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Efficiency of Artificial Intelligence among Engineers in Manufacturing Firms in Nigeria

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A B S T R A C T

This study examined "Efficiency of Artificial Intelligence among Engineers in Manufacturing Firms in Nigeria". Methodology: Relevant data were drawn from selected journals, textbooks. Qualitative content analysis was used to analyze the data. Study conclusion and policy recommendations: The study concluded that the efficiency of artificial intelligence (AI) among engineers in manufacturing firms in Nigeria reflects both promising potential and significant challenges. Empirical evidence suggests that AI technologies, when effectively adopted, enhance productivity, accuracy, and task performance by automating routine engineering processes, enabling real-time monitoring, and improving data-driven decision-making. In firms with sufficient infrastructure and skilled personnel, AI integration has already resulted in measurable gains, such as reduced downtime, faster maintenance cycles, and improved product quality. Finally, the study recommends that to enhance the efficiency of artificial intelligence among engineers in manufacturing firms in Nigeria, it is recommended that firms invest in continuous training and capacity-building programs to equip engineers with the necessary AI-related technical skills. Government and private sector collaboration should be strengthened to improve digital infrastructure, such as stable power supply and high-speed internet, which are critical for the smooth operation of artificial intelligence systems.

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INTRODUCTION

Over the last few years, Nigeria has made several attempts to implement digital technologies that would lead to the growth of its industrial sector and the overall competitiveness of the manufacturing sector. Through the government's digital promotion, Industry 4.0, and technical skill development strategies, it has become clear that AI is being considered one of the most effective tools for raising productivity, reducing waste, facilitating quality control, and lowering operating costs. Manufacturing firms, which are among the most heavily impacted by the high costs of materials, energy, and labor, are the primary beneficiaries of the solutions offered by AI. In these companies, it is the engineers who redesign, supervise, and maintain the production systems, and through their capacity to implement, use, and modify AI technologies, the question of whether the efficiency gains will appear or not becomes a matter of their competence.

Reports backed up by data in Nigeria demonstrate that implementing AI technology in manufacturing has a positive correlation with the flow of productive efficiency, quality of decision-making, and the ability to compete with other companies. The study by Amaugo (2024) is a perfect example, as it shows that the two companies Dangote Cement Plc and Nigerian Breweries Plc, the more AI was integrated, the less downtime, the fewer errors were made by the staff, and the overall performance of the operations was elevated (Amaugo, 2024). Moreover, the study on business process automation, conducted in Nigeria, revealed that the manufacturing sectors that implemented AI had a significantly stronger position in the competition. The reason for it was that they efficiently managed to adjust to the market's dynamism, cut their production costs, and innovated at a faster pace (Amaugo, 2024; Amaugo et al., 2024). Nonetheless, most of these optimistic accounts are from reports of big companies that are financially and technically strong to start off with, and thus, there is still the issue of how small and low-resourced businesses, along with their engineering staff, perceive AI adoption and efficiency.

Notwithstanding the potential benefits, several constraints complicate the realization of AI’s promise in the Nigerian manufacturing sector sounds confused with the different list of obstacles faced by the industry. One of the top issues mostly talked about is infrastructure that is not enough: electricity supply that is not reliable, internet connectivity that comes and goes, and equipment that is old or not compatible with cutting-edge technology give the companies a hard time to use AI systems that are usually stable, require high bandwidth, and are made of the latest hardware (Akinola, 2023). Besides the problem of infrastructure, a lack of human resources is the main reason: the skills required for data science, machine learning, systems integration, and AI upkeep are persistently lacking. The staff that is engaged in engineering could be well trained in the general engineering field, but normally, they do not have the necessary AI skills, especially in situations where the formal curriculum or in-house training is not quite enough for the latest developments (PwC Nigeria, 2024; "Adoption of Smart Factories in Nigeria," 2024). Financial issues also hold Nigeria back, in addition to all the other challenges in Nigeria. The initial steps to get software/hardware for AI, system deployment, data collection,

processing, and even providing for a few updates are most of the time unaffordable, especially for small and medium enterprises (SMEs) in the manufacturing sector (Akinola, 2023; Amaugo, 2024).

