INTERNATIONAL JOURNAL OF BUSINESS AND MANAGEMENT RESEARCH
P-ISSN: 1118-4256, E-ISSN:3034-4327
Vol. 5| No.3 | December 2024
Page No.: 172 - 189

ARTIFICIAL INTELLIGENCE AND OPERATIONAL EFFICIENCY OF LAFARGE CEMENT COMPANY PLC, AKPABUYO CROSS RIVER STATE, NIGERIA

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Abstract

Artificial intelligence enhances operational performance in cement companies in Nigeria by optimizing production processes, reducing energy consumption, and improving predictive maintenance for machinery. Therefore, this study focused on the nexus between artificial intelligence and operational performance in Lafarge Cement Company Plc, Akpabuyo, and Cross River State, Nigeria. Specifically, the study examined the relationship between the robotic automation process and operational efficiency. The study adopted a survey research design. The population comprises the top management cadre (64) and the middle management (108). Convenience sampling techniques and Taro Yamenes' formula

were used to determine the sample of 120. With the aid of SPSS IBM version 25, Pearson Moment coefficient correlation analysis was used to test the hypotheses. Results obtained from the test of the formulated hypothesis shows that the robotic automation process has a significant and positive relationship with operational efficiency in Lafarge Cement Company plc (P < 0.05; r =.214). The study concluded that the integration of robots in cement manufacturing can lead to significant improvements in efficiency, safety, and quality. The study recommended that leveraging automated processes will boost operational efficiency.

Keywords: Artificial Intelligence, Operational efficiency**,** *Robotic Automation,* and Cement Company

1.0 Introduction

Globalization and the technological era have reshaped today's business world through the evolution of artificial intelligence in operations of both the service and manufacturing industries. Artificial intelligence is a relatively young field of computing and automation that creates machines that can perform actions that would previously require human faculties (Ibekwe & Opigo, 2020). This activities has spread to other field of human endeavour. Artificial intelligence refers to the ability of `machines to mimic intelligent human behaviour´ (Syam & Sharma, 2018), encompassing the subdomains of machine learning, neural networks and deep learning (Shrestha, Krishna, & von Krogh, 2021; Sze, Chen, Yang & Emer, 2017). Artificial intelligence, according to Gurpartap (2017), is the capacity of robots to think, comprehend, reason, and react to outside stimuli like that of organic things. Artificial intelligence is capable of mimicking human intelligence in a variety of tasks that call for analytical learning and thinking, problem-solving, and decision-making (Shabbir & Anwer, 2015). The basis for artificial intelligence business applications has been laid by the significant advancements in cognitive computing and natural language processing brought about by the quick growth of machine learning and deep learning (Bughin et al., 2017). Machine learning techniques produce the most accurate forecasts, according to Albrecht, Rausch, and Derra (2021); however, Ma and Sun (2020)

contend that artificial intelligence (AI) produces accurate predictions that support operational decisions and enhance an organisation's performance as a whole. Thus, we expect that the introduction of artificial intelligence in the manufacturing industry will improve operational inputs and outputs.

Lohr (2017) opined that many businesses take up artificial intelligence (AI) technology to reduce operational costs, increase efficiency, grow revenue, and improve customer experience. For the greatest benefits, businesses look at putting on or investing in the full range of smart technologies; including robots, machine learning, data mining, Internet of Things (IoT), and natural language processing, amongst others, into their processes and products (Ibekwe & Opigo, 2020).

In emerging markets, artificial intelligence provides a technological solution to the economic challenges faced by firms, and people at the bottom of the economic pyramid. Integrating data from multiple sources (e.g., websites, social media, and traditional channels) can help manufacturing firms build data management platforms, develop sound business strategies, lower barriers to doing business, create innovative business models, and spur economic development (Arora & Rahman, 2017). Manufacturing firms in developing countries may use innovative AI-based solutions to enhance autonomous goods and service delivery, implement production automation, and develop mobile AI apps for services and credit access (Strusani & Houngbonon, 2019). Artificial intelligence plays a pivotal role in enhancing efficiency by enabling predictive maintenance, optimizing production schedules, and streamlining supply chain logistics (Adebayo, Obiuto, Olajiga & Igberaese, 2024; Lee, Singh, Azamfar, & Pandhare, 2020). The adaptability of AI-driven robotic systems allows them to seamlessly adjust to changes in production demands, product variations, and environmental conditions (Adebayo et al., 2024; Huang, Shen, Li, Fey, & Brecher, 2021).

