into the construction processes on this site.	4.4198	0.49659	0.8840	3rd
IV	Industry 4.0 has brought up exchange of skill and knowledge.	4.3951	0.49191	0.8790	4th
V	Industry 4.0 technology has been implemented on this site.	4.3827	0.48908	0.8765	5th
VI	Industry 4.0 has potential to improve the efficiency of construction processes on this site.	4.2963	0.45947	0.8594	6th
VII	It leads to an increased job satisfaction among workers on this site.	4.2840	0.45372	0.8568	7th
VIII	The knowledge of Industry 4.0 has spread effectively on-site.	4.2469	0.48813	0.8494	8th
IX	The Term 'Industry 4.0' is well familiar to works on construction sites	4.2222	0.47434	0.8444	9th
X	Applying Industry 4.0 has led to an emergency of quality job output on site	4.2099	0.43921	0.8420	10th

Table 4.5 shows the situation analysis of the extent of adoption of Industry 4.0 technology on selected sites in Lagos state. Industry 4.0 has enhanced productivity on site and came in 1st. Industry 4.0 has brought up the exchange of Technology transfer and enhanced craftsmanship on site and came in 2nd. Industry 4.0 has been effectively integrated into the construction processes on this site. came in 3rd. Industry 4.0 has brought up the exchange of skill and knowledge came in 4th. Industry 4.0 technology has been implemented on this site came in 5th. Industry 4.0 has the potential to improve the efficiency of construction processes on this site came in 6th with a relative agreement index of. It leads an increased job satisfaction among workers on this site came in 7th. The knowledge of Industry 4.0 has spread effectively on-site came in 8th. The Term 'Industry 4.0' is well familiar to works on construction sites came in 9th. Applying Industry 4.0 has led to an emergency of quality job output on-site came in 10th in ranking.

From this, the major factor that highlights the situation analysis of the extent of adoption of Industry 4.0 technology on selected sites in Lagos state is that Industry 4.0 has enhanced productivity on site. This means that by integrating these technologies into construction operations, productivity on site would significantly increase, leading to much quicker project completion, cost reduction, and improve overall efficiency in resource management and construction processes (Coursera 2020, Dattijo 2022,Deloitte 2019,Ehab 2022, Enoch 2020).

4.2.6 Factors That Influence The Effective Adoption Of Industry 4.0 Technology In Construction Resources Management

Table 4.6 shows factors that influence the effective adoption of Industry 4.0 technology in construction resources management of manpower

S/N	FACTORS THAT INFLUENCE THE EFFECTIVE ADOPTION OF INDUSTRY 4.0 TECHNOLOGY IN CONSTRUCTION RESOURCES MANAGEMENT	RAI	STANDARD. DEVIATION	MEAN	RANK

I	Lack of effective system to integrate Industry 4.0 technologies on site.	4.6173	.51400	0.9234	1st
II	Proliferation of technical expertise on application of Industry 4.0.	4.5679	.49845	0.9136	2nd
III	Disruption of supply chain and potential costs.	4.5062	.50308	0.9012	3rd
IV	Instability of government causing uncertainty and investment hindrance on site.	4.5062	.52734	0.9012	3rd
V	Poor perception on automation technologies.	4.4938	.50308	0.8988	5th
VI	Lack of political policies that support education and training to help create a skilled workforce.	4.4815	.50277	0.8963	6th
VII	Inability to reach expected ROI target.	4.4568	.50123	0.8914	7th
VIII	Inadequate to no availability of resources.	4.4321	.49845	0.8864	8th
IX	Cultural differences in collaboration styles, decision making processes and problem-solving strategies.	4.4198	.49659	0.8840	9th
X	Highly competitive pressure between companies to invest in Industry 4.0 technology.	4.4198	.49659	0.8840	9th
XI	Environmental aim to achieve sustainability goals.	4.3951	.49191	0.8790	11th
XII	Government policies and regulations	4.3704	.48591	0.8741	12th
XIII	Lack of technological framework for skill transfer	4.3580	.48241	0.8716	13th
XIV	Trade or tariff restrictions on importation of raw materials/technologies	4.3457	.47855	0.8691	14th
XV	Uncertainty of maintenance and support cost of Industry 4.0 technologies.	4.3457	.47855	0.8691	14th
XVI	Lack of integration of Industry 4.0 technology with existing systems and processes.	4.2963	.48591	0.8593	16th
XVII	Availability of awareness about industry 4.0 technology application.	4.2593	.49441	0.8519	17th
XVIII	Lack of available energy for technological operations.	4.2469	.46181	0.8494	18th
XIX	Digital divide that limit the extent of technology that could be imported.	4.0494	.75666	0.8099	19th
XX	Hinderance of environmental factors such as extreme temperatures and humidity on the technology operations.	4.0494	.73995	0.8099	19th
XXI	Resistance response of awareness about industry 4.0 technologies application.	4.0000	.65192	0.8000	21st

