# Artificial Intelligence and the Performance of Manufacturing Firms in North-Central Nigeria: Reward System as the Moderator

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## ABSTRACT

**Purpose:** The study investigates the influence of Artificial Intelligence (AI) on the performance of Manufacturing Firms in North-central Nigeria with Reward System as a moderator. The study labored to identify how AI technology has been leverage upon by Managers of Manufacturing Firms to cut-costs and improves performance of their organizations and the near futility in such application without factoring in the human elements whose work AI technology complements. Hence, the study factored in this missing link by introducing a moderator- Reward System. The study proved empirically that performance of the target manufacturing Firms has improved much more when the moderator was introduced. This is achieved by conducting test when AI technology is applied before the moderator and after the inclusion of the moderator respectively.

**Research Methods**: The study adopted a descriptive research design. Data were gathered from the population of 200 respondents made up of Top, Senior and Middle level Executives of the target Manufacturing Firms using proportional sampling method. Primary data was used for the study, and it was gathered through questionnaire designed in five points Likert Scale of strongly agree to strongly disagree. Factor analysis was conducted to ascertain the content validity and reliability of the research instruments. All the factors were significant. Data gathered through questionnaire were analyzed using descriptive and parametric statistical instruments. Tables, percentages, and mean scores were the descriptive statistical tools used while simple linear regression was the parametric statistical tool used to test the hypotheses.

**Results:** The study found a positive and significant influence of AI on Manufacturing Firms performance on one hand, and that performance of the targeted Manufacturing Firms improved more when a moderating variable was introduced.

**Limitations:** The study focused on the Manufacturing Firms in North-Central Nigeria only whereas there are other geographical zones of Nigeria that was not touched by the study. This may impair the generalization of the findings of this study. Equally, been a relatively new area of study, there is scarcity of literatures that would have enriched the study more. However, the researcher does not leave any stone unturned by engaging in all available and relevant search Goggles to look for available literature.

**Novelty:** Although there are skeletal studies in the area of AI technology and its application in the world of business, no work to the best of the researchers' knowledge has been undertaken to examine the moderating role of reward system on the application of an AI technology to cut-costs and improve performance of the Manufacturing subsector in Nigeria and North-Central in particular. The study has uniquely distinguish itself from other studies by introducing a moderator to explain that AI are robots which complements the work of humans, and as such, the human elements must be adequately rewarded if the goal of adopting AI in organizations must be achieved. This, the study has been able to prove empirically.

**Keywords:** Artificial Intelligence, Performance, Manufacturing Firms, and North-Central Nigeria

# INTRODUCTION

The concept of performance either in the manufacturing subsector or other subsectors is a multidimensional concept with varying meanings (Audu & Nwagbala ,2024); Atalay, Anafarta & Sarvan, 2013). The indicators of manufacturing performance measures could be objective or subjective (Dawes, 1999; Harris, 2001; Atalay et. al, 2013; Audu, 2023). The metric of performance according to Ziyaminyana & Pwaka (2019) include level of customer satisfaction as measured by numbers of complaints about the organization's products, and customer retention, market performance, production efficiency, and accounting performance among others.

Although there are objective metrics of measuring performance, the study adopts subjective measures of manufacturing performance which include: operational efficiency, customer satisfaction, and cost reduction. The study adopts the subjective measure because of the difficulty involved in accessing objective data from Companies. Equally, Managers of these Firms are not willing and are reluctant to share the objective performance of their organizations (Atalay et.al, 2013; Gunday, 2015). Based on the foregoing, the study employed subjective measures of performance.

Concerned with the dwindling performance of the Manufacturing subsector of the Nigerian economy, and North-Central in particular, Managers of Manufacturing organizations went on the voyage of searching for how to reduce costs, increase operational efficiency, and enhance customer satisfaction of the subsector. The readily available option in a dynamic competitive business environment is the new bride in town – Artificial Intelligence (AI). AI is a new business fad in town today. Its application to business operations is believed to reduce costs, enhance operational efficiency, and increase customer satisfaction. This, is a sure bet to increasing return on investment to share holders and stakeholders.

One of the ways to achieve cost reduction and operational efficiency in recent time is the application of Artificial Intelligence (AI). (Greenberg, 2017, Udeogu & Okoye, 2024, Arakpogun, et.al, 2021) Increasing human errors, poor judgment and limited capacity to handle volumes of data has become the short-coming of human beings. To overcome these limitations, and to dove-tail costs, automation of repetitive tasks using machine algorithm becomes imperative.

Today, AI has been applied to tasks that have been hitherto performed by man. However, the application of AI is not an end in itself but a mean to an end. The tasks of AI which include reasoning, decision-making, and an incredible data processing capability to aid businesses decisions , and solving problems only serves as a tool to facilitate the jobs or tasks of humans in organizations (Udeogu & Okoye, 2024). To this extent, the application of AI has limitations. The limitation is rooted in its inability to implement decisions completely on its own. Implementation of AI generated data rests basically on human beings. Thus, Managers need to balance this two contending but complementary resources if they must get desired result. AI no doubt is an emerging concept in Africa and Nigeria in particular. For it to succeeds, Managers of organizations in Nigeria need to put in place reward system that will not make workers look at AI as rivals in terms of job loss but as complements and partners in progress. In advanced Countries, like China, for instance, workers do not face threat of job loss as a result of the introduction of automation; rather they gain from increased productivity of automating the system through increased wages (Michael, 1985). Thus, make the application of technology to tasks a win- win situation for employer and employee in Asian countries. In Africa, however, automation is synonymous with decrease in the dignity in labor and job loss. Hence, instead of seeing automation as partners in progress, workers see automation as a threat and an albatross that must be avoided by all means possible.

