EFFECT OF TECHNOLOGICAL VARIABLES ON ALUMINUM MANUFACTURING COMPANIES IN FCT IDU INDUSTRIAL AREA

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ABSTRACT

The study examines the effect of technological variables on aluminum manufacturing companies in FCT Idu industrial area. The main objective of study investigated and analyzed the effect of technological variables on the operational performance aluminum manufacturing companies in FCT Idu industrial area. The study adopted both descriptive and causal research designs to expose the correlative attributes between technological infrastructures and operational performance in aluminum companies. The population of the study is 154 and the sample size is 111 and the study adopted ordinary least square method of regression using E-view Statistical Software Package, 23.00 Editions to analyze the stated hypotheses. Findings from the study revealed that there is significant contributory impact and correlation between technological variables (Robotic Machines) and innovativeness of aluminum manufacturing companies at Idu industrial area of Abuja. The second findings show that the adopting and implementing technological variables such as (Adoption of Artificial Intelligence) affected positively the competitiveness of aluminum manufacturing companies at Idu industrial area of Abuja. The third findings also show that there is significant contributory impact and correlation between technological variables Internet of Things (IOT)and customer satisfaction of the aluminum companies in Idu industrial area of Abuja. The study concluded that technologies and technological variables are strategic tools and backbone for modern manufacturing companies to excel in the sustainability of operational performances and attainment of strategic objectives. The study recommended that top management and managers of the aluminum manufacturing companies in Abuja, Nigeria should be proactive in adopting strategic thinking in their operational activities in alignment with growing new technological variables from the business context.

Key Words: *Aluminum Manufacturing Companies, Effect, and Technological Variables.*

1.1 Background to the Study

Modern businesses in manufacturing and other corporate settings of different size and level cannot operate smooth and enhance their strategic and operational performances without concrete deployment and advancement in technological variables in their operations in dynamic and complex business contexts. Especially during this novel corona virus pandemic that causes several panics and trauma to many businesses in Nigeria and other part world business environment, several business settings failed to survival their operational settings that lead to total closed down of shops, factories and corporate empires. The reasons behind their shops closed down were because they do not have modern technological infrastructures to adopt and run the new changes in operational activities that surfaced during the novel pandemic. And many others in the manufacturing sectors took the advantage of their new and modern technological infrastructures that pave ways for them to foresee opportunities for diversification and drive new investment during the novel Covid-19 pandemic.

Technological variables have been a strategic business context that strategic managers in modern business settings adopt to enhance smooth and sustainable operational performances and help to attain companies their strategic goals and objectives. Modern corporate enterprises in today business world adopt and deploy technological variables in their operational activities to improve innovativeness of their product and process as well as holistic innovativeness of the organization. Technological driving forces adoption and implementation in modern manufacturing settings can be deploy in operational activities to take competitive advantage, attain high competitive strengths and achieve desire position in the competitive market environment. Many strategic manufacturing firms in the global business settings have adopted new technological variables such as technological innovation, use of Robotic Machines, modern digital appliances, use of modern technological infrastructure, adoption of Artificial Intelligence and internet of Thing (IOT) to modernize and modify their products and services that have positively create improvement in the level of customer satisfaction. And this has variably leaded to increases in market share and customer retention of these strategic companies on the long run. In fact, modern technology strengths and capabilities in 21th century is facing out all old acceptance because the value chain in the new technologies are improving on daily basis (Polas & Raju 2021; Sushil 2020; & Vuong 2019).

Recent studies have described technology in different perspectives in their literatures and theoretical frameworks and have contributed significantly in the improvement of modern corporate enterprises and manufacturing sectors operational performances that cannot be ignored in this study (Mohamed & Jokonya 2021; Zhang et al., 2021; Polas & Raju 2021). Wilburn and Wilburn, (2018) opined and described technology as an instrument to create sophisticated relationship between employees and robotic machines in workplace on to enhances easy workflow of employees with machines and automation in order to attain smooth productivity and operational performance. From the perspective of the researcher, technological variables are strategic tools that modern organizations adopt and implement in their operational activities in order to sustain and attain strategic growth in operations and adopt

with every change from other business contexts. It is sequel to the above that this study intends to investigate and analyze the correlative effect of technological variables on operational performance of selected aluminum manufacturing companies in FCT Idu industrial area of the FCT-Abuja.