Table 4.6 shows factors that influence the effective adoption of Industry 4.0 technology in construction resources management of manpower. Lack of effective system to integrate Industry 4.0 technologies on site came in 1st. Proliferation of technical expertise on application of Industry 4.0 came in 2nd Disruption of supply chain and potential costs came in 3rd Instability of government causing uncertainty and investment hindrance on site came in 4th Poor perception on automation technologies came in 5th. Lack of political policies that support education and training to help create a skilled workforce came in 6th. Inability to reach expected ROI target came in 7th. Inadequate to no availability of resources came in 8th. Cultural differences in collaboration styles, decision making processes and problem-solving strategies came in 9th. Highly competitive pressure between companies to invest in Industry 4.0 technology came in 10th. Environmental aim to achieve sustainability goals came in 11th Government policies and regulations came in 12th. Lack of technological framework for skill transfer came in 13th. Trade or tariff restrictions on importation of raw materials/technologies came in 14th. Uncertainty of maintenance and support cost of Industry 4.0 technologies came in 15th. Lack of integration of Industry 4.0 technology with existing systems and processes came in 16th. Availability of awareness about industry 4.0 technology applications came in 17th. Lack of available energy for technological operations came in 18th. The digital divide that limits the extent of technology that could be imported came in 19th. Hinderance of environmental factors such as extreme temperatures and humidity on the technology operations came in 19th.

Resistance response of awareness about industry 4.0 technologies application came in 19th. From this, the major factor that shows factors that influence the effective adoption of Industry 4.0 technology in construction resources management of manpower is the lack of an effective system to integrate Industry 4.0 technologies on site. This means that without a well-designed and cohesive system for implementing, integrating technologies (Abdullahi, Adamu & Hamza 2021, Access Bank 2020).

4.2.7 Issues Involved In The Adoption of Industry 4.0 Technology In Resources Management in Construction Firms

Table 4.7 shows challenges involved in the adoption of Industry 4.0 technology in resources management in construction firms

S/N	ISSUES INVOLVED IN THE ADOPTION OF INDUSTRY 4.0 TECHNOLOGY ON CONSTRUCTION SITES	RAI	STANDARD DEVIATION	MEAN	RANK
I	Deficit framework for data management in areas of data processing, data analysis, and data storage system.	4.4815	.50277	0.8963	1st
II	Data security and privacy.	4.4074	.51908	0.8815	2nd
III	High cost of acquiring these technologies.	4.3951	.49191	0.8790	3rd
IV	Infrastructure deficits like power supply, poor connectivity, and transportation.	4.3457	.47855	0.8691	4th
V	Low level of digital literacy	4.2593	.44096	0.8519	5th
VI	Low or no support from government in forms of policies or incentives.	4.1605	.36935	0.8321	6th
VII	High rate of cultural resistance to change in technology and innovation adoption.	4.0370	.57975	0.8074	7th
VIII	Digital Divide.	3.9877	1.00615	0.7975	8th
IX	Unavailability of skilled workers or qualified professionals.	3.8025	1.07726	0.7605	9th
X	The current workforce is equipped to handle the changes brought about by the adoption of Industry 4.0 technology.	3.6790	.87788	0.7358	10th