To achieve change in this adversarial behavior of workers against anything automation, Managers of organizations in Africa and Nigeria in particular need to re-focus their reward system. The focus should be on the behavior which is rewarded in work organizations. This is because; it has been proven that a behavior that is positively rewarded is bound to repeat (Michael, 1985). Reward must be linked to performance. Hence, an employee who knows that the introduction of automation will lead to his own sack will not be friendly with its introduction by the organization. Thus, the greatest challenges facing performance in organizations today in spite of the introduction of an AI is the mismatch of reward with performance. The study argues that for organizations to reap maximum benefits from the application of AI there should be reward system in place that marries increase in productivity to increase in rewards for workers who work in synergy with the AI

technology.

The manufacturing sector is the driving force behind the growth of nations, and no gain saying, therefore, that the optimal performance of the subsector will improves the general well-being of the nation (Audu, 2024). It is one area that AI can be applied. However, the poor performance of the sector has left much to be desired. For instance, in 2023 alone, 767 Manufacturing Firms shut down business while 335 became distressed (MAN, 2023) partly due to high cost of doing business in Nigeria. In search for cost-cutting with a view to reducing costs and improve organizational performance, the application of AI becomes imperative ((Basri, 2020; Chan et al., 2019; Jabłońska & Pólkowski, 2017; Ulas, 2019; Ulrich, Frank, & Kratt, 2021; Ebuka, Dibua, & Idigo, 2023, Udeogu, Arinze & Okoye,2024)). Today, AI application is gradually gaining ground around the world and Nigeria is not an exception. However, to reap the gains of AI application as an instrument to increase performance, Managers of organizations need to balance the adversarial relationship between humans whose work AI complements through a performance link reward system. The idea should not be that AI has come to replace the work of workers, but to in an efficient manner, complement one another. Thus, linking AI to performance directly seems to give a spurious result without factoring in the human element that directs the activities of AI. Managers of organizations must demonstrably show that the human elements in their organizations are given the pride of place rather than seeing them as playing second fiddle roles. Linking reward with performance is undoubtedly one of the greatest challenges in modern organizations and Managers are advertently or inadvertently falling victims of rewarding wrong behavior and thus get poor performance (Michael, 1985). Hence, this study calls for the special attention of Managers of Manufacturing Firms to this special but oblivious aspect of what drives performance in organizations to enable them do well and improve performance.

This study therefore is embarked upon to examine the application of an AI and performance of manufacturing firms in North-Central, Nigeria with reward system as the moderating variable.

**Statement of the Problem**

The general responsibility of business failure most often is linked to Management failure. Thus, each time there is poor performance in organizations, the blame goes to Managers. This is in spite of the multitude of business Management Graduates that are churned-out of our higher institutions every year to manage our businesses.

To this end, Managers of organizations have been on the vanguard of seeking for cost-cutting mechanisms to enhance operational efficiency and performance of their organizations. One of the available ways to wriggle out of this menace is the application of Artificial Intelligence (AI) by Managers with a view to reducing operational costs and improves the performance of their organizations. However, Managers pay more attention to the application of AI, without balancing the concerns for the human components of the organizational process. This, no doubt, posses a great challenge to the gains of application of AI in Nigerian organizations. The development of adversarial relationship between workers and the application of AI in organizations cannot be ignored. This may not be unconnected with the attitudes of Managers toward reward system put in place in the organizations. Thus, the inability of Managers to link reward with performance seems to lead to under-performance of organizations in Nigeria despite the applications of AI.

Unlike in advanced societies around the world, applications of machines to perform those tasks that have been hitherto performed by human beings do not lead to loss of jobs. Rather, it increases productivity arising from automation and consequent increase in reward to workers. However, in Nigeria, workers face threat of job loss as a result of automation of processes. This often leads to unnecessary apprehension among worker who works to sabotage the gains of automation. Hence, poor persformance persists despite the application of AI in our organizations. This study therefore is embarked upon to examine the nature of relationship between AI and organizational performance using reward system as the moderating variable.

From the foregoing, the study is set to achieve the following objectives:

1. Investigate the influence of machine learning on operational efficiency of manufacturing firms in

North-Central Nigeria

2. Examine the effect of Digital Twins on customer satisfaction of the manufacturing firms in North-Central Nigeria

3. Determine the influence of Generative Design technology on cost reduction of manufacturing firms in North-Central Nigeria

4. Ascertain the moderating effect of reward system on the application of AI on the performance of manufacturing firms in North-Central Nigeria

## LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

Artificial intelligence is a concept derived from natural human beings who employ their intellects to handle jobs that ordinary people cannot fathom (Udeogu, Okoye & Ikechukwu, 2024). Thus AI is an all-catch term to refers to the assemblage of computer systems that is powered to perform complex tasks that historically are been performed by humans which includes reasoning, decision-making, and problem solving. The advent of technology has made it possible for the creation of machines that work like humans though not humans. AI is known for its effectiveness, efficiency, and without errors. It has the capacity to solve complex problems, seamlessly handling of volumes of data effectively and efficiently more than human beings (Udeogu, Arinze, & Ikechukwu, 2024). AI according to Arakpogun et.al (2021; Rai, Constantinides & Sarker,2019) is the assemblage of Information and Communication Technologies (ICTs) that model human intelligence, and hence perform duties that were hitherto undertaken by human beings. The primary purpose of the application of AI is to improve jobs, create greater operational efficiency, and drive performance and economic growth (Arakpogun et.al, 2021). Wechie and Opigo (2020) in their work submitted that there is a significant positive relationship between AI and organizational performance of Manufacturing Firms. The primary goal of AI is to reduce operational costs, increase efficiency, grow revenue and increase customer satisfaction (Lohr, 2017). It is a funnel for industrial value creation and leading businesses, and the emerging world order must commence the visualization of and deployment of AI as strategic pillar for building smart products, improve market share, attain business diversification and expansion (wechie & Opigo. 2020). Today businesses are relying on AI to take advantage of the usage of big data which enable them to develop the capability to streamline their operations, ensure efficient management of inventory and supply chain with monumental level of effectiveness, and create innovative new business models that aid the management of businesses strategically (Lee, 2011). Extant literature such as Financial Stability Board, 2017, Cockburn, Henderson & Stern, 2017; Morikwa, 2016; Salfano, 2016 ; Gale 2011; Ishak 2010; Oke 2008; Ibekwe & Helen, 2020 ; Bolloju 2022; Thearling 1998; Himanshu, Chaudrika & Rabindra 2022; Udeogu & Okoye 2024; Dhruv, Ritu and Manish 2022; Chaudri; Chatterjee, Vroutis, & Chaudri 2022; Rosa, Bento, Pereira DaCosta, Dias, & Goncalves, 2022 have submitted respectively that AI has a positive relationship with organizational performance.

Equally, AI serves as strategic tool that confers on organizations competitive advantage that leads to improve performance through the possession of rare attributes of valuability, inimitability, and non-substitutability (Mikalef, & Gupta, , 2021). AI has the capacity to process large volume of datasets, automate repetitive tasks, and improve decision-making leading to operational efficiency, customer satisfaction, and innovation. This makes AI a valuable goal achieving asset to the organization that posses it (Mikalef & Gupta, 2021; Barney, 1991; Bharadwaj, Elsawy, Pavlou &Venkatraman, 2013, Fosso, Akter, Edwards, Chopin & Gnanzon, 2020). Thus, based on the foregoing, the study relied on resource based view theory proposes the following hypotheses:

$H_1$: Machine learning has a relationship with operational efficiency of Manufacturing firms in North-Central Nigeria.

According to Burian (2020) firms deploy a range of AI tools and solutions which include AI machine learning and deep learning to improve the level of their precision in forecasting and solving of logistic problems. Furthermore, AI powered Chabots and virtual assistants' aid in the management of customer enquiries, furnish necessary information that will aid decision making, managing platforms which leads to the enhancement of

customer services and customer relationship management (Ebuka, Dibua, & Idigo, 2023). Equally, AI inventory management technologies has the capacity to forecast demand, optimizes stock levels, and curb excessive stock holdings that would have tied down capital and also mitigate the effect of stock-outs. This can help in cost reductions and improve customer satisfaction (Greenberg, 2017). From the literature above, AI Digital Twins and Generative designs are necessary tools that businesses use to improve performance. Organizations are deploying AI tools such as machine learning, Digital twins, and Generative design to improve their forecasting accuracy, and detect problems early enough to take proactive actions (Burian, 2021). Similarly, Arakpogun (2021; Udeogu & Okoye, 2024) submit that the purpose of the deployment of AI in business is to improve performance by reaching out to more customers thereby increase market share, Making data-driven decisions thus avoid trial and error, increasing speed of service leading to customer satisfaction all these are metric of effectiveness and efficiency which is a hallmark of organizational performance. Hence, the following hypotheses are derived:

$H_2$: Digital twins have influence on customer satisfaction of manufacturing firms in North-Central Nigeria.

$H_3$: Generative Design has no influence on cost reduction of Manufacturing Firms in North-Central Nigeria

Today, AI has been applied to tasks that have been hitherto performed by man. However, the application of AI is not an end in itself but a mean to an end. The tasks of AI which include reasoning, making businesses decisions , processing volumes of data, and or solving problems only serves as a tool to facilitate the jobs or tasks of humans in organizations (Udeogu & Okoye, 2024). To this extent, the application of AI has limitations. The limitation is rooted in its inability to implement decisions on its own in some cases. Implementation of AI generated data rests basically on human beings. Thus, Managers need to balance this two contending but complementary resources if they must get desired result. For it to succeeds, Managers of organizations in Nigeria need to put in place reward system that will not make workers look at AI as rivals in terms of job loss but as complements and partners in progress. In advanced Countries, like China, for instance, workers do not face threat of job loss as a result of the introduction of automation; rather they gain from increased productivity of automating the system through increased wages (Michael, 1985). Thus, application of technology to tasks is a win- win situation for employer and employee in Asian countries. In Africa, however, automation is synonymous with decrease in the dignity in labor and job loss. Hence, instead of seeing automation as partners in progress, workers see automation as a threat and an albatross that must be avoided by all means possible. Reward system is acknowledged globally by extant literature as driving force behind any commitment of workers in organizations and had been found to have positive relationship with organizational performance. For instance, Bello and Adebayanjo, 2014; Yulia 2019; Felix, Zirra and Charles 2020; Ogenna and Uju 2020; Olurotimi, Norida and Norhidya 2016; Onuorah, Okeke and Ibekwe 2019; Ejomudo 2014; Zirra, Mambula and Anyatonm, 2019; Ekwochi, Nwudugbo and Okoene, 2018 have found a positive influence of reward system on organizational performance. Hence, the study based on reinforcement - Expectancy theory submits that a behavior that is rewarded is more likely to occur in the future (Thorndike's Law of Effect). Aswathappa (2017) asserts that a behaviour which has a rewarding experience is likely to be repeated. The implication for reward system is that high employee performance follow high reward and will make future employees performance more likely.