According to McKinsey Global Institute (2018), the use of largely automatic equipment in a system of manufacturing will produce a shift away from fundamental cognitive skills towards technology skills (Woetzel, Madgavkar, Seong, Manyika & Sneader, 2018). By 2025, human-machine collaboration may lead to the elimination of 85 million employment while creating 97 million new ones through a new division of labour between humans, robots, and algorithms (Hepaktan & Şimşek, 2022). Because of this, workers are constantly under pressure to upskill and reskill in order to stay up with the demands of the machine (Li, 2022). Even with the range of alternatives made possible by integrating cutting-edge technologies in human resource management, workers can still complete many activities that machines cannot (Vrontis, Christofi, Pereira, Tarba, Makrides & Trichina, 2023). Therefore, previous research suggests that rather than artificial intelligence completely replacing humans, the organisation will benefit most from AI integration with human resources (Jarrahi, 2018).

Numerous earlier studies imply a connection between artificial intelligence and corporate effectiveness. Several academics, like Ibekwe and Opigo (2020) and Clark (2015), have argued in the literature that artificial intelligence can be a valuable instrument for achieving effective outcomes in the manufacturing sector. All contemporary firms must acknowledge that investing in artificial intelligence is a necessary means of lowering operating costs, boosting productivity, expanding revenue, and enhancing customer satisfaction. This study aimed at answering this stated research question:

i. What is the relationship between robotic process automation and the operational efficiency of Lafarge Cement Company Akpabuyo Cross River State?

2.0 Review of Related Literature

Artificial Intelligence

Artificial intelligence is technological tools that imitate human. Artificial intelligence (AI) is a collection of information communication technologies (ICTs) that imitate human intelligence for the primary purpose of improving jobs, creating greater efficiencies, and driving economic growth (Arakpogun, Elsahn, Olan, & Elsahn., 2021). Vazquez and Goodwin (2024) referred to artificial intelligence in business as the use of tools of AI like computer vision, language processors and machine learning to enhance business operations and boost the productivity of the workers and the overall business outcomes. Zhou, Fu and Yang (2016) opined that artificial intelligence possesses the capability of a computer or computer-controlled robot to act upon tasks usually related to intelligent beings.

Artificial Intelligence will allow the organisation to increase its efficiency in human resources, operation, supply chain, customer experience, improved products, and quick services (Kuzey, Uyar, & Delen, 2014; Pwc, 2019).

Robotic Process Automation

Al-driven automation has the potential to streamline operations and increase efficiency in various business processes (Syeda, 2023). Chui (2023) cited in Syeda (2023) demonstrated how Al-based robotic process automation can reduce manual workloads and enhance productivity. Businesses can better manage resources and concentrate on value-added activities by automating repetitive operations.

Artificial intelligence's introduction marked a major advancement in the field of factory robotics (Adebayo et al., 2024). Conventional industrial robots had little adaptability due to their rigid programming. Robots are now capable of processing real-time data and making dynamic judgements and modifications during industrial processes because of AI-enhanced control systems (Sun et al., 2021). Better operational performance and adaptability could result from this flexible automation, which uses robots, increases

manufacturing agility and enables companies to react quickly to changes in the market and customer needs (Ilugbusi, Akindejoye, Ajala, & Ogundele, 2020).

Robots enhance workflow efficiency by taking over repetitive or physically demanding tasks, allowing human workers to focus on more complex and cognitive aspects of production (Adeleke, Segun, & Olaoye, 2019). This will ensure just-in-time workflow for its accuracy in material handling, which will reduce lead time in manufacturing processes.

