AN EVALUATION OF THE EFFICIENCY OF AI POWERED ROBOTS IN MANUFACTURING AND LOGISTICS: A COMPARATIVE STUDY WITH HUMAN PRECISION IN SELECT COMPANIES IN ANAMBRA STATE.

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ABSTRACT

The study was conducted to evaluate the efficiency of AI powered robots in manufacturing and logistics: a comparative study with human precision in select companies in Anambra State. A comparative survey design was adopted for this study. The population for the study comprised all management and senior staffs in manufacturing and logistics companies. Simple random sampling technique was used to select 200 respondents (100 staff each from manufacturing and logistics companies). The researcher validated "AI Powered Robots and Human Efficiency Questionnaire (AIPRHEQ) for the study. The reliability coefficient obtained was 0.83 to justify the instrument use. The researcher subjected the data to percentage analysis and chi square analysis. The result proved that in the logistics AI powered Robot proved better in many aspects including ability in choosing an alternate route while the human was better with possession of cognitive skills and situational awareness that are valuable in certain logistics tasks. It was concluded that, AI robots exhibit remarkable efficiency, speed, and precision in executing repetitive tasks, leading to increased productivity and reduced operational costs. The researcher recommended among others that organizations should prioritize investing in AI technologies and robotics systems tailored to their specific manufacturing and logistics needs.

KEYWORDS: AI Powered Robots, Manufacturing companies, Logistics Companies and Human Precision

INTRODUCTION

In the realm of manufacturing and logistics, the integration of Artificial Intelligence (AI) powered robots has revolutionized traditional processes, promising heightened efficiency, precision, and cost-effectiveness. This transformative shift has prompted a critical evaluation of the effectiveness of AI-powered robots compared to human labor, particularly in tasks requiring meticulous precision. At the forefront of this discourse lies the intrinsic attraction of AI-powered robots: their potential to augment and even surpass human precision in various manufacturing and logistical endeavors. Equipped with advanced sensors, machine learning algorithms, and sophisticated programming, these robots boast the capacity to execute repetitive tasks with unparalleled accuracy and consistency. Their ability to operate 24/7 without fatigue is a significant advantage, potentially boosting production output. Additionally, AI-powered robots can handle dangerous or hazardous environments, safeguarding human workers.

While the initial investment in AI-powered robots may be substantial, proponents argue that the long-term benefits in terms of increased productivity and reduced operational costs justify the expenditure. However, skeptics caution against overlooking the socio-economic implications of widespread automation, including potential job displacement and exacerbation of socio-economic inequalities. As technologies continue to advance and consumer demands evolve, the optimal balance between automation and human intervention may vary across industries and contexts. Consequently, the comparative study adopts a forward-looking perspective, anticipating future trends and potential disruptions in the manufacturing and logistics ecosystem.

In essence, the evaluation of the efficiency of AI-powered robots in manufacturing and logistics represents a pivotal juncture in the trajectory of industrial automation. By conducting a comprehensive comparative study with human precision as the benchmark, this endeavor aims to inform strategic decision-making, foster innovation, and facilitate a nuanced understanding of the symbiotic relationship between technology and human labor in the modern industrial landscape. Through rigorous analysis and empirical insights, this study endeavors to unravel the intricacies of automation, empowering stakeholders to navigate the complexities of the Fourth Industrial Revolution with clarity and foresight.

STATEMENT OF PROBLEM

In Anambra State, as in many other regions globally, there is a growing interest in adopting artificial intelligence (AI)-powered robots for various tasks in manufacturing and logistics. These robots are purported to offer enhanced efficiency, speed, and precision compared to human labor. However, despite the potential benefits, there exists a significant gap in understanding the comparative performance of AI-powered robots versus human workers in terms of precision, adaptability, and overall efficiency within the local context. This study aims to assess the effectiveness of AI-powered robots in executing manufacturing and logistics tasks compared to human workers in Anambra State. This involves evaluating factors such as speed, accuracy, adaptability to different tasks, and overall productivity, and also establishing a benchmark for human precision in manufacturing and logistics tasks in Anambra State. By addressing these key issues, this study aims to provide valuable insights into the efficiency of AI-powered robots in manufacturing and logistics operations compared to human precision in Anambra State, thereby informing decision-making processes for stakeholders in both the public and private sectors.