Hence, on the basis of expectancy- reinforcement theory the study proposes the following hypothesis:

$H_4$: Reward system has an influence on the application of AI to improve organizational performance of Manufacturing Firms in North-Central Nigeria.

**Empirical Review**

Udeogu and Okoye (2024) examined AI and competitive advantage of Micro, Small and Medium Enterprises (MSMEs) in Anambra State, Nigeria. The objective of the study was to investigate the extent of the introduction of AI in achieving competitive advantage among MSMEs in Anambra State. To achieve the objective of the study, a survey research design was employed and the population was1399 MSMEs in Anambra State out of which a sample of 301 was arrived at using Krejcie and Morgan sample size determination formula. Data for the study were gathered through questionnaire design in five points Likert

scale and analyzed descriptively and inferentially. The hypotheses were tested using Pearson product moment correlation coefficient. The study found a significant positive relationship between data-driven targeted online adverts and increase in quality lead generation.

Also, Himanshu, Chaudrika and Rabindra (2022) assess the influence of AI on the operating performance of companies in Bhubaneswar, India. The goal of the study was to establish the nature of relationship that exists between AI and performance of companies in diverse sectors in India. For the purpose of the study, primary data were gathered from annual reports of sampled companies covering 2004-2018. The data were analyzed using MS. Excel E –view 10 to run the t- tests and panel regression model for statistical inferences. The study discovered that AI has a significant influence on companies operating costs as well as operating profits.

Furthermore, Dhruv, Ritu and Manish (2022) investigated the relationship between digital advertising (DA) and AI and its impact on creating a suitable market strategy (MS) for organizations in India. To achieve the objectives of the study, a descriptive research survey design was employed and data gathered were descriptively analyzed and Smart PLS software utilizing inferential statistics and structural equation modeling (SEM) was used. The study discovered that communication with customers has changed the face of marketing.

Rosa, Bento, Pereira DaCosta, Dias, and Goncalves (2022) examined the extent of the introduction of AI in companies in Portugal on marketing activities. The objective of the study was to explore reasons and challenges that confront companies in introducing AI, their perceptions of AI and whether they feel pressured to adopt AI technology. To achieve the objective of the study, a qualitative research design was adopted and data were collected through interviews of 21 professionals that are familiar with the theme of the study. The study discovered that the main challenges faced are the costs of the investment and the loss of human connection with customers.

Meanwhile, Chaudri; Chatterjee, Vroutis; and Chaudri (2022) studied AI dynamism and its impact on the sustainability of firms, including Small and Medium Enterprises (SMEs) in India. They authors developed a theoretical model through the lenses of Expectation Disconfirmation theory (EDT), Technology Trust-Fit (TTF) theory, contingency theory, and the knowledge contained in the existing literature. The theoretical model was tested using the factor-based PLS-SEM technique by analyzing data from 343 Managers of SMEs. The study found that organizational characteristics, and individual characteristics all influenced SMEs deployment of AI technologies to achieve sustainability, with technological and leadership support acting as moderators.

Dipak (2021) conducted a study to examine the influence of several variables on the adoption, implementation, and usage of AI in the Indian Small and Medium-Sized (SME) business sector. To achieve the goals of the study, a quantitative cross-sectional co-relational research design was used and data gathered from pre-validated survey and online surveys using the survey monkey platform. Ten choosing components from DOI, TOE, and TAM theories were shown to be correlated among survey data from 152 individuals. The analysis revealed a modest to moderately significant positive statistical connections with decisions affecting the adoption of AI.

Kumar; Pandey; Pujari; and Arora (2023) studied the impact of AI and E-commerce on enhancing the marketing performance of small and medium-sized Enterprises (SMEs). The research technique used was the conduct of a comprehensive evaluation of the existing literature and research focusing on the characteristics of AI and E-commerce that have the potential to enhance various aspects of SMEs marketing processes. The study found integration of AI in SMEs has resulted in the enhancements in various areas such as the development of intelligent content, and innovative business models, predictive modeling, automated decision-making processes, real-time customer insights, and advancements in products and service innovations.

Equally, Amesho, Edoun, Naidoo; and Pooe (2022) investigated the influence of technology and innovation systems on service delivery in South Africa. To achieve the objective of the study, secondary data was gathered and used. The finding of the study indicated that managing technology and innovation for SCA is not a method of achieving an aim in and of itself, but rather a collection of instruments and tactics to ensure effective service delivery.

So also, Ebuka; Emmanuel; and Idigo (2023) investigated the role f AI in small business operations in Nigeria. The objective of the study was to identify areas of application of AI and barriers to the deployment of AI in SMEs. To achieve the objectives, a descriptive research design was employed and the population of the study was 27,546 small businesses in Nigeria that were registered with Corporate Affairs Commission (CAC) out of which a sample of 376 was chosen using Krejcie and Morgan sample size determination formula. The data for the study was obtained through interviews, and structured questionnaire. The analysis of the data using descriptive statistics revealed that SMEs in Nigeria are still operating manually; hence, they do not enjoy the massive potentials of AI deployment and perpetually remain small in size the study concludes.