It obviously believed that technological variables are the life wire and strategic pillar that hold and strengthen the operational activities of manufacturing companies in the modern time. Because technology and technological variables such as have been adopted as strategic assets to change the face of organization into innovativeness, improve competitive strengths and competitive advantage and boost customer satisfaction in modern manufacturing sectors especially and specifically in aluminum manufacturing companies. Many strategic manufacturing firms in the global business settings have adopted new technological variables such as technological innovation, use of Robotic Machines, modern digital appliances, use of modern technological infrastructure, adoption of Artificial Intelligence and internet of Thing (IOT) to modernize and modify their products and services that have positively create improvement in the level of customer satisfaction. And this has variably leaded to increases in market share and customer retention of these strategic companies on the long run. In fact, modern technology strengths and capabilities in 21th century is facing out all old acceptance because the value chain in the new technologies are improving on daily basis (Polas & Raju 2021; Sushil 2020; & Vuong 2019).

One critical challenge faced in adopting and implementing technological infrastructures in modern aluminum companies is the rapidity in invention of more new technologies that face out the old ones and the cost implications as well as swiftness to adoption by manufacturing companies. This bane has pose threat of unfavourable effect on innovative, competitive advantage and customer satisfaction in Aluminum companies in FCT Idu industrial area in recent time from preliminary study conducted. And the dynamism and complexity from other business contexts like unfavourable economic and political reasons have also affected the swift adoption of modern digital technological variables in the operational activities of aluminum companies in Idu industrial area of FCT. It's on this premise that the study intends to examine the effect of technological variables on smooth operational performances of selected aluminum companies in FCT Idu industrial area.

The following research questions flow from the statement of the problem in the study:

1. To what extent does technological variables enhance innovativeness of selected aluminum companies in Idu industrial area of FCT -Abuja?
2. To what extent does technological variables improve competitive advantage of selected aluminum companies in Idu industrial area of FCT-Abuja?
3. To what extent does technological variables improve customer satisfaction of selected aluminum companies in Idu industrial area of FCT-Abuja?

The study focused on the effect of technological variables on smooth operational performances of selected aluminum companies in FCT Idu industrial area. The study has two important variables where the

technological variables is a standing independent variable with the following proxies: Robotic Machines, Adoption of Artificial Intelligence and Internet of Things (IOT), while operational performance of aluminum companies is dependent variable that have key indicators of innovativeness, competitive advantage and customer satisfaction. The study was conducted in three selected aluminum companies in FCT Idu industrial area namely: Classical Aluminum & Metal Product Limited, Abumet Nigeria Limited and System Metal Industries Ltd. The three companies were selected based on their operational commitment in the industry and have track records of long stay in operational activities and performance based on preliminary study conducted. This study covers four (4) operational years beginning from 2017-2020 to assess the effect of modern technological variables on operational performance of selected aluminium companies in Idu industrial area FCT.

2.0 Literature Review

Conceptual Review

Concept of Technology and Technological Variables

One of the greatest demands of modern business settings operations to attain and sustain profitable operational activities and performance is technology and technological infrastructures. Any organization in modern digital business environment that failed to key in with adoption and implementation of modern technological variables in its operational system and processes failed woefully to attain sustainable and profitable business operational and performance. It on this climax to believe that technology plays critical and significant contributory roles operational and strategic performances in modern manufac+turing companies. Jacob et al., (2021) described technology as the systematic adoption and implementation of strategic forces and strengths of physical attributes in production processes. Technology and technological infrastructures was an adoptable and implementable resource the many successful global companies used to create new business opportunities and diversification before and during the novel corona virus pandemic.

Lim, et al. (2021) and Alina and Martin (2021) in their opinion ascertained that technology has been adopted as strategic choice to digital modification and modernization customer investment decisions and help to improve and reduce risk in returns in modern business investment. That is in today investment environment digitalization and application of modern technological infrastructures will enhance the smooth flow in investment decisions in modern business settings. Wielgos, et al. (2021), and Alina and Martin, (2021) believed that the adoption and implementation of modern technological infrastructures helps modern business and manufacturing industries to address the situational changes in customer satisfaction and help strategically to enhance customer retention and variably improve organization's operational sustainability. Strategic invention and implementation of newer technology in organization's marketing strategic management can enhance the holistic operational function marketing strengths and capabilities to attain sustainable and profitable marketing objectives (De Luca, et al. 2021). Lamey, et al. (2021) and Alina & Martin, (2021) asserted that the strategic functionality

and performance competency in stock market innovativeness is powered by modern digital technological variables. In today business enterprise settings, technology and technological variables have set pace to manipulate effect from competitive war and create changes in modern marketing environment that have significant impact on their operational performance and strategic attainment and sustainability of corporate objectives.

Sganzerla, et al., (2016) cited in Andrea, (2021) generated opinion from his study that application and implementation of technological variables in modern business and manufacturing settings enhances new business opportunities, operational effectiveness and efficiency, ensure effective value chain alignment and help to develop agility strategic planning and implementation in complex business situations. The strategic impact of technology and technological variables has also shows strengths and competency in the development and improvement in efficiency in business dealing and flow in transactions and strategically adopted and implemented to sustainable and profitable entrepreneurship growth (Polas and Raju, 2021; Ransbotham et al. & 2018; Sushil 2019). It is also proven that technology and technological variables are strategic tools to enhance smooth and sustainable entrepreneurial marketing strategic decisions in modern business contexts even during the novel corona virus pandemic trauma (Grange, et al. 2020; Go¨ssling, et al. 2020; Polas, et al.2020; & Polas and Raju, 2021).