Operational Performance

Performance is a sweeping meter that assimilates productivity and quality, uniformity, and other factors (Ikegwuru & Acee-Eke, 2020; Ikegwuru, Jack & Amadi, 2023). Previous scholars in the field of performance management have discussed performance solely as operational and financial perspectives that impact directly on organizational competitiveness and strategies (Grinyer, Mckiernan, & Yasaiardekani, 1988; Neider & Schriesheim, 1988; Scholz, 1988; Olan, Arakpogun, Suklan, Nakpodia, Damij, & Jayawickrama, 2022). According to Davis and Schul (1993), Olan et al. (2022), and Priem (1994), the operational approach places greater emphasis on the organisational success elements that lead to the long-term competitive edge, such as cost management, process management, and overall quality control. On the other hand, the financial viewpoint typically pertains to an evaluation of the entity's resources and obligations, as well as the methods by which income is produced to mirror the financial reports of the organisation (Lin & Carley, 1997; Roland, Cronin, Guberman, & Morgan, 1997). To achieve organisational objectives like operational excellence, financial aims, and customer happiness, technology plays a critical role in enhancing operational performance (Olan et al., 2022). Furthermore, it is thought that operational performance is crucial to quality management procedures (Shar, Onwuchekwa, & Anoke, 2024). Operational performance is defined as the strategic dimensions of competing firms and consists of operational-level indicators, such as flexibility and delivery (Chavez, Yu, Gimenez, Fynes, & Weingarten, 2015).

Operational Efficiency

Operational efficiency is the ability of an organisation to deliver a quality product with less cost of production. Operational efficiency is a term used to describe the state or level at which a manufacturing firm is producing the greatest number of units while utilizing the least number of resources possible (Okwu, Bagshaw, & Florence, 2024). The idea is to achieve a balance of task assignments in the workstations so as not to overload or under-load a given workstation (Bagshaw, 2020). Operational efficiency is frequently accomplished by streamlining firms' centre operations to viably react to persistently changing market forces in a more cost-effective way (Anoke, 2022). In other words, firms can achieve operational efficiency by decreasing repetition and squandering leveraging their assets that contribute generally to their victory; additionally, utilizing the best of their workforce, innovation and business operations.

According to McClay (2019), operational efficiency entails the maximum use of available resources including raw materials and labour to create high-quality products and services. In this study, operational efficiency is measured in product quality and timely delivery.

Theoretical Framework

The foundation of this research is Dynamic Capability Theory.

Dynamic Capability Theory

The dynamic capability theory was developed by Teece and Pisano (1994) and is the extension of the resource-based view (RBV) of the firm (Barney, 1986, 1991). Based on the RBV, firms in similar industries perform differently because they have different kinds of resources and capabilities (Barney, 1986, 1991; Peretaf, 1993) whereas RBV is considered static and insufficient to explain the competitive advantage of the firm in a changing market environment (Priem & Butler, 2001). Dynamic capability assumes the ability of the firm to combine, develop, and reconfigure external and internal expertise to

respond to a speedily changing environment. By incorporating AI into the dynamic capability theory framework, an organization's ability to recognize opportunities, act upon them, and reallocate resources toward long-term success is highlighted (Warner & Wäger, 2019). In addition to increasing productivity and creativity, AI makes sure that businesses are flexible and adaptable when faced with sustainability issues (Dwivedi et al., 2021). Businesses can achieve long-term sustainable growth by using AI to balance economic, environmental, and social aims (Zhao & Fariñas, 2023). The theory of dynamic capability centres on the ability of an organization to effectively integrate, construct, and reorganize both internal and external competencies in response to swiftly evolving environments (Wang & Shi, 2011). For example, AI drives sustainable performance in a variety of ways, including AI contributes to the efficient use of natural resources, reducing waste, and minimizing the negative environmental effects (Kar, Choudhary & Singh, 2022). Artificial intelligence tools can help organizations stay ahead of sustainability challenges by continuously checking the effects on the environment, changes in regulations, and technological advancements (Ahmad et al., 2021).

Dynamic capacity theory is relevant to artificial intelligence and manufacturing firms as it underscores the importance of adaptability and responsiveness in a rapidly changing environment. By integrating artificial intelligence, manufacturing companies can enhance their capacity management, leading to improved performance and competitiveness.

Empirical Review

Prabu, Venkata, Pranjali, and Poornima (2024) explored the application of artificial intelligence in business operations and its impact on organisational performance in India. A sample of 214 people from different departments of business organizations were surveyed with the help of a questionnaire. Convenient sampling method was used to collect the primary data and multiple linear regression was applied to get the results. The study concludes that there is a significant impact of AI on organizational performance.