Besides the tangible infrastructure and financial problems, there are also the organizational and human dimensions that influence the impact of artificial intelligence on engineering efficiency. The engineers' mood towards AI, the feeling of usefulness, and the trust in AI systems are highly potential factors for the uptake and the following use. The performance increase, which is co, expected from the deployment of AI, may be slowed down by resistance to change, fear of losing a job, or the unreliability of AI, in particular. Additionally, organizational aids, e.g., the reward system, leadership commitment, and continuous training policies, may have the potential to alter the efficiency yield of AI. For example, recent research of manufacturing firms in North, Central Nigeria revealed that the performance improvement due to AI was more than twice as high when a strong reward system was established to acknowledge or motivate the engineers' contributions towards the AI-related objectives (Amaugo, 2024).

Even though research is widely increasing, there are still sizable gaps. The first gap is the lack of a detailed engineering work focus, along with only the performance of firms as a whole (aggregate). Many studies look at various performance metrics (i.e., productivity, competitiveness, or profitability of markets), but few of those concentrate on how AI changes the task composition, time allocation, error rates, decision-making speed, and required competencies of engineers. Another gap is the lack of tracking efficiency using longitudinal data before, during, and after the implementation of artificial intelligence, to identify not only short-term disruptions but also if efficiency gains last and what organizational or contextual factors support the sustained improvements. Moreover, most of the studies emphasize large or flagship firms; small and medium manufacturers are not adequately represented, particularly how engineering staff in these firms deal with resource constraints. Lastly, there is little consideration of moderating variables specific to the Nigerian context, such as the governmental policy environment, energy stability, regulatory support, and cultural attitudes toward automation in shaping artificial intelligence efficiency outcomes. Taking all these into account, this study is brought about by questions regarding how engineers in Nigerian manufacturing firms experience and contribute to efficiency when artificial intelligence is introduced, what factors enable or hinder those efficiency gains, and how firm, infrastructure, human, and policy level variables interact. This study, by tightly focusing on engineers' perceptions, skills, workflow changes, and output metrics, can help unravel what it is that makes artificial intelligence successful in manufacturing settings in Nigeria and thus guide both business strategy and public policy. it is to this that the study centres on the Efficiency of Artificial Intelligence Among Engineers in Manufacturing Firms in Nigeria.

Statement of the Problem

In spite of the worldwide acknowledgement of artificial intelligence (AI) as a game changer in the manufacturing sector, its adoption and effect on the

engineering efficiency of Nigerian manufacturing firms have remained irregular, not well-documented, and riddled with systemic challenges. Some big Nigerian manufacturers have already started to utilize artificial intelligence tools to automate their processes, carry out predictive maintenance, and maintain quality standards. However, the extent to which these technologies have led to the operational efficiency of engineering tasks through empirical research is still very low. The majority of these firms still use traditional methods and human judgment for decision-making in many areas where AI could provide faster, more accurate, and cheaper solutions. The situation reveals that the efficiency potential of AI has not yet been achieved to the maximum in the engineering departments of most Nigerian manufacturing firms.

Numerous reasons contribute to the gap. One of the reasons is that engineers do not have the specific training that they need to fully carry out AI implementations due to their limited exposure in school and the lack of professional development programs in the organization. Besides, even if AI is in place, the malfunctioning of infrastructures such as unstable power supply, slow internet, and old equipment can result in their inefficient operation. Another point is that these employees might not be willing to extend full cooperation to the systems due to a fear of job loss, a lack of confidence in the AI outputs, and resistance to change. Furthermore, the problems associated with management, like weak support from the top, lack of clarity in performance incentives, and the absence of structured policies for digital transformation, worsen the situation. Moreover, most of the studies that exist now about the use of artificial intelligence in Nigeria generally zoom out to the economic or strategic perspective of AI, leaving questions about the interaction of the technical staff of the manufacturing sector engineers with the new technologies, and whether their work processes, output, or decision-making have changed for the better. A focused study on how AI incorporation directly affects engineering efficiency in the Nigerian milieu, particularly dealing with local infrastructure, culture, and skills, is the only way for decision-makers to be sure they are investing their funds prudently. Hence, the question of which AI is the cause or solution to engineering inefficiency in Nigerian manufacturing firms remains critical, as well as the inquiry into which contextual factors act as determinants of these outcomes. it is to this that the study centers on the Efficiency of Artificial Intelligence Among Engineers in Manufacturing Firms in Nigeria.