In the nutshell, technology and technological variables have dramatically and systemically adopted and implemented in modern business and manufacturing settings to replace and reshape human contributions in operational activities and productivity. The modern technological variables which comprise the adoption of artificial intelligence, Internet of Things (IOT), machine learning and many other technological infrastructures are gradually and incrementally taking over the operational system and processes from employees in modern organizations. The major significant contributing strengths of technological variables in modern manufacturing companies is that, it helps to fast track strategic decision making process in operational activities that improve operational performance.

Concept of Operational Performance in Manufacturing Companies

The main reason for every manufacturing and modern business settings to set up their factory and operational bases is to enhance sustainable and profitable operational performance that will assist in attainment of the holistic strategic goals and objectives. Operational performance is a strategic benchmark that modern organizations use to assess and evaluate the strengths and competency of strategic resources in line with the strategic objectives. That is for modern manufacturing companies to attain their corporate objectives, the strategic managers must adopt effective evaluative system to compare and contrast the attained operational performance with the expected strategic strengths and competency of strategic organizational resources both human and material resources. Organizational operational performance described the effectiveness and sustainability from the outcome of production, the marketing and market strengths of a company, strengths in customer satisfaction and suitability in

market share, organizational innovativeness and competitive strengths and advantage.

That is when a company in manufacturing sector has a leading structure in the competitive market, wide market operational strengths and competent strategic resources; it said that such company has sustainable and profitable operational performance. Martin, (2016) cited in Alfredo and Nurcahyo, (2018) and Hong, et al., (2019) described operational performance as the internal operation strengths in terms product and service quality, operational process quality, performance in inventory system and have driving competitive and marketing strengths to attain operational sustainability in a systemic organization. Hong, et al. (2019); Kareem and Kummitha, (2020) believed that operational performance in modern manufacturing companies rely heavily on the capability and competency of effective supply chain management. Operational performance also focuses on the alignment and integration of organization's operational strategies with the changes from the business contexts to ascertain operational sustainability in modern manufacturing settings. The key indicators operational performance in modern manufacturing companies varies from industries to another. One critical too to enhance operational performance in modern manufacturing is technological infrastructures because it have advance effect in ensuring operational activities and to attain competitive strengths and competitive advantage in manufacturing industries. The innovative strengths and competency of manufacturing companies to stand still in a highly competitive market and maintain suitable competitive position that heightens the market share can also be use to assess operational performance. Phorncharoen, (2020) suggested that suitable operational performance in modern manufacturing companies can be determine by high competitive war in competitive markets, changes in market situations and the uncertainty from the business contexts. Ya'kob and Jusoh, (2016) and Ramakrishnan, et al., (2015) cited in Tarigan, (2018) suggested that operational performance vested on the financial and non financial strengths of the manufacturing companies. That is from their perspectives; operational performance tends to measures the financial and non financial resources and capabilities and their effect on operational sustainability of modern manufacturing companies in Nigeria.

Impact of Technological Variables on Aluminum Manufacturing Companies.

Technological variables are critical strategic choices that cannot be averted in the operational of any manufacturing industries because of its significant contributions in sustaining and enhancing its strategic operational performances. Without technological variables in modern manufacturing operations the strengths of competitiveness and target customer satisfaction will have being on the decline stage. Technological advancement in aluminum manufacturing industry made the competitive market more interesting because this has expose the customers to competitive and product choices in the market and lead to dramatic changes in customer taste and fashion.

Zhang, et al., (2021) have asserted and concluded in their study one of greatest impact of technological infrastructures implementation in modern manufacturing companies and other modern business

settings is the improvement in the integration of value chain. They also agreed that modern technological variables adoption in operational activities fast track advancement in research and development and increases sales revenue in manufacturing sectors. Saurabh and Dey, (2021) concluded that the adoption of advanced technological variables like machine learning and cloud computing help to enhances value and supply chains and qualities improvement in agro-business sectors. They also ascertained those technological variables adoption enhances sustainable market orientation, improve revenue and help to attain favourable risk and uncertainty in agro business lines. Saurabh and Dey, (2021) and Morkunas, et al., (2019) concretely agreed that modern technology application in modern business and manufacturing industries foster sustainable and profitable business enterprises operational performances.