OBJECTIVES OF THE STUDY

- To find out the difference between the efficiency of AI powered robots and human precision in the manufacturing companies.
- To determine the difference between the efficiency of AI powered robots and human precision in the Logistic companies.

RESEARCH QUESTIONS

- What is the difference between the efficiency of AI powered robots and human precision in the manufacturing companies?
- What is the difference between the efficiency of AI powered robots and human precision in the Logistic companies?

LITERATURE REVIEW

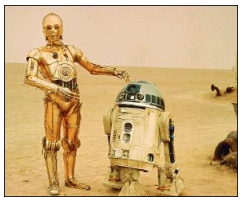
CONCEPT OF ARTIFICIAL INTELLIGENCE

The goal of the diverse branch of computer science known as artificial intelligence (AI) is to create intelligent systems that are able to carry out tasks that normally call for human intelligence. According to Bassey and Owushi (2023), artificial intelligence (AI) refers to the development of computer systems that can perform tasks that typically require human intelligence. Kwafo (2019), as cited in Allami (2023), mentioned that artificial intelligence is defined as the smart actions that the machine provides by imitating human behaviour.

The Investopedia Team (2024) defined artificial intelligence (AI) as a technology that allows computers and machines to simulate human intelligence and problem-solving tasks. Glover (2024) posited that artificial intelligence (AI) is a wide-ranging branch of computer science that aims to build machines capable of performing tasks that typically require human intelligence.

CONCEPT OF ROBOTS

Robots are automated devices that can perform complicated sequences of tasks, particularly those that can be programmed by a computer. According to Guizzo (2023), a robot is an autonomous machine capable of sensing its environment, carrying out computations to make decisions, and performing actions in the real world. Moravec (2024) defined a robot as any automatically operated machine that replaces human effort, though it may not resemble human beings in appearance or perform functions in a humanlike manner. Daley (2024) defined a robot as a programmable machine that can complete a task.



CONCEPT OF ARTIFICIAL INTELLIGENCE POWERED ROBOT (AI)

AI powered robots are robots that are provided with a range of sensors, such as vision devices including 2D and 3D cameras, vibration sensors, proximity sensors, accelerometers, and other environmental sensors to provide them with sensing data that they can assess and act upon instantly. AI-powered robots are new era of automation and intelligent machines heralded by groundbreaking synthesis of robotics and artificial intelligence. These robots have advanced artificial intelligence (AI) algorithms installed in them, which allow them to reason, learn, and interact with their surroundings on their own.

CONCEPT OF MANUFACTURING

Manufacturing is the process of transforming raw materials into completed commodities by utilising technology, people, and tools. According to Shopify (2022), manufacturing is the making of goods by hand or by machine that, upon completion, the business sells to a customer. Kenton (2024) mentioned that manufacturing is

processing raw materials or parts into finished goods through the use of tools, human labor, machinery, and chemical processing.

Manufacturing can refer to the large-scale conversion of raw materials into completed commodities or the development of more complicated products by selling basic goods to producers who then use those products to produce further things. Ye (2023) mentioned that manufacturing is the process of transforming raw materials or components into finished goods through various equipment, methods, techniques, and processing.

CONCEPT OF LOGISTICS

The term "logistics" was first used in the military to describe the methods by which soldiers acquired, stored, and transported supplies and equipment. However, the definition of logistics has changed over time. According to Kenton (2024), logistics refers to the overall process of managing how resources are acquired, stored, and transported to their final destination. Finding potential distributors and suppliers and evaluating their efficiency and reach are key components of logistics management. Logicians are the term used to describe logistics managers.

According to Jenkins (2024) logistics is the collection of processes involved in moving goods internally or from buyer to seller. She went further to enunciate that logistics is the movement of goods from Point A to Point B, which entails two functions: transportation and warehousing.