According to Adekoya (2017) submitted that utilization of advanced mechanics in Nigerian assembling traces back to when robots were introduced in vehicle plants. From that point forward they have become ordinary in certain ventures, taking on jobs that could already just be completed by human laborers. As of now, neighbourhood gathering plants send the utilization of robots for certain cycles, while the Nigerian concrete industry currently conveys the utilization of robots to deal with a piece of its cycles to guarantee legitimate adjustment of its machines, so items satisfy managed guidelines. In Table 4.7 shows challenges involved in the adoption of Industry 4.0 technology in construction resources management of manpower on sites. Deficit framework for data management in areas of data processing, data analysis, and data storage system came in 1st. Data security and privacy came in 2nd. The high cost of acquiring these technologies came in 3rd. Infrastructure deficits like power supply, poor connectivity, and transportation came in 4th. A low level of digital literacy came in 5th. Low or no support from the government in the forms of policies or incentives came in 6th. A high rate of cultural resistance to change in technology and innovation adoption came in 7th. Digital Divide came in 8th. Unavailability of skilled workers or qualified professionals came in 9th. The current workforce is equipped to handle the changes brought about by the adoption of Industry 4.0 technology came in 10th .

From this, the key factor that impacts the influence of the adoption of Industry 4.0 technology in construction resources management of manpower on sites is the deficit framework for data management in areas of data processing, data analysis, and data storage system which involves

addressing these challenges by investing in robust data management infrastructure, implementing efficient data processing and analysis techniques, and establishing reliable and scalable data storage systems.

4.2.8 Critical Success Factors That Influence The Adoption Of Industry 4.0 Technology In Resource Management on Construction Sites.

Table 4.8 shows the critical success factors that influence the adoption of Industry 4.0 technology in construction resources management of manpower on sites.

S/N	CRITICAL SUCCESS FACTORS THAT INFLUENCE THE ADOPTION OF INDUSTRY 4.0 TECHNOLOGY IN CONSTRUCTION RESOURCES MANAGEMENT.	RAI	STANDARD DEVIATION	MEAN	RANK
I	Willingness to adapt and change processes to take advantage of the new technology.	4.3951	.49191	0.8790	1st
II	Training of skilled and unskilled ICT workers.	4.3086	.51580	0.8617	2nd
III	Setting up technological development leadership structure.	4.3086	.46481	0.8617	2nd
IV	Effective collaboration between internal departments and external partners.	4.2840	.45372	0.8568	4th
V	Availability of technological infrastructure.	4.2716	.52470	0.8543	5th
VI	Establishment of data analytics.	4.2716	.44756	0.8543	5th
VII	There is a tendency for return on investment (ROI) in efficiency, competitiveness, or productivity.	4.2593	.44096	0.8519	7th
VIII	Availability of cybersecurity system policy.	4.2222	.47434	0.8444	8th

Table 4.8 shows the critical success factors that influence the adoption of Industry 4.0 technology in construction resources management of manpower on sites. Willingness to adapt and change processes to take advantage of the new technology came in first with a relative agreement index of. Training of skilled and unskilled ICT workers and setting up technological development leadership structure came in second with a relative agreement index of. Effective collaboration between internal departments and external partners came in fourth with a relative agreement index of. Availability of technological infrastructure and Establishment of data analytics came in 5th. There is a tendency for return on investment (ROI) in efficiency, competitiveness, or productivity came in 7th availability of cybersecurity system policy came in 8th with a substantive relative agreement index. From this, the key factor that impacts the critical success factors that influence the adoption of Industry 4.0 technology in construction resources management of manpower on sites is the willingness to adapt and change processes to take advantage of the new technology which involves embracing digital transformation, redefining workflows, and adopting new tools and systems to optimize resources management (Lekan, Clinton, Stella, Moses, Biodun 2022; Lekan, Aigbavboa, Emetere 2023).