Wilburn and Wilburn, (2018) from their study ascertained that the adoption of technological variables and infrastructures in modern business and manufacturing industries has concrete impact and critical role in building robotic machine, internet of thing and artificial intelligence system to reduce production cost and increases in quantity of productivity. Su, C.-W et al., (2021) also exposes that adoption of modern technological variables has double significant effect to trigger sustainable innovation in electrical and electronic industries and enhance holistic growth in economy of a nation Polas and Raju, (2021) from their study concluded that the adoption of technological variables has tremendous impact in entrepreneurship operational sustainable and foster entrepreneurial strategic decisions in their marketing activities during the advent of the novel corona virus pandemic. Alina and Schreier, (2021) exposes that modern digital technological infrastructure deployment in modern business operational activities foster sustainable changes in customer and firm expectations. They also ascertained that new technologies fast track new innovation and in values create new satisfaction to customers and improve the operational profitability of the firm.

Fig.1; Proposed Model of Technological Variables and Operational Performance in Manufacturing Companies

1. Effective Strategic Decisions: One critical impact of new technologies in modern manufacturing companies is that strategic managers take the advantage to ensure effective and sustainable strategic decisions to enhance operational performance and attain the stated strategic objectives. The effect of technological variables set in strengths to attain smooth strategic planning and implementation in modern manufacturing industries.

2. Enhances Innovativeness: Innovation and innovativeness in modern manufacturing companies were attainable and sustainable through concrete effort of modern digital technologies. The advancement in technological variables enhances smooth innovation in product modification and modernization, processes in production, market change, organizational improvement in structure change and competitive innovation in modern manufacturing companies.

3. Improve Customer Satisfaction: One great impact of new and unforeseen new technologies and technological variables is that new technologies bring new satisfaction and modern taste and fashion to customers in modern manufacturing companies. Modern technological infrastructures are strategic variables to change the perception of customers' satisfaction and improve their taste and fashion in modern manufacturing companies.

4. Boost Market Share: Modern manufacturing companies adopt new advance technologies to improve and expand their market penetration and market development that lead to the improvement in their market share and customer base. Strategic business managers in modern manufacturing companies adopt modern technological infrastructures as strategic capability and competency to enhance product modification and diversification to improve customer satisfaction and create new market and new customers.

5. Efficiency and Effectiveness in Production: The adoption of robotic machine, internet of thing, cloud computing and machine learning are in production processes and system have improve effectiveness and efficiency in productivity and operational performances in manufacturing companies in Nigeria.

6. Competitive Advantage and Strengths: The effect of new technologies and technological variables create huge competitive strengths and capabilities among manufacturing companies. One critical value adopting and implementing new technological infrastructures in modern manufacturing companies it also create competitive advantage and help to maintain high competitive positions in competitive marketing environment.

Theoretical Framework

This study intends to review some theories in relation to technology and technological strategic implications in modern manufacturing companies in global perspective. Many previous studies have strategically reviewed larger numbers of theories in connection with the current study on technology and technological variables operational effects in manufacturing industries but this study concentrated on three theoretical reviews and frameworks.

1. Technological Organization and Environment (TOE) Framework

This framework was invented and ascertained by DePietro, et al., (1990) and it has three (3) concrete tools to ascertain its effects and contributory in development and improvement in modern manufacturing industries. The TOE framework ingredients comprise the technology, the organization and the environment. TOE framework posits that the dynamic and complex variables that affect the smooth flow and adoption of technological infrastructures in modern manufacturing companies are the technological factors, the organizational

variables and the environmental variables. This means that factors' surrounding the adoption and implementation of modern technology and technological variables is the technology itself, which need to be evaluated internally and externally to attain sustainable and smooth adoption of modern digital technological infrastructures in manufacturing operational system. The framework believed that the adoption of modern digital technology is a creative destruction and disruption to the old ones in modern manufacturing operational activities these are political and legal variables, economic variables and natural variables that also effect the adoption of modern technologies in modern business settings. TOE framework has been strategic framework that many studies have used to assess the sustainable effect of adopting new technological infrastructures to ascertain suitable operational performance in manufacturing and construction industries (Badi et al., 2020; Chen *et al*. 2019; & Chandra & Kumar, 2018).

2. Absorptive Capacity Theory

This is another tremendous theory that has strategic alignment with the current study on technological variables in aluminum manufacturing companies. The coming of this theory was credited to Cohen and Levinthal, (1990). Absorptive capacity theory is a predictive theory that foresees the capability and competency of firm adaptability to new trends in order to attain future sustainability. The theory posits on the ability of firm's to push its strengths to adopt and embrace new resources externally that will enhance smooth attainment of future business sustainability in operations. It is the strategic strengths of organization to recognize new strategic resources externally and adopt and exploit it in its operational system to enhance strategic operational performances. Walls and Barnard, (2020) and Alnoukari, (2020) posits that the Absorptive capacity theory specified the competency of modern manufacturing firms to foresee new trending external technological infrastructures and adopt it for future business deployment and innovativeness in operational system. The theory has concretely supported and has strategic alignment with this study because the theory specified on the adoption and implementation of modern technological variables to foster future operational performance and enhance innovative improvement in productivity which deeper the correlation with study on the effect of technological variables on aluminum manufacturing companies at Idu industrial area in Abuja.