Yulia and Wamba (2022) examined how AI shapes business resilience to supply chain disturbances which in turn improves firms' performance in Europe. AI was conceptualized as a dynamic information processing capability with the trio-components of coordination/ integration, learning and strategic competitive response capability as a measure of firm resilience to supply chain disruptions, and a mediating factor between AI use and firm performance. Data for the study was gathered from 107 organizations in Europe using a two-stage survey and analyzed. The study discovered that AI usage has a direct influence on business resilience and that firm resilience completely mediates the link between AI application and firm performance.

Mohammed and Ghaleb (2022) investigated the role of AI marketing strategies and organizational capabilities on organizational performance. The moderating roles of organizational behavior on Tourism Industry in the United Arab Emirate (UAE).The study also examines the mediating role of organizational capabilities in linking AI , marketing strategies and organizational performance of the Tourism Industry. Questionnaire was the instrument used to collect primary data from respondents and analysis conducted using SMART- PLS. The result revealed that AI and marketing strategies have a positive association with organizational performance of the Tourism Industry in UAE. The study also discovered that organizational capabilities positively mediate the links between AI, marketing strategies, and organizational performance.

Financial Stability Board (2017) examined the implication of AI and Machine learning on financial service market development. The study conducted in 6325 companies in 18 European Countries. The companies were selected using convenience sampling technique and quasi- experimental research design was employed. The study generated its data from the respondents through questionnaire administered out of which 135 representing 2. 13% were not completed and returned and the data gathered were analyzed using chi-square statistical instrument. The study discovered that AI and Machine learning are being rapidly adopted for a range of applications in the financial services industry

Wechie and Opigo (2020) studied AI with the aim of determining its effect on organizational performance of Manufacturing Firms in Portharcourt Nigeria. Survey research design was used. The population of the study was 56 General Managers of Manufacturing Firms in Portharcourt and questionnaire employed in data gathering. Data gathered were tested using Pearson Product Moment coefficient of correlation. The result of the analysis revealed that AI has a significant positive effect on organizational performance

Figure 1: Conceptual Model
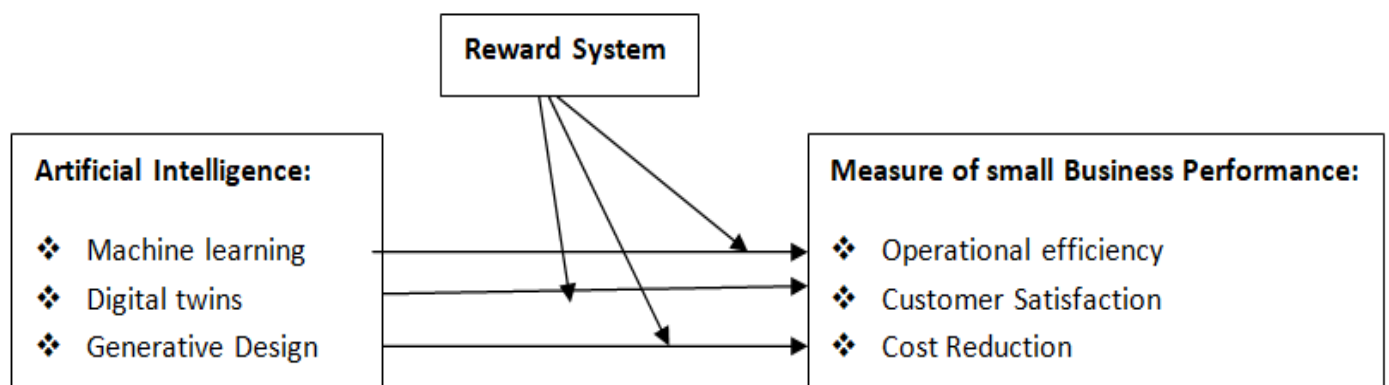


Source: Research's Model, 2025

The model explains the duo- relationships between AI, Manufacturing Firms' performance and reward system. The paper argues that AI leads to high organizational performance through enhanced operational efficiency, customer satisfaction, and cost reduction using machine learning, Digital twins, and Generative design as AI tools. To achieve the goals of enhanced operational efficiency, customer satisfaction and cost reduction, using AI, the human elements which AI complements must be factored into the equation through performance-reward system.

## METHODS

The study adopted a descriptive survey research design. Hence, a structured questionnaire was designed in five points Likert scale of strongly agree to strongly disagree and distributed proportionally to targeted 200 respondents who were Top level Management, Managers, middle level Managers and supervisors of the target Manufacturing Firms in the North-Central Nigeria of Abuja, Kogi, Niger, Plateau and Kwara States that were registered with the Corporate Affairs Commission (CAC) as shown in the table below. The 200 respondents made up of Top level Management, Managers, middle level management, and supervisors formed the population for the study. Complete enumeration of the target respondents was achieved. Data gathered from the respondents were analyzed using Statistical Packages for Social Sciences (SPSS). Hence, in order to achieve the objectives of the study, simple linear regression analysis was performed

Table 3.1: shows the registered Manufacturing Firms in various States of North-Central and FCT Abuja

| S/N | States | Number of registered manufacturing firms | Proportions of respondents |
|-----|--------|-------------------------------------------|----------------------------|
| 1 | Abuja, FCT | 42 | 42/57 x200 =147 |
| 2 | Plateau State | 6 | 6/57 x200 =21 |
| 3 | Kwara State | 7 | 7/57 x 200 =25 |
| 4 | Kogi State | 1 | 1/57 x 200 = 4 |
| 5 | Niger State | 1 | 1/57 x 200 = 4 |
| 6 | Benue State | 0 | - |
| 7 | Total Sample | 57 | 200 |