THE POTENCY OF ARTIFICIAL INTELLIGENCES POWERED ROBOTS IN MANUFACTURING INDUSTRY

AI-powered robots are revolutionising industrial processes, increasing efficiency, and spurring innovation. Artificial intelligence (AI) has transformed several industries, and the manufacturing sector is being greatly impacted by it. These robots possess advanced capabilities such as machine learning, computer vision, and natural language processing, enabling them to perform complex tasks with precision and speed (Smith, 2021). The capacity of AI-powered robots to adjust to shifting production demands is one of their main advantages in the manufacturing sector. Through machine learning algorithms, these robots can analyse vast amounts of data in real time, optimise production schedules, and make data-driven decisions to improve productivity (Jones & Brown, 2020). This flexibility is essential in dynamic manufacturing settings where agility and flexibility are critical.

Furthermore, robots with AI capabilities make a big difference in defect identification and quality control. With advanced computer vision systems, these robots can inspect products with high accuracy, identify defects, and take corrective actions, reducing waste and enhancing product quality (Chen et al., 2019). This skill guarantees adherence to quality standards, reduces rework, and enhances total manufacturing output. On the other hand, robotics powered by AI is essential to predictive maintenance. By leveraging predictive analytics and IoT sensors, these robots can monitor equipment conditions, predict potential failures, and schedule maintenance proactively (Wang et al., 2022).

THE POTENCY OF AI POWERED ROBOTS IN LOGISTICS

In the field of logistics, AI-powered robots have changed the game by enhancing the efficacy and efficiency of supply chain processes. These robots provide hitherto unseen degrees of automation and optimisation in warehousing, inventory management, and order fulfilment, among other logistics-related tasks. They are outfitted with sophisticated artificial intelligence algorithms, sensors, and actuators. Their power comes from their capacity to quickly and accurately complete jobs, adjust to changing conditions, and make judgements in real time—all of which help to streamline processes and cut expenses. Warehouse management is one of the main applications where AI-powered robots show their effectiveness. These robots can autonomously navigate through warehouse environments, intelligently pick and pack items, and optimise storage space to maximise efficiency (Smith, 2023). They can analyze incoming orders, identify the most effective picking routes, and complete tasks with the least amount of human intervention by utilizing AI algorithms.

Within the field of transportation and logistics, autonomous delivery robots that are equipped with artificial intelligence (AI) technologies are transforming last-mile delivery operations. These robots are an affordable and effective solution for e-commerce companies and logistics providers looking to shorten delivery times and cut back on traditional delivery methods. Additionally, the incorporation of AI-powered robots into pre-existing logistics systems facilitates smooth coordination and communication throughout the supply chain network. Better decision-making is made possible by this increased visibility and openness, which also enables companies to proactively resolve possible bottlenecks or disruptions.AI-powered robots also hold immense potential for enhancing workplace safety in logistics operations (Gupta & Singh, 2024). These robots lower the risk of damage to humans connected with manual labor by performing repetitive and physically demanding activities. The expanding use of AI-powered robots in logistics is not without difficulties, despite their many advantages. Concerns regarding job displacement, data security, and regulatory compliance need to be addressed to ensure the responsible and ethical deployment of these technologies (Johnson & Williams, 2023).

COMPARISON OF EFFICIENCY OF AI POWERED ROBOTS WITH HUMANS IN MANUFACTURING INDUSTRY

The effectiveness of artificial intelligence (AI)-powered robots in comparison to humans is a topic of great interest in the manufacturing business. Numerous research works have examined this contrast, illuminating the benefits and drawbacks of each workforce. First off, in production processes, AI-powered robots provide unmatched accuracy and consistency. They can perform repetitive tasks with high accuracy, reducing the margin of error to minimal levels (Frey & Osborne, 2017). This precision leads to enhanced product quality and reliability, crucial factors in manufacturing.