4. Theoretical bases for the Study

From the above theoretical review on the study subject matter, the two theories have immensely and significant contributed and supportive to this on technological variables effect in manufacturing companies but for the purpose of theory adoption to the study, TOE framework will flow in alignment and concretely supported the study because the framework express three(3) concrete elements and variables that are enable factors to enhance the adoption and implementation of modern digital technological infrastructures operations in modern manufacturing sectors specifically in Aluminum producing firms.

Empirical Review

Zhang, et al., (2021) conducted a study on technological innovation and value creation of enterprise innovation

ecosystem based on system dynamics modeling. The main objective their study was to ascertain the effect of technological innovation in value and supply chains invention and management effectively in modern business and manufacturing settings. The study adopted both qualitative and quantitative research methods to access data for the conduct of the study. The study collected data from the statistical database of the DRCnet, combined with data sources such as China High Technology Industry Statistical Yearbook, CNKI Express and many other technological data sources from China with the period of 2008-2016 and the used system model for analysis and interpretation. And they study concluded that technologies and technological innovation have significant contributory role and impact in the invention in value and supply chains implementation in modern business and manufacturing sectors operational system and management.

Polas and Raju, (2021) conducted a study on technology and entrepreneurial marketing decisions during Covid-19. The study aimed to investigate and expose how technologies and technological variables change face of entrepreneurship structural sustainable management and enhance suitable marketing decisions during the advent of Covid-19 pandemic trauma. The study collected 127 small and medium enterprises as sample size in Bangladesh and used closed ended structured questionnaire via electronically distributed and Smart PLS (SEM) 3.0 was adopted for data analysis using quantitative method. The study exposes that there is significant correlation between technological infrastructural adoptions and entrepreneurial marketing decisions system, enhance customer satisfaction and development of entrepreneurship during the pandemic.

Singhai, et al., (2021) conducted a study on the analysis of factors influencing technology transfer: a structural equation modeling based approach. The study aimed to assess and evaluate the effect of technological transfer determinants variables on modern entrepreneurship operational performances in modern industries. Quantitative method was adapted to collected data through well administered questionnaire to experts in modern technological transfer to modern business settings and 321 prospective respondents were used as sample size. And the study revealed that five critical elements are significant contributory variables that enhance the transfer of modern technological variables in operational activities and improvement in customer satisfaction of manufacturing settings.

Parra and Guerrero, (2020) also conducted technological variables for decision-making IOT adoption in small and medium enterprises. The study aimed to investigate and analyze the how modern internet of thing solution can effectively and sustainably enhance SMEs strategic decisions making system. The study selected experts and professionals in IOT to conducted in house analysis and the vividly concluded that despite the high cost of IOT adoption and implementation in modern business settings, there are tremendous contributions of IOT in the effective and sustainable operational management and performance of SMEs.

Nara, et al., (2020) conducted a related study on expected impact of industry 4.0 technologies on sustainable development: a study in the context of Brazil's plastic industry. The main objective of the study

was to investigate and assess Triple Bottom Line perspective for sustainable and profitable improvement in operational performance in plastic industry in Brazil using industry 4.0 technologies. The study adopted quantitative research approach to collect data and used TOPSIS multi-criteria technique to separate the various industry 4.0 technologies and to expose the variation among them.

Kiani, et al., (2021) conducted a study on Entrepreneurial passion and technological innovation: The mediating effect of entrepreneurial orientation. The study aimed to investigate and assess the effect of entrepreneurial position and direction in correlation between entrepreneurs' affection and the adoption and implementation of technological innovation in SMEs. The study selected privately owned SMEs in China through structured survey questionnaire in manufacturing industries. The revealed from findings that there is significant correlation between entrepreneurial direction and CEOs affection and the adoption and implementation of technological variable of innovation in SMEs modern manufacturing industry in China.

Ghobakhloo, et al., (2021) also conducted a study on digital transformation success under Industry 4.0: a strategic guideline for manufacturing SMEs. The study aimed to investigate how digital and modern technologies can be adopted as polices to changes the faces of manufacturing SMEs in industry 4.0. The study adopted systematic literature reviews to assess the sustainability of digital transformation of SMEs in manufacturing industry 4.0. And they concluded form their findings that there is significant contribution of external forces of technological variables in ensuring successful and sustainable adoption of digital transformation and competitive advantages in modern SMEs in industry 4.0.