Objectives of the Study

i) Assess the current level of artificial intelligence adoption and integration within engineering operations in Nigerian manufacturing firms
ii) Evaluate the perceived and actual impact of artificial intelligence tools on the productivity, accuracy, and task performance of engineers
iii) Investigate the challenges engineers face in utilizing artificial intelligence technologies effectively in the Nigerian manufacturing context

LITERATURE REVIEW

For this research, the researchers opted for content analysis with a systematic and qualitative approach as their method. In this case, the relevant materials are newspapers, textbooks, journals, articles, and other written records dealing with the use of artificial intelligence for the efficiency of engineers in manufacturing firms in Nigeria. Hence, secondary data collection methods were used for the research/study. Data and information were taken from such places as Google Scholar, IEEE Xplore, ScienceDirect, and SpringerLink. Keywords focused on terms like Artificial Intelligence, engineers, and manufacturing firms. The study was restricted to English data from 2015 onwards.

Theoretical Framework

1. Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) is one of the most important models to understand the efficiency of AI applications in engineering and the decision-making AI in favor of Nigerian manufacturing firms. Simply put, it is a fundamental framework to know how and why engineers working in the industrial department choose to adopt AI technologies and in what way they use these technologies in their work environment. By its nature, TAM identifies only two main beliefs: perceived usefulness (to what extent a person assumes that by using a particular technology, he will increase the effectiveness of his work) and perceived ease of use (to what extent a person assumes that by using the technology, it will be without effort). These two elements have a direct impact on the individual's approach towards the use of the technology, which in turn affects the performance of their usage behavior.

In the setting of manufacturing companies in Nigeria, AI utilisation is at a tender stage and has not yet completely penetrated. On the other hand, this is a very promising sector for AI technology. The introduction of AI in the manufacturing industry in Nigeria may face infrastructural, cultural, or organizational barriers. In this situation, the TAM is explaining a lot of differences in the behavior of engineers in the use of this tool. For example, if engineers consider an AI system as useful in the easy running of operations, accuracy, or even in the saving of time, they will be more likely to accept it, thus making the overall efficiency rise. Contrary to this, if these systems are regarded as complicated to the degree that one cannot comprehend them, unreliable, and are not supported well, then the rate of adoption will be low, which in turn will lead to little efficiency gains.

Moreover, the focus of TAM on user perceptions is really an essential factor in the Nigerian setting, where external factors like a shortage of training opportunities, poor digital infrastructure, or resistance to change can not only influence how engineers see AI technologies but also their usage. Organizations can take the help of TAM to identify the perceptions of users, which can help them in deciding the right strategy to come up with training that is resourceful, engaging users through user-centered design, and also managing actions effectively. These are some of the key enablers for AI deployment to create maximum utility. In the end, the TAM model is a very helpful framework that

can take into consideration the opinions of both scholars and industrialists on whether AI tools are there, as well as the question of their efficient usage by engineers, which is the real factor that can influence the level of the manufacturing process in Nigeria.

METHODOLOGY

Artificial Intelligence

Artificial intelligence is our system that is created to function and correspond to humans, like thinking and processing human qualities. One such example is computer science experiments, which result in the creation of intelligent machines that can perform various tasks using their intelligence (Dongre, Pandey, & Gupta, 2020). Along these lines, Ezeribe (2019) also regarded Artificial Intelligence as a way of making a computer, a computer, controlled robot, or software that thinks like the human mind, i.e., thinks intelligently. Odoh et al (2018) further characterized artificial intelligence as a computing program of the kind that has software features to do what is expected only by the human brain, namely, to perform tasks. Moreover, these activities include both the ability to learn and the capacity to know. Judgment capacity, interpersonal understanding, and creative cognition are also included in the package. In another perspective, artificial intelligence is the ability of a computer system to observe, learn from, and replicate human intelligence when making decisions (Ezeribe, 2019). Artificial Intelligence is known as software programs that aim to replicate the behavior and the expertise of human experts, and then to collect human knowledge and experience and convert it into commands which they use to solve accounting problems and execute accounting operations (Stancheva Todorova, 2018). She added that AI aims to make a machine that has the characteristics of human intelligence and can react like humans. It also involves the features of decision-making, empathy, and creative thought process.