Al-Balushi, Singh, and Al-Shibli (2024) assessed the impact of artificial intelligence, and human capital on the sustainable performance of manufacturing companies in Malaysia. The study highlighted the key value of artificial intelligence and sustainable performance for the consideration of the owners/managers of Malaysian SMEs in the manufacturing sector. The study used both Dynamic Capability concepts (DCT) and Resource-Based View (RBV) concepts. The conceptual model of the research was constructed from the systematic literature. The current study proposed a favourable association between artificial intelligence, human capital, and sustainable performance based on the conceptual model that was developed. Additionally, artificial intelligence and sustainable performance are positively correlated. Furthermore, the study suggests that human capital acts as a mediator in the connection between artificial intelligence and long-term success.

Abubakar and Momoh (2024) examined the effect of artificial intelligence (AI) on the efficiency of business operations. It investigates the effects of high technology adoption, mobile phone subscriptions, and public-private partnerships on AI-driven technologies on company productivity in the business environments of Nigeria and the Gambia. Using the multiple regression technique, a thorough overview of AI's influence on the efficiency of the business environment was produced, providing stakeholders, business leaders, and policymakers with insightful information. The significance of the universal uses of artificial intelligence to increase corporate efficiency globally is not diminished by the differences in the impact of AI adoption and subscription between the two countries. In order to promote global company efficiency, the report suggests embracing the use of high-tech and increasing mobile subscriptions and public-private collaborations as components of AI.

Ikegwuru, Jack and Amadi (2023) evaluated the nexus between artificial intelligence and organisational performance using empirical analysis. The population of the study was drawn from the eleven (11) mainstream oil and gas companies which are

quoted on the Nigerian Stock Exchange and the population is also assumed as the sample size since it is less than 30. Using a sample frame of sixteen (16) respondents per firm, the simple random sampling approach was used to select one hundred and seventy-six (176) respondents for the study. In place of alternative statistical techniques like non-parametric testing, a structured questionnaire anchored on a five-point Likert scale spanning from strongly disagree to strongly agree was used to evaluate the cause-effect association between two or more variables. The present study employed descriptive analysis, namely presenting the mean and standard deviation, to underscore the dependability and accuracy of the estimated data. The results of a confirmatory factor analysis show a substantial relationship between the application of artificial intelligence and organisational effectiveness. Thus, the study comes to the conclusion that the use of artificial intelligence is highly correlated with the organisational performance of Nigerian mainstream oil and gas businesses.

Himanshu, Chandrika and Rabindra (2021) analysed the impact of artificial intelligence on the operational performance of Indian companies. Artificial Intelligence is measured by variables such as computer hardware and intangibles (computer software etc.). The operating profit and operating cost have been taken as the proxy variables for the operational performance of companies. Secondary data gathered from sample companies' annual reports served as the study's foundation. The manufacturing, communications, and information technology companies that make up the sample corporations under investigation span the years 2004 through 2018. The panel regression model and t-test have been run for statistical conclusions using Ms. Excel and EViews 10, the statistical software. According to the report, artificial intelligence significantly affects both the operating costs and operating profitability of businesses.

Ibekwe and Opigo (2020) evaluated the effect of artificial intelligence on the organizational performance of manufacturing companies in Port Harcourt. The fifty-six (56) general managers of Port Harcourt-based manufacturing firms made up the study's

population. To determine whether to accept or reject the hypotheses, the data were collected using a structured questionnaire. The Pearson product-moment coefficient of correlation was used to evaluate the data, and t-statistics were used to examine the significance of the effect at a 5% level of significance. The results from the analysis showed that artificial intelligence has a positive significant effect on organizational performance in manufacturing companies in Port Harcourt.

3.0 Methodology

This study adopts a survey research method. The population is 172 which was drawn from the top management (64), and middle management staff (108). The statistical formula devised by Taro Yanenes' was used to determine sample size of one hundred and twenty (120) respondents, and convenience sampling technique was adopted to select respondents for the study base on their knowledge on the subject. A sample frame of fourty-five (45) for the top management and sevenity-five (75) for the middle management staff using bowley formula to distribute the questionnaire. A structured questionnaire anchored on a five point Likert scale ranging from strongly disagreed to strongly agree was adopted. The content and face validity were used to validate the research instrument through the expert option. The reliability of the instruments was ensured by piloting the questionnaire with twenity staff who are not part of the study element. From Table 1 below, the result reveals that the coefficient of the construct of the Cronbach Alpha reliability test is .704, which shows that the instrument has strong internal consistency and is considered to be fit. The study hypotheses were tested using Pearson Moment coefficient correlation analysis. The study encountered some limitations from the management-level staff who were reluctant to fill out the questionnaire until they were assured of confidentiality.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
704	.706	3

Source: SPSS Output IBM version 25

4.0 Result

Data were collected through a six (6) item questionnaire administered to the respondents. Subsequently, one hundred and twenty (120) copies of the questionnaire produced were distributed to the respondents. Out of the 120 copies issued, 98 representing 82% were retrieved while 22 copies representing 18% were properly filled.