Moreover, AI-powered robots excel at tasks requiring speed and endurance. They can operate continuously without breaks, resulting in increased production rates and faster turnaround times (Lee et al., 2019). This effectiveness helps to quickly satisfy client requests and adhere to strict timeframes. However, human workers have adaptability and problem-solving abilities that robots driven by AI do not yet have. Humans can quickly adjust to new tasks, handle unforeseen challenges, and innovate solutions on the fly (Agrawal et al., 2018). In dynamic production contexts where processes change regularly, this adaptability is very essential. Furthermore, human

labourers exhibit higher levels of inventiveness and sophisticated decision-making capabilities. They can engage in tasks that require intuition, emotional intelligence, and critical thinking, such as design optimisation and process improvement (Brynjolfsson & McAfee, 2017). Innovation and ongoing process improvement are greatly aided by these cognitive abilities in manufacturing operations.

COMPARISON OF EFFICIENCY OF AI POWERED ROBOTS WITH HUMANS IN LOGISTICS

AI-driven robots in logistics have shown to be remarkably adept at using GPS technology for guidance and judgement. Although humans are cognitively capable and flexible, AI-driven robots do better at jobs requiring accuracy, consistency, and data-driven decision-making—particularly when it comes to using GPS to find alternate routes and directions. In logistical operations, AI-powered robots with GPS navigation systems are incredibly efficient when compared to humans. One of the key advantages lies in the ability of AI systems to process vast amounts of real-time data from GPS satellites, enabling robots to calculate optimal routes, anticipate traffic conditions, and dynamically adjust their paths to avoid delays (Chen et al., 2019).

AI-powered robots, in contrast to humans, are neither distracted nor fatigued, so they can work consistently and according to timetables. Moreover, AI algorithms can analyse historical GPS data to identify patterns and optimise route planning over time, leading to further efficiency gains and cost savings in logistics operations (Li et al., 2020). Robots with AI skills outperform humans when it comes to choosing an alternate route. These robots can integrate data from multiple sources, including GPS, traffic sensors, weather forecasts, and real-time traffic updates, to evaluate various route options and choose the most time-efficient and cost-effective path (Rustagi et al., 2021).

AI systems may also learn from input and adjust accordingly, which helps them make better decisions over time. This adaptive learning enables robots to navigate complex logistics environments with changing conditions, such as road closures, construction zones, or traffic diversions, without human intervention (Chen et al., 2022). The efficiency, accuracy, and adaptability of AI-powered robots, particularly in using GPS for navigation and alternative route selection, highlight the transformative impact of AI in optimising logistics operations, even though humans possess cognitive skills and situational awareness that are valuable in certain logistics tasks.

METHODOLOGY

In carrying out the study, comparative survey design was adopted for this study. The study was carried out in Anambra state. The targeted population for the study comprised all management and senior staffs in manufacturing and logistics in Anambra State. Simple random sampling technique was used to select 100 staff from manufacturing companies and 100 staff from logistics company, which gave a total of 200 respondents used for the study. The instrument used for data collection was a structured questionnaire titled “AI Powered Robots and Human Efficiency Questionnaire (AIPRHEQ)”. Face and content validation of the instrument was carried out by an expert in test, measurement, and evaluation in order to ensure that the instrument has the accuracy, appropriateness, and completeness for the study under consideration. The reliability coefficient obtained was 0.83, and this was high enough to justify the use of the instrument. The researcher subjected the data generated for this

study to appropriate statistical analysis such as percentage analysis to answer research questions and chi square to test the hypothesis.

Research Questions 1: The research question sought to compare the efficiency of AI powered robots with human precision in the manufacturing companies. To answer the research question, percentage analysis was performed on the data, (see table 1).

Table 1
Percentage analysis of the compared efficiency of AI Powered Robots with Human Precision in the manufacturing companies

COMPARISON	ROBOT	%	HUMAN	%	TOTAL
Provision of unmatched Accuracy and consistency	190	95	10	5	200
Excellence at task requiring Speed and endurance	185	92.5	15	7.5	200
Adaptability and Problem Solving Abilities	17	8.5	183	91.5	200
Exhibition of higher levels of inventiveness and sophisticated decision-Making capabilities	16	8	184	92	200
Engagement in tasks that require intuition, emotional intelligence, and critical thinking	9	4.5	191	95.5	200