Artificial intelligence (AI) has become a transformative tool in organizational management, including education and finance, by enhancing efficiency and reducing dependence on manual intervention. Unlike other emerging technologies, AI has the unique ability to adapt to dynamic environments, perform complex tasks, and simulate human intelligence with minimal oversight (PwC, 2019). In the financial sector, this adaptability contributes to operational efficiency and innovation, helping institutions respond effectively to market challenges (Odoh et al., 2018). Similarly, in educational contexts, AI and related ICT tools are increasingly valuable for crisis management in schools, enabling administrators to anticipate risks and coordinate responses more effectively (Osegbue, Ohamobi, Ekwe, & Alordiah, 2025). Studies also highlight the role of ICT and AI-driven applications in the management of Universal Basic Education programs in Nigeria, strengthening accountability and teaching outcomes (Manafa, Ohamobi, & Osegbue, 2022). Furthermore, effective computer utilization has been linked to improved academic achievement among students (Enwereji, Ohamobi, & Nwokeji, 2022).

Artificial Intelligence Tool in Manufacturing Firms

The predictive maintenance tools that are powered by machine learning and sensor networks are the mainstay of engineers in the manufacturing sector. They aim to prevent the occurrence of a breakdown of the equipment. Such systems take in data like vibration, temperature, and acoustic emissions from the most critical machinery; machine learning models then predict the time of the next maintenance; thus, companies can lower the amount of unplanned downtime and increase the life of the equipment (NetSuite, 2025). Different research has been reported where biology-inspired algorithms like Hierarchical Temporal Memory have been implemented for anomaly detection in manufacturing systems, and the result was more reliable early failure detection than some deep-learning and statistical methods when dealing with streaming, noisy sensor data (Malawade, Costa, Muthirayan, Khargonekar, & Al Faruque, 2021).

One of the areas which have been greatly influenced by the use of AI tools is quality control. Particularly, computer vision systems are being installed and integrated into the production lines. Engineers use high-resolution cameras and machine vision software to find product defects in real time, thus minimizing the possibility of human error, speeding up the process of inspection, and improving the level of consistency (Octal-Software, 2025; Automotive Manufacturing Solutions, 2024). For instance, there are AI, based studies where modules are accompanied by computer-aided design (CAD) systems for automated inspection of trimming die designs; those systems are substituting or supporting the decision of the expert human, shrinking the time of inspection, and keeping errors of measurements at a low level (Lee, Kim, Jeon, Park, Kim, Lee, & Lee, 2023).

Design and process optimization have been revved up with the help of tools developed using generative design and digital twin technologies. One of the benefits of generative design algorithms is that the engineers can set up several limitations, such as the material used, cost, size, and performance, and then the software would generate a multitude of alternative design solutions; the manufacturers then can pick out the best one for them or even make further changes to it (AI-Multiple, 2025). A digital twin is a virtual duplicate of physical objects or even a whole supply chain, going beyond just the mere monitoring, simulation, and real-time optimization. They can bring the changes in the virtual world to see the impacts before they make the actual changes to the workflow, hence reaping the benefits of the optimized workflow and lower waste (Chas-Hamel, Manjurul Ahsan, & Raman, 2024).

In the case of Nigeria, empirical studies have confirmed that companies like Dangote Cement Plc and Nigerian Breweries Plc are adopting AI technologies to streamline their production. Consequently, the engineers in those companies have reported that the machine operations have improved, decision-making is faster, the downtime has been reduced, and the product quality is better due to the implementation of AI. The size of these upgrades tends to be bigger in companies with highly skilled labor, where the engineers have the skills to interact with and utilize the AI tools (Amaugo, 2024).

Furthermore, some of the tools that help the engineers in their technical work are the systems engineering software, such as MATLAB, Simulink, and LabVIEW, which are utilized for the purposes of modeling, simulation, and control design. The engineers in Nigeria resort to the use of these software packages to depict process dynamics, to simulate system behavior under different conditions, and to carry out control logic for automation and real-time monitoring tasks (Disciplines.ng, 2025).