Existing Study Gap

Researchers have written many literatures and researches on this topic arriving on different conclusions and findings in many academic journals. None of the studies were conducted in Nigeria but from other parts of the world such as China, Brazil, Bangladesh. The study also empirically reviewed the works of Zhang et al., (2021), Polas and Raju (2021), Singhai et al., (2021), Nara et al., (2020), Ghobakhloo et al., (2021) and Kiani et al., (2021). However, this has prompted the researcher to extend this study to a new environment, Nigeria covering three (3) selected aluminum companies in FCT Idu industrial area namely: Classical Aluminum & Metal Product Limited, Abumet Nigeria Limited and System Metal Industries Ltd. The study has two important variables where the technological variables is a standing independent variable with the following proxies: Robotic Machines, Adoption of Artificial Intelligence and Internet of Things (IOT), while operational performance of aluminum companies is dependent variable that have key indicators of innovativeness, competitive advantage and customer satisfaction. Analyses was conducted using correlation and regression analysis via e-view software.

3.0 Methodology

Research Design

This study adopted descriptive and causal research designs to investigate and analyzed the effect of technological

variables in Aluminum manufacturing settings at Idu industrial Area of Abuja. The study used descriptive research design to describe the contributing effects of technological variables on the operational performances of Aluminum producing industry. The study used causal research design on the study because it helps the researcher analyzed the cause and effects of relationship between technological variables and operational performance of Aluminum manufacturing settings.

Sources of Data Collection

Primary sources of data for this study were data collected from the field in the course of conducting this study under the control and watch of co- researchers, experts and superiors in this field of study and secondary sources data are collected from existing data emanated from precious researchers' articles and journal publications, text books and paper sources in the field of technological variables and operational performances in Aluminum transformation industry.

Population and Sample Size Determination

The study selected three (3) different Aluminum manufacturing settings at Idu industrial Area of Abuja to ascertain whether there are concluding effects of technological infrastructures and operational performance in the industry operational activities. These companies were selected based on their reputable operating performance in recent years and they are effective area of study for this study based on the previous operational performance and sustainability. The selected corporate organizations are Classical Aluminum & Metal Product Limited, Abumet Nigeria Limited and System Metal Industries Ltd. Within the selected companies, the targeted potential respondents are various senior staff and junior staff who are strategic thinkers and key players who play critical role in making strategic decisions adoption of new technological variables to enhance operational performance within the selected organizations. Classical Aluminum & Metal Product Limited has population of eight (8) top management and thirty-six (36) junior staff. Abumet Nigeria Limited has population of ten (10) top management staff and forty-four (44) junior staff. And System Metal Industries Ltd., has ten (10) top management staff and forty-six (46) junior staff. The population of the study was one hundred and fifty-four (154) that made of top managers and junior staff of the selected firms and using Taro Yamane's (1967) sample size determination formula, the study came out with a sample size of 111 potential respondents.

Table 1.1 Breakdown of the Population Distribution

S/N	Selected Corporate Organizations	Senior Staff	Junior Staff	Total
1	Classical Aluminum & Metal Product Limited	8	36	**44**
2	Abumet Nigeria Limited	10	44	**54**
3	System Metal Industries Ltd.	10	46	**56**
Total		**28**	**126**	**154**

Source: *Field Survey, 2021*

The study used Taro Yamane's (1967) sample size determination formula

Taro Yamane's (1967) formula

$$n = \frac{N}{1 + N(e)^2}$$

$$n = \frac{154}{1 + 154(0.05)^2}$$

$$n = \frac{154}{1 + 154(0.0025)}$$

$$n = \frac{154}{1 + 0.385}$$

$$n = \frac{154}{1.385}$$

$$n = 111.19$$

$$n = 111$$

Using Burley's proportional allocation formula:

$$n = \frac{n(n)}{N}$$

Where n = Element within the sample frame. i.e number allocated to each management staff and non-management staff.

n = Sample or proportion of the universe used for the study (total sample size)

N = Population of the study

Top management

$$n = \frac{28 \times 111}{152}$$

$$n = \frac{3108}{154}$$

$$n = 20.18$$

$$= 20$$

Junior Staff

$$n = \frac{126 \times 111}{156}$$

$$n = \frac{13986}{154}$$

$$n = 90.82$$

$$n = 91$$

To cross check:

20+ 91= 111 (Sample size)

Validity and Reliability

The instrument used in data collections for this study especially the primary data was well structured and administered questionnaire. The study adopted Mail and WhatsApp channels to the selected organizational where the study was conducted and distributed questionnaires to the sampled respondents. Content validity was used in this study because the questionnaires were drawn from the objective, the research question and stated hypotheses from the study and these questionnaires were critically vetted and assessed by group of experts in the field of technologies from different academic professions concretely before push to the potential respondents. Most studies previously have used questionnaires in the field of technological variables in Aluminum manufacturing industries consistently that yield them dependable findings and conclusions which made the same instruments used in this study reliable to attain creditability and acceptability.