** **The highest percentage frequency**
* **The least percentage frequency**

SOURCE: Field Survey

The above table 1 presents the percentage analysis of the compared efficiency of AI Powered Robots with Human Precision. From the result of the data analysis, it was observed that with respect to Provision of unmatched Accuracy and consistency AI Powered Robots was observed to do better (95%) than human precision (5%). Secondly, it was observed that as regards excellence at tasks requiring speed and endurance, AI Powered Robots was observed to do better (92.5%) than human precision (7.5%). Thirdly, it was observed that with respect to Adaptability and problem-solving abilities, human precision was observed to do better (91.5%) than AI Powered Robots (8.5%). Fourthly, it was observed that with respect to exhibition of higher levels of inventiveness and sophisticated decision-making capabilities, human precision was observed to do better (92%) than AI Powered Robots (8%). Finally, it was observed that as regards the engagement in tasks that require intuition, emotional

intelligence, and critical thinking, human precision was observed to do better (95.5%) than AI Powered Robots (4.5%).

Research Questions 2: The research question sought to compare the efficiency of AI powered robots with human precision in the Logistic companies. To answer the research question, percentage analysis was performed on the data, (see table 2).

Table 2
Percentage analysis of the compared efficiency of AI Powered Robots with Human Precision in the Logistic companies

COMPARISON	ROBOT	%	HUMAN	%	TOTAL
Better at jobs requiring accuracy, consistency, and data-driven decision-making—particularly when it comes to using GPS	192	96	8	4	200
Above distraction and fatigue, so they can work consistently and according to timetables.	183	91.5	17	8.5	200
Analyse historical GPS data to identify patterns and optimise route planning over time, leading to further efficiency gains and cost savings in logistics operations	172	86	28	14	200
Ability in choosing an alternate route	196	98	4	2	200
possession of cognitive skills and situational awareness that are valuable in certain logistics tasks.	3	1.5	191	98.5	200

** **The highest percentage frequency**
* **The least percentage frequency**

SOURCE: Field Survey

The above table 2 presents the percentage analysis of the compared efficiency of AI Powered Robots with Human Precision. From the result of the data analysis, it was observed that with respect to better at jobs requiring accuracy, consistency, and data-driven decision-making—particularly when it comes to using GPS AI Powered Robots was observed to do better (96%) than Human Precision (4%). Secondly, it was observed that with regard to working above distraction and fatigue, to work consistently and according to timetables, AI Powered Robots was observed to do better (91.5%) than Human Precision (8.5%). Thirdly, for the work of analyzing the historical GPS data to identify patterns and optimise route planning over time, leading to further efficiency gains and cost savings in logistics operations, AI Powered Robots was

observed to do better (86%) than Human Precision (14%). Fourthly, it was observed that with respect to ability in choosing an alternate route, AI Powered Robots was observed to do better (98%) than Human Precision (2%). Finally, it was observed that with respect to possession of cognitive skills and situational awareness that are valuable in certain logistics tasks., Human Precision was observed to do better (98.5%) than AI Powered Robots (1.5%).

CONCLUSION

The evaluation of AI-powered robots in manufacturing and logistics through a comparative study with human precision reveals a transformative landscape. AI robots exhibit remarkable efficiency, speed, and precision in executing repetitive tasks, leading to increased productivity and reduced operational costs. Their ability to analyze vast amounts of data in real-time enables proactive decision-making, optimizing processes and enhancing overall performance. AI-powered robotics with human capabilities. By integrating AI technologies into manufacturing and logistics workflows while leveraging human expertise where it is most effective, organizations can achieve a harmonious balance that maximizes efficiency, innovation, and overall success in the modern industrial landscape.

RECOMMENDATIONS

- Organizations should prioritize investment in AI technologies and robotics systems tailored to their specific manufacturing and logistics needs. This may involve partnering with AI solution providers or developing in-house capabilities to design and implement AI-powered robotics solutions.

- Organizations should establish robust monitoring mechanisms to track key performance indicators (KPIs) such as speed, accuracy, adaptability, and cost-effectiveness.

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