Empirical Review

Amaugo (2024) carried out a study to evaluate the present extent of the adoption of Artificial Intelligence (AI) and its seamless integration in engineering operations at Dangote. He went on to publish a paper based on research he did in Dangote Cement Plc and Nigerian Breweries Plc, where he used structured questionnaires to collect data from 301 respondents. This was done to test the impact of using artificial intelligence in process optimization in Nigerian manufacturing. The research utilized multiple regression analysis and discovered a significant positive correlation between the implementation of artificial intelligence and the efficiency of manufacturing. The outcomes exhibited that AI could facilitate the diminishing of the machine breakdown periods, the increase of decision making, and the upgrading of the quality of the products through the real, time monitoring and the use of predictive analytics. More so, the results implied that bigger companies should benefit more from AI in terms of efficiency, particularly if their engineers and technically skilled workforce have higher levels of skills.

Additional empirical research was concentrated on technology companies in Delta State, Nigeria, conducted by Chukwuka and Imide (2025), which studied the influence of artificial intelligence on the productivity of workers. While this research was not confined to engineers only, it had a look at the impact of the implementation of AI in the technological sector on the output, the speed, and the accuracy of the work. Over 150 respondents were surveyed using a descriptive survey method, and the results signified that the use of artificial intelligence tools not only raises productivity to the expected level but also increases employee engagement and task performance accuracy. The respondents believed that artificial intelligence is automating the repetitive or faulty tasks, thus, they can focus more on the value-added tasks, which require more critical thinking.

One more empirical research was targeted on industrial companies in North, Central Nigeria. The study was about the role of reward systems as a moderator in the relationship between the use of artificial intelligence and the performance of the company. Audu and Ihuoma (2025) got the data from the top executives of manufacturing firms and reported that although the introduction of artificial intelligence has a positive impact, it is limited by some human and organizational factors. The staff of the technical department including engineers are affected with the fear of losing their jobs, they experience the performance improvement through the use of artificial intelligence being not compatible with the reward or incentive system of the firm and also, they do not trust the artificial intelligence tools if the benefits are

not revealed or rewarded. These human factors were shown to have an impact on the reduction of the inflow of people's willingness to show the engagement, adoption, or even exploitation of AI tools fully, so consequently, the reduction of the effective contribution to performance improvements occurs.

RESULT AND DISCUSSION

The Current Level of Artificial Intelligence Adoption and Integration within Engineering Operations in Nigerian Manufacturing Firms

The current level of artificial intelligence adoption and integration within engineering operations in Nigerian manufacturing firms is moderate and characterized by both advances and constraints. This can be traced to the study of Amaugo (2024) assessed the current level of artificial intelligence adoption and integration within engineering operations in Dangote and Cement Plc and Nigerian Breweries Plc, administering structured questionnaires to 301 respondents. The results showed that AI helps reduce downtime, improve decision-making, and enhance product quality via real-time monitoring and predictive analytics. Importantly, the findings also indicated that larger firms tend to extract greater efficiency gains from artificial intelligence, particularly when their engineers and technical workforce possess higher levels of skill. Furthermore, it shows that the adoption of artificial intelligence tools seems to be moderate among engineers in manufacturing firms. However, artificial intelligence integration is not yet deep or uniform across all engineering functions. While equipment monitoring, predictive maintenance, and error/quality control are relatively well adopted in these leading firms, many engineering operations still rely on more basic automation or traditional control systems rather than fully AI-driven systems. Infrastructure constraints such as unreliable power, limited high-bandwidth network capabilities, and deficiencies in data collection and processing systems, as well as gaps in specialized technical skills among engineers, inhibit more comprehensive artificial intelligence deployments.

The Perceived and Actual Impact of Artificial Intelligence Tools on the Productivity, Accuracy, and Task Performance of Engineers

The perceived and actual impact of artificial intelligence tools on the productivity, accuracy, and task performance of engineers in Nigerian manufacturing firms has been the subject of several empirical investigations. Engineers generally perceive artificial intelligence as a transformative force that enhances their ability to perform complex tasks more efficiently and with greater precision. In practice, the integration of artificial intelligence tools such as predictive maintenance systems, computer vision for quality control, and data analytics platforms has been linked to measurable improvements in productivity by reducing downtime and enabling faster, data-driven decision-making. These tools help engineers identify faults early, optimize processes, and automate repetitive tasks, leading to increased accuracy and a reduction in human error. However, the degree of impact varies across firms, largely depending on the level of infrastructure, training, and support available. This is supported by empirical evidence of Chukwuka and Imide (2025), which

assessed the impact of artificial intelligence on employees' productivity. The findings signified that artificial intelligence tools positively and significantly enhance productivity, as well as increase employee engagement and accuracy in task performance. The respondents perceived that artificial intelligence automates repetitive or error-prone tasks, allowing them to concentrate more on higher-value tasks, which require more critical thinking.