4. CONCLUSION

The discussion of findings for this study is showcased at this section part. From the data analysis findings, it is revealed that the majority that responded to the questionnaires were males with a percentage ratio of 72.8% , meanwhile, the minority of respondents that responded to the questionnaire were females with a percentage ratio of 27.2%. 53.1% of the respondents have a W.A.S.C.E academic qualification, 22.2% of the respondents have OND/ NCE academic qualifications, 24.7% of the respondents have a B.SC academic qualifications, 0% of the respondents have M.SC and PH.D academic qualifications. 75.3% of the respondents are Builders, 7.4% of the respondents are Structural Engineers, 4.9% of the respondents are Quantity Surveyors, Architects and Project Managers each respectively and 2.5% of the respondents are HSE personnels. 12.3% of respondents were from medium scale companies (<100), 12.3% of respondents were from small scale companies (<50) and 3.7% of respondents were from large scare comp scale companies.

From the extractions of this research study, there are features used to examine the challenges involved in the adoption of industry 4.0 technology for resources management of manpower in construction firms in Nigeria, Lagos State they are: the situation analysis of the extent of adoption of Industry 4.0 technology on selected sites in Lagos state, factors that influence the effective adoption of Industry 4.0 technology in construction resources management of manpower, challenges involved in the adoption of Industry 4.0 technology in construction resources management of manpower on sites and the critical success factors that influence the adoption of Industry 4.0 technology in construction resources management of manpower on sites (Lekan, Clinton, Stella, Moses, Biodun 2022).

However, from the research findings, it was discovered that the factor "Industry 4.0 has enhanced productivity on site " ranked the greatest. This indicates that the respondents believed that implementing industry 4.0 would bring about efficiency.

Furthermore, "lack of effective system to integrate Industry 4.0 technologies on site" was the greatest factor that influence the effective adoption of industry 4.0 technology in construction resources management of manpower. This interprets that proper structured systems should be in place.

Additionally, "Deficit framework for data management in areas of data processing, data analysis, and data storage system "ranked as the highest challenges involved in the adoption of Industry 4.0 technology in construction resources management of manpower on sites. This means investing in new data systems that are scalable. Lastly, "Willingness to adapt and change processes to take advantage of the new technology" ranked as the highest critical success factors that influence the adoption of Industry 4.0 technology in construction resources management of manpower on sites. This means that respondents agreed to creating new tools, re-strategizing systems and embracing technologies.

5.Recommendation

Given that Industry 4.0 has or will increase productivity on building sites, it is advisable for construction companies in Lagos State to think about using Industry 4.0 technologies into their business practices. To increase overall efficiency and production on the job site, this may entail implementing intelligent automation systems, cutting-edge equipment, and data-driven procedures. Construction companies should spend in creating a strong technological infrastructure to solve the absence of efficient integration systems and the requirement for technical know-how in adopting Industry 4.0 technologies. To assist the adoption and use of Industry 4.0, this would involve putting integrated software solutions into place, offering training courses so that staff members may pick up necessary skills, and cultivating alliances with technology companies or consultants.

Construction companies should give the issues with data management, processing, analysis, storage, security, and privacy as a top priority. This can be accomplished by putting in place reliable data management systems, using cybersecurity safeguards, and making sure that data protection laws are followed. Effective solutions to these problems can be achieved by working together with IT specialists or data management specialists.

To accept Industry 4.0 technology, construction companies should promote a culture of flexibility and change. This entails fostering an atmosphere that promotes innovation, giving skilled and unskilled people chances for ongoing training and upskilling, and putting in place solid leadership structures to promote technological growth and adoption.

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