Source: Business Directory, 2025

Model Specification

To establish the nature of influence of the independent variable on the dependent variable, a simple linear regression was conducted. The study tested the following model:

PM= (AI, RS)

Where:

PM = Manufacturing Firms Performance

AI = Artificial Intelligence and RS is the Reward System

RS=Reward System

ML=Machine learning

DTs = Digital twins

GD =Generative Design

AI = (ML, DTs, GD,)

Hence, $PM = B_O + B_1ML + B_2DTs + B_3GD + E$ ---------------1

$PM = B_O + B_1ML + B_2DTs + B_3GD + B_4RS + E$-------------II

ML, DTs, GD, RS are the coefficient of independent variables to be estimated

The two equations above are to be estimated to find the influence of AI on manufacturing firms performance and the second equation seek to know the influence of AI on manufacturing firms performance with the presence of Reward System as moderator

## DATA ANALYSIS AND RESULTS

Table 4.1 shows the results of factor analysis and reliability tests conducted.

| Variables | KMO | Bartlett's test | Eigen value | Variance explained | Cronbach Alpha |
|---|---|---|---|---|---|
| Machine learning (ML) | .757 | Significant | 3.56 | 59.4% | .823 |
| Digital Twins (DTs) | .713 | Significant | 3.109 | 51.8% | .762 |
| Generative Design (GD) | .590 | Significant | 2.914 | 48.6% | .762 |
| Operational efficiency (OPE) | .773 | Significant | 3.311 | 55.2% | .776. |
| Cost reduction (CR) | .729 | Significant | 3.35 | 55.8% | .824 |
| Customer satisfaction (CS) | .42 | Not Significant | 3.69 | 61.6% | .763 |
| Reward System (RS) | .649 | Significant | 2.84 | 47.3% | .745 |

SPSS Analysis, 2025

Table 4.2  Descriptive Statistics of respondents

| S/N | Item | Frequency | Percentage |
|---|---|---|---|
| 1 | **Gender** | | |
| | Male | 120 | 60 |
| | Female | 80 | 40 |
| | **Total** | 200 | 100 |
| 2 | Age | | |
| | 18-30 | 52 | 26 |
| | 31-40 | 68 | 34 |
| | 41-60 | 60 | 30 |

|   |   |   |   |
|---|---|---|---|
|   | 61 above | 20 | 10 |
|   | **Total** | 200 | 100 |
| 3 | Status |   |   |
|   | Top level Management | 40 | 20 |
|   | Senior Managers | 42 | 21 |
|   | Low Level Managers | 63 | 31.5 |
|   | Supervisors | 65 | 32.5 |
|   | **Total** | 200 | 100 |
| 4 | Length of service |   |   |
|   | 1-5 years | 65 | 32.5 |
|   | 6-10 years | 70 | 35 |
|   | 11years and above | 65 | 32.5 |
|   | Total | 200 | 100 |
| 5 | Literacy level |   |   |
|   | SSCE | 40 | 20 |
|   | ND/NCE | 35 | 17.5 |
|   | HND/BSC | 75 | 37.5 |
|   | Postgraduate | 20 | 10 |
|   | Others | 30 | 15 |
|   | Total | 200 | 100 |

Source: Field Survey, 2025

The table 4.2 above shows the demographic statistics of respondents. From the table 120 (60%) respondents were male while 80(40) respondents were female. This implies that majority of the respondents were male. In the table, respondents within ages 18-30 were 52 which represents 26% while those within ages 31-40 were 68 made up of 34%. Also, respondents within ages 41-60 were 60 and comprised of 30% with those within ages 61 and above were 20 constituting 10% of the respondents respectively. Respondents within the age of 31-40 were the majority. On the status of the respondents, 40 representing 20% were top Management staff while 42 made up of 21% were on the rank of senior management level. Equally, 63 respondents comprised of 31.5% were on the low level management cadre with 65 made up of 32.5% were supervisors respectively. The impulse of this finding is that the respondents were fairly distributed among the various levels hence possibility of reaching a balanced opinions. The table shows the length of service of the respondents. Respondents that have been in business from 1-5 years were 65 representing 32.5% while those that have served between 6-10 years were 70 made up of 35% and those that were in business for above 10 years were 65 representing 32.5%. The data shows a fairly distribution of the experiences of respondents. On the literacy level of respondents, 40 hold a secondary school certificate and they constitute 20% while 35 hold National Diploma and General Certificate of Education and they made up of 17.5% of the respondents. Meanwhile, 75 respondents hold Higher National Diploma and Bachelor Degree and they comprised 37.5% of the target respondents and 20 hold a postgraduate qualifications and made up of 10% with 15 respondents hold other certificates not mentioned here, they constitute 15% of the respondents.

**Hypothesis One:** $H_1$: Machine learning has a relationship with operational efficiency of Manufacturing Firms

in North-Central Nigeria.