Table 3.4 Test for validity and reliability using Cronbach's Alpha

Scale Reliability of Variables

Items	Cronbach's Alpha
Robotic Machines	0.75
Adoption of Artificial Intelligence	0.75
Internet of Things (IOT)	0.75
Innovativeness,	0.92
Competitive Advantage	0.75
Customer Satisfaction.	0.82

Source: *Researcher's Computation (2021)*

Table 3.2 shows the test for reliability and validity for Cronbach's Alpha. The independent and dependent items with Alpha value are greater than 0.6 which is adequate for the study according to Sekran, 2001.

Method of Data Analyses

The study used various statistical tables, percentage, descriptive statistical tools in analysis of variables and multiple regressions to whether there is correlation on the study adopted ordinary least square method of regression using E-view Statistical Software Package, 23.00 Editions to analyze the stated hypotheses appropriately in order to ascertain statistical result and conclusions on this study.

Estimation of Study Variable

$I = a + b_1 RM + e$…….1
$CA = a + b_2 AAI + e$……2
$CS = a + b_3 IOT + e$……3

Where:
I= Innovativeness
CA= Competitive Advantage and
CS= Customer Satisfaction
a = constant
RM= Robotic Machines
AAI= Adoption of Artificial Intelligence and
IOT= Internet of Things
They are proxies of the Dependent Variable (Operational Performance in Aluminum Manufacturing Companies)

b_1, b_2, b_3, are regression coefficients which measure the degree of the responsiveness of the dependent variables to the independent variables

e = residual or stochastic term (which reveals the strength of $b_1x_1 + b_2x_2 + b_3x_3$; if e is low, this implies that the amount of unexplained factors is low, then the residual R1 and R2 will be high and vice versa.

4.1 Data Presentation and Data Analysis

4.0 Data Presentation, Analysis and Discussion of Findings

Due to the contribution of Covid-19 in the global business environment, questionnaires were distributed to 111 respondents as the size of the sample but 95 were returned correctly and 16 were unreturned. That is 86% of the questionnaires were returned and filled completed and 14% were unreturned. This 86% returned questionnaire will adequately ensure the validity and reliability of the instrument used in collecting data to attain sustainable results from the study.

SECTION A

Table 4.1: Demographic characteristics of the respondents

Variable	Frequency	Percentage
Gender		
Male	65	0.67
Female	30	0.33
Age		
20-40	74	0.72
41 and above	21	0.28
Educational Qualification		
SSCE/ND	45	0.47
HND /BSC	35	0.37
MSC/MBA/ Professional	15	0.16
Years of experiences of participants		
6-10 Years	56	0.59
11 Years and above	39	0.41

Source: Field Data, (2021)

From the study above, the number of 65 male participants of 67% from the study is higher than the 30 females of 33% participants from the study and this show that more men are engaged highly in operational activities of Aluminum companies. From age 20-40, 74 respondents of 72% participated highly and 21 respondents of age group 40 years and above of 28% engaged in Aluminum manufacturing companies from the study. The research shows that 45 respondents representing 47% have SSCE/ND as educational qualification in the selected companies. 37% of the respondents have educational qualification of HND /BSC holders and 16% of the respondents have MSC/MBA and professional certificates in the selected Aluminum companies for the study. The study shows that 59% of the respondents have 6-10 years, have deep knowledge in aluminum businesses and 41% of the respondents have 11 years and above similar experience in Aluminum manufacturing companies.

Test of Hypotheses

Hypothesis One

Ho_1. There is no significant relationship between technological variables and innovative of selected aluminum companies in Idu industrial area of FCT-Abuja.

Table 4.2: Ordinary Least Square Method of Regression.

E-view Statistical Software Package, 23.00 Editions.

Dependent Variable: Inn
Method: Least Squares
Date: 09/01/21 Time: 11:50
Sample (adjusted): 95
Included observations: 95 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.592814	0.143171	4.140605	0.0001
TV	0.197605	0.036156	5.465319	0.0000

R-squared	0.832566	Mean dependent var	1.320000
Adjusted R-squared	0.370744	S.D. dependent var	0.471212
S.E. of regression	0.373792	Akaike info criterion	0.908944
Sum squared resid	6.706587	Schwarz criterion	0.985425
Log likelihood	-20.72361	Hannan-Quinn criter.	0.938069
F-statistic	29.86971	Durbin-Watson stat	0.262792
Prob(F-statistic)	0.000002		

Source: *Computed by the Author Using E-view Statistical Software (Version 23)*
1% level of significance, 5% level of significance and 10% level of significance

Table 4.2 show the regression result for hypothesis one which indicates that the selected aluminum companies in Idu industrial area of FCT in terms of innovativeness will increase by 19% for every 1% increase in technological variables (Robotic Machines). The coefficient (0.197) of technological variables (TV) is positive and significant at 5% with p- value of (0.00) in achieving innovativeness. This implies that technological variables (Robotic Machines) significantly impact innovativeness in the selected aluminum companies in Idu industrial area of FCT. Therefore, the null hypothesis is rejected and we accept the alternative hypothesis that there is a significant positive relationship between technological variables (Robotic Machines) and innovativeness in the selected aluminum companies in Idu industrial area of FCT.