The Challenges Engineers Face in Utilizing Artificial Intelligence Technologies Effectively in the Nigerian Manufacturing Context

Engineers in Nigerian manufacturing firms face several significant challenges in effectively utilizing artificial intelligence technologies, which hinder the full realization of artificial intelligence's potential benefits. One major obstacle is the lack of adequate infrastructure, including inconsistent power supply and limited access to high-speed internet, which affects the reliable deployment and operation of artificial intelligence systems. Additionally, there is a pronounced shortage of skilled personnel trained in both artificial intelligence technologies and their application within manufacturing engineering, leading to difficulties in implementing, maintaining, and optimizing artificial intelligence tools. Many engineers also encounter resistance to change within organizations, where traditional practices and skepticism towards new technologies slow down adoption. Financial constraints further limit the ability of many firms to invest in sophisticated artificial intelligence systems or continuous training for their engineers. Furthermore, there are organizational challenges such as weak alignment between artificial intelligence deployment and existing workflows, insufficient management support, and inadequate incentive structures that fail to motivate engineers to fully engage with artificial intelligence tools. These factors collectively create a complex environment where, despite the recognized advantages of artificial intelligence, its effective utilization remains limited in Nigerian manufacturing engineering operations. Addressing these challenges requires not only investment in infrastructure and training but also strategic organizational change to foster a culture that embraces artificial intelligence adoption. This can be traced to the study of Audu and Ihuoma (2025) collected data from executives in manufacturing firms and found that although AI has positive effects, its utility is curtailed by human and organizational factors. Engineers and other technical staff are constrained by fears of job displacement, weak alignment between performance improvements via artificial intelligence and the reward or incentive systems in the firm, and mistrust toward artificial intelligence tools when their benefits are not visibly acknowledged or rewarded

CONCLUSIONS AND RECOMMENDATIONS

To sum up, the actualization of artificial intelligence (AI), which resulted in the successful application of technology by engineers in the manufacturing sector of Nigeria, is a composite of both bright potentials and challenges. The reality of technologies related to AI when put to practice in the right way yields the productivity of the firm alongside its accuracy and the task performance that results from the automation of routine engineering processes, the introduction of real-time monitoring, and the utilization of data-driven

decision-making. Firms that are well-endowed with infrastructure and have highly skilled personnel have benefited from the implementation of AI-based solutions to the extent of the elimination of downtime, accelerated maintenance cycles, and enhanced product quality. However, the sector has to wait for a good time when these advantages will be universal. In fact, a lot of engineers are at the point of facing many obstacles. Some of these obstacles are the lack of enough technical training, limited digital infrastructure, lack of finance, and organizational resistance to change. These problems have constrained the extent and regularity of artificial intelligence penetration and have even lessened the effectiveness of everyday engineering operations. If all is said and done, though artificial intelligence has a large capacity of making engineering efficient in Nigerian manufacturing, orchestrating its whole overwhelming effect will definitely mandate serious commitment to capacity building, investing in technologies that enable, and the formulation of policies that will support major digital transformation in industry over time.

To make better use of AI in manufacturing firms in Nigeria, it is advised that the companies invest in continuous training and capacity-building programs, which are necessary to provide the workers with the required AI-related technical skills. A collaborative effort between the government and the private sector needs to be boosted to achieve a better digital infrastructure (such as stable power and high-speed internet), which is essential for the smooth operation of AI systems. Part of the recommendation is also for manufacturing firms to embrace the planned and stepwise method of AI integration, which involves matching technologies with specific engineering needs and ensuring that the implementation is supported by clear policies and measurable objectives. Furthermore, the development of a culture of innovation among engineers, with the support of management and the incentive of performance-based rewards, can raise the level of participation and lower the opposition to the use of AI. National strategies that fund research, aid local AI development, and provide access to cutting-edge technologies at subsidized rates will also be agents that bring about wider and effective AI application in the manufacturing sector.

FURTHER RESEARCH

This research still has limitations, so further research on this topic is still needed.

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