In testing of hypothesis one, the following regression tables were generated and interpreted as shown here underneath:

Table 4. 3 Model Summary[b]

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .721[a] | .520 | .517 | .431 |
| a. Predictors: (Constant), ML | | | | |

Table 4.4    ANOVA[a]

| Model | Sum of Squares |
|---|---|
| Regression | 39.775 |
| Residual | 36.777 |
| Total | 76.552 |
| a. Dependent Variable: OPEF | |
| b. Predictors: (Constant), ML | |

Table: 4.5 Coefficients[a]

| Model | | Unstandardized Coefficients | | Standardized Coefficients | T | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | .733 | .289 | | 2.532 | .012 |
| | ML | .996 | .068 | .721 | 14.634 | .000 |
| a. Dependent Variable: OPEF | | | | | | |

The model summary table reports the strength of the influence of the independent variable on the dependent variable. The result of R stood at .721 indicative of a positive influence of the independent variable Machine Learning (ML) on the dependent variable operational efficiency (OPE). The coefficient of multiple determinations $R^2$ is .520 and it measures the percentage of change in the dependent variable occasioned by the explanatory variable. The variance of change was 72%-52% which is 20%. The ANOVA table confirms the result of the model summary which revealed that F=214.144 which is significant at 0.000<0.05 and shows a significant influence of Machine learning on operational efficiency. This shows that the hypothesis that Machine Learning has a relationship with customer satisfaction is accepted. The coefficient of determination provides the information on how the explanatory variable influences the dependent variable. The result shows the regression constant of .996 giving the predictive value of the dependent variable when all other variables are at zero level. The coefficient of Machine Learning is .68 with a P-value of 0.000 < 0.05 critical values.

**Hypothesis Two:** $H_2$: Digital twins have an influence on customer satisfaction of manufacturing firms in North-Central Nigeria.

In testing hypothesis two, the following regression tables were generated and interpreted as shown here underneath:

Table 4.6 : Model Summary[b]

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|
| 1 | .687[a] | .472 | .469 | .439 | 1.536 |
| a. Predictors: (Constant), DTs | | | | | |
| b. Dependent Variable: CS | | | | | |

The model summary table reports the strength of the influence of the independent variable on the dependent variable. The result of R stood at .687 indicative of a positive influence of the independent variable Digital twins (DTs) on the dependent variable customer satisfaction (CS). The coefficient of multiple determinations $R^2$ is .472 and it measures the percentage of change in the dependent variable occasioned by the explanatory variable. The variance of change was 69%-47% which is 22%. The ANOVA table confirms the result of the model summary which revealed that F=176.923 which is significant at 0.000<0.05 and shows a significant influence of Digital twins on customer satisfaction. This shows that the hypothesis that Digital twins have a relationship with customer satisfaction is accepted. The coefficient of determination provides the information on how the explanatory variable influences the dependent variable. The result shows the regression constant of .269 giving the predictive value of the dependent variable when all other variables are at zero level. The coefficient of Digital Twins is .66 with a P-value of 0.000 < 0.05 critical values.

**Test of Hypothesis Three:** H[3]: Generative Design has influence on cost reduction of Manufacturing Firms in North-Central Nigeria

The table below presents the model summary, ANOVA and coefficient of determination on the independent variable effect on the dependent variable without the introduction of the moderating variable.

Table: 4.7 Model Summary[b]

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|
| 1 | .673[a] | .453 | .450 | .420 | 1.106 |
| a. Predictors: (Constant), GD | | | | | |
| b. Dependent Variable: CR | | | | | |

Table:4.8  ANOVA[a]

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 28.889 | 1 | 28.889 | 164.137 | .000[b] |
| | Residual | 34.849 | 198 | .176 | | |
| | Total | 63.738 | 199 | | | |
| a. Dependent Variable: CR | | | | | | |
| b. Predictors: (Constant), GD | | | | | | |

Table: 4.9   Coefficients[a]

| Model | | Unstandardized Coefficients | | Standardized Coefficients | T | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | 1.504 | .202 | | 7.432 | .000 |
| | GD | .755 | .059 | .673 | 12.812 | .000 |
| a. Dependent Variable: CR | | | | | | |

The model summary table reports the strength of the influence of the independent variable on the dependent variable. The result of R stood at .673 indicative of a positive influence of the independent variable Generative Design (GD) on the dependent variable cost reduction (CR). The coefficient of multiple determinations $R^2$ is .453 and it measures the percentage of change in the dependent variable caused by the explanatory variable. The variance of change was 67%-45% which is 22%. The ANOVA table confirms the result of the model summary which revealed that F=164.137 which is significant at 0.000<0.05 and shows a significant influence of Generative design technology on customer satisfaction. This shows that the hypothesis that Generative Design has a relationship with cost reduction is accepted. The coefficient of determination provides the information on how the explanatory variable influences the dependent variable. The result shows the regression constant of .755 giving the predictive value of the dependent variable when all other variables are at zero level. The coefficient of Generative Design is 0.59 with a P-value of 0.000 < 0.05 critical values.

H4: Reward system Moderates the influence on the application of AI to improve performance of Manufacturing Firms in North-Central Nigeria.

Table 4.10  Model Summary[b]

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|
| 1 | .862[a] | .744 | .742 | .236 | 1.605 |
| a.  Predictors: (Constant), AI | | | | | |
| b.  Dependent Variable: PERF | | | | | |

The model summary shows the influence of Artificial Intelligence the independent variable combined with the moderator- Reward System on the performance of manufacturing Firms.  R stood at .862 which revealed a significant positive influence of the independent variable combined with the moderator on the dependent variable. The coefficient of multiple determinations R square measures the percentage of total change in the dependent variable that can be explained by the explanatory and moderating variables. The result indicate an $R^2$ of .744 indicating that 74% of the variances in the dependent variable is explained by the combined effect of the independent and moderating variables while the remaining 26% (100-74) of the variation could be explained by the variables not considered in this model.