Hypothesis Two

Ho_2. There is no significant relationship between technological variables and competitive advantage of selected aluminum companies in Idu industrial area of FCT-Abuja.

Table 4.3: Ordinary Least Square Method of Regression.
E-view Statistical Software Package, 23.00 Editions.

Dependent Variable: CA
Method: Least Squares
Date: 09/01/21 Time: 11:51
Sample (adjusted): 95
Included observations: 95 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.657293	0.186292	8.896203	0.0000

TC	0.511436	0.055223	9.261214	0.0000

R-squared	0.941872	Mean dependent var	3.120000
Adjusted R-squared	0.633700	S.D. dependent var	1.154229
S.E. of regression	0.698571	Akaike info criterion	2.159618
Sum squared resid	23.42407	Schwarz criterion	2.236099
Log likelihood	-51.99046	Hannan-Quinn criter.	2.188743
F-statistic	85.77008	Durbin-Watson stat	0.496973
Prob(F-statistic)	0.000000		

Source: *Computed by the Author Using E-view Statistical Software (Version 23)*
1% level of significance, 5% level of significance and 10% level of significance

Table 4.3 show the regression result for hypothesis one which indicates that the selected aluminum companies in Idu industrial area of FCT in terms of competitive advantage will increase by 51% for every 1% increase in technological variables (Adoption of Artificial Intelligence). The coefficient (0.511) of technological variables (TV) is positive and significant at 5% with p-value of (0.00) in achieving competitive advantage. This implies that technological variables (Adoption of Artificial Intelligence) significantly impact on competitive advantage in the selected aluminum companies in Idu industrial area of FCT. Therefore, the null hypothesis is rejected and we accept the alternative hypothesis that there is a significant positive relationship between technological variables (Adoption of Artificial Intelligence) and competitive advantage in the selected aluminum companies in Idu industrial area of FCT.

Hypothesis Three

Ho_3. There is no significant relationship between technological variables and customer satisfaction of selected aluminum companies in Idu industrial area of FCT-Abuja.

Table 4.4: Ordinary Least Square Method of Regression.
E-view Statistical Software Package, 23.00 Editions.

Dependent Variable: CS
Method: Least Squares
Date: 09/01/21 Time: 11:52
Sample (adjusted): 95
Included observations: 95 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.193697	0.229536	0.843863	0.4029
TV	0.501922	0.064057	7.835510	0.0000

R-squared	0.961326	Mean dependent var	1.840000
Adjusted R-squared	0.552083	S.D. dependent var	0.976458
S.E. of regression	0.653510	Akaike info criterion	2.026260
Sum squared resid	20.49962	Schwarz criterion	2.102741

Log likelihood	-48.65650	Hannan-Quinn criter.	2.055385
F-statistic	61.39522	Durbin-Watson stat	0.375563
Prob(F-statistic)	0.000000		

Source: *Computed by the Author Using E-view Statistical Software (Version 23)*
1% level of significance, 5% level of significance and 10% level of significance

The regression result in table 4.4 for hypothesis three indicates that the selected aluminum companies in Idu industrial area of FCT in terms of customer satisfaction will increase by 50% for every 1% increase in technological variables (Internet of Things). The coefficient (0.501) of technological variables (TV) is positive and significant at 5% with p-value of (0.00) in achieving customer satisfaction. This implies that technological variables (Internet of Things) significantly impact on customer satisfaction in the selected aluminum companies in Idu industrial area of FCT. Therefore, the null hypothesis is rejected and we accept the alternative hypothesis that there is a significant positive relationship between technological variables (Internet of Things) and customer satisfaction in the selected aluminum companies in Idu industrial area of FCT.

Discussion of Findings

The analysis in hypothesis 1, the regression result for hypothesis one which indicates that the selected aluminum companies in Idu industrial area of FCT in terms of innovativeness will increase by 19% for every 1% increase in technological variables (Robotic Machines). The coefficient (0.197) of technological variables (TV) is positive and significant at 5% with p- value of (0.00) in achieving innovativeness. This implies that technological variables (Robotic Machines) significantly impact innovativeness in the selected aluminum companies in Idu industrial area of FCT. Therefore, the null hypothesis is rejected and we accept the alternative hypothesis that there