Analysis of Data Related to Research Question

Decision Rule:

The decision in the analysis section is determined by the average of the response of respondents. Strongly Agreed (5 points), Agreed (4 points), Undecided (3 point), Disagreed (2 points), and Strongly Disagreed (1 points). The average of the responses:

$$\frac{(5 + 4 + 3 + 2 + 1)}{5} = 3.0$$

Therefore, mean score below 3.0 would be considered as rejected and mean score of 3.0 and above will be considered as accepted.

Table 2: Analysis of responses to the question on the relationship between robotic automation process and operational efficiency

S/N	Items	SA	A	N	D	SD	Mean	Remark
	Robotic Automation Process	**5**	**4**	**3**	**2**	**1**		
1	Robot enables human workers to focus on more complex task	50 (51%)	42 (43%)	6 (6%)			4.45	Agree
2	Robot are equipped with AI algorithms that enable them to interact with human and workflow system	30 (31%)	52 (53%)	12 (12%)	4 (4%)		4.10	Agree
3	Robot enhance minimization of downtime	16 (16%)	48 (49%)	8 (8%)	18 (19%)	8 (8%)	3.47	Agree
	Operational Efficiency							
4	Automation of processes reduces operational cost	24 (25%)	46 (47%)	10 (10%)	16 (16%)	2 (2%)	3.76	Agree

5	Automation of routine tasks enhance efficient service delivery	26 (27%)	68 (69%)	4 (4%)			4.22	Agree
6	Automation enhances product quality	20 (21%)	50 (51%)	6 (6%)	18 (18%)	4 (4%)	3.65	Agree

Source: Filed Survey, 2024

Table 2 analysed the responses of the respondents regarding the relationship between robotic automation process and operational efficiency in Lafarge Cement Company plc. From the data analysis, items 1, 2, 3, 4, 5, and 6 obtained a mean rating above the criterion mean of 3.0. The result of the analysis indicated that the majority of the respondents supported that there is a relationship between robotic automation process and operational efficiency in Lafarge Cement Company plc.

Correlations

		Robotic automation process	Operational efficiency
Robotic automation process	Pearson Correlation	1	.127
	Sig. (2-tailed)		.214
	N	98	98
Operational efficiency	Pearson Correlation	.127	1
	Sig. (2-tailed)	.214	
	N	98	98

Source: SPSS Output version 25

Interpretation

The results show that the Pearson correlation co-efficient index between the robotic automation process and operational efficiency is r = .214, Sig = .000, less than .05. This suggests a moderate positive significant relationship between the robotic automation process and operational efficiency in Lafarge Cement Company plc. The result therefore implies that with more efforts to increase automated processes will improve effective service delivery, and there will be greater chances of improving operational efficiency and the reverse is true.

Discussion of Findings

The finding revealed that robotic automation process has a significant and positive relationship with operational efficiency in Lafarge Cement Company plc. This finding

supports the dynamic capability theory, which states that the ability of the organisation to combine, develop and reconfigure external and internal expertise in order to respond to speedily changing environment. The study finding is in line with the study of Al-Balushi et al. (2024), Abubakar, and Momoh (2024), Ikegwuru et al. (2023), whose findings revealed that implementation of artificial intelligence through robotic automation process have a very high effect on organisational performance.

5.0 Conclusion

Artificial intelligence is increasingly becoming important for organizations to create business value and achieve a competitive advantage. However, the integration of robots in cement manufacturing can lead to significant improvements in efficiency, safety, and quality. Furthermore, a balanced approach that combines robotics with human skills may offer the most sustainable path forward, ensuring both technological advancement and workforce stability in the industry.

6.0 Recommendations

The company should leverage automated processes to boost operational efficiency. The implication is that the use of robotic automated processes will help to monitor product quality in real-time, and minimization of workplace injuries.

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