Table 4.11 ANOVA[a]

| Model | | | Df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 31.907 | 1 | 31.907 | 574.188 | .000[b] |
| | Residual | 11.003 | 198 | .056 | | |

| | | | | | |
|---|---|---|---|---|---|
| Total | 42.909 | 199 | | | |

a.  Dependent Variable: PERF

b.  Predictors: (Constant), AI

The ANOVA table confirms the result of the model summary which revealed that F=574.188 which is significant at 0.000<0.05 and shows a significant influence of the independent and moderating variables on Manufacturing Firm's Performance. This shows that the hypothesis which states that Reward system Moderates the influence of the application of AI to improve performance of Manufacturing Firms in North-Central Nigeria is accordingly supported and accepted. The coefficient of determination provides the information on how the explanatory variables influence the dependent variable. The result shows the regression constant of .909 giving the predictive value of the dependent variable when all other variables are at zero level. The coefficient of AI is .038 with a P-value of 0.000 < 0.05 critical value

Table 4.12 Coefficients[a]

| | | Unstandardized Coefficients | | Standardized Coefficients | T | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | .617 | .138 | | 4.459 | .000 |
| | AI | .909 | .038 | .862 | 23.962 | .000 |

a.  Dependent Variable: PERF

The influence of the independent variable AI on the performance of Manufacturing Firms without the influence of a moderator is shown by the regression analysis below:

Table 4.13 Model Summary[b]

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|
| 1 | .697[a] | .486 | .484 | .394 | 1.247 |

a. Predictors: (Constant), MAI

b. Dependent Variable: MPERF

The model summary shows the influence of the independent variable Artificial Intelligence on the performance of manufacturing Firms.  R stood at .697 which revealed a significant positive influence of the independent variable on the dependent variable. The coefficient of multiple determinations R square measures the percentage of total change in the dependent variable that can be explained by the explanatory variable. The result indicate an $R^2$ of .486 indicating that 49% of the variances in the dependent variable is explained by the independent variable while the remaining 51% (100-49) of the variation could be explained by the variables not considered in this model.

Table 4.14  ANOVA[a]

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 29.170 | 1 | 29.170 | 187.532 | .000[b] |

| | | | | | |
|---|---|---|---|---|---|
| Residual | 30.798 | 198 | .156 | | |
| Total | 59.968 | 199 | | | |
| a. Dependent Variable: MPERF | | | | | |
| b. Predictors: (Constant), MAI | | | | | |

The ANOVA table confirms the result of the model summary which revealed that F=187.532 which is significant at 0.000<0.05 and shows a significant influence of independent variables on Manufacturing Firm's Performance. The coefficient of determination provides the information on how the explanatory variable influences the dependent variable. The result shows the regression constant of .640 giving the predictive value of the dependent variable when all other variables are at zero level. The coefficient of AI is .082 with a P-value of 0.008 < 0.05 critical values.

Table 4.15 Coefficients[a]

| Model | | Unstandardized Coefficients | | Standardized Coefficients | T | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | .640 | .237 | | 2.698 | .008 |
| | MAI | 1.124 | .082 | .697 | 13.694 | .000 |
| **a.** Dependent Variable: MPERF | | | | | | |

# DISCUSSION OF FINDINGS

The results of the analysis conducted revealed a significant positive influence of AI on one hand and Reward System as moderator on the other hand on the performance of the manufacturing firms in North-Central Nigeria. The first hypothesis showed a significant positive influence of Machine learning (ML) on operational efficiency (OPE) of manufacturing firm. This finding corroborates with the findings of Hamanshu et.al (2022) who in his work discovered a significant positive influence of ML on OPE of manufacturing firms in India.

Equally, hypothesis two found a positive effect of Digital Twins (DTs) technology on customer satisfaction (CS) of manufacturing firm. Again, this finding is in tandem with the finding of Dhruv, et.al (2022) and Amesho et.al (2022) who submitted in their work that DTs technology has a significant and positive relationship with customer satisfaction in India and South Africa respectively.

The third hypothesis also revealed significant and positive influence of Generative Design (GD) technology and cost reduction in manufacturing firms in North-Central Nigeria. The work of Hamanshu et.al corroborates the finding of this study when they submitted that AI generative design helps cutting costs and improve organizational performance.

On the moderating roles of reward system, the study discovered a significant positive relationship between the moderator and performance of the manufacturing firms in North-Central Nigeria. The findings of Mohammed & Ghaleb (2022) and Wechie & Opigo (2020) support the finding of this study that the combined force of the independent variable (AI) and reward System (RS) have significant effect on the performance of the manufacturing Firms.

# CONCLUSION

Based on the findings, it can be summed up that AI moderated by (RS) plays strategic roles in enhancing the

performance of manufacturing firms in North-Central Nigeria. That is, if Managers of Manufacturing Firms are to achieve performance improvement, application of AI laced with RS is a way to go. Equal attention must be given to AI and RS to take care of human elements that derive the work of machines in organizations.

## RECOMMENDATIONS

The finding of this study is significant in several folds to Managers of Manufacturing Firms in Nigeria.  To this end, the following recommendations are made:

1. Investment in machine learning (ML) by Managers of the manufacturing firms should be given top priority for strategic performance of the manufacturing firms through operational efficiency

2. Digital Twins (DTs) technology should be encouraged in the organization so as to satisfy customer. Top Management should take the introduction of DTs technology as a matter of priority.

3. To reduce cost of operations and improve performance, Managers of the Manufacturing firms should encourage and invest in Generative Design to gain competitive advantage over rivals in the market.

4. For the application of AI to succeeds in boosting performance of the manufacturing firms, conscious effort should be made to offer rewards that will make the human elements connected to the use of AI not to sabotage the gains of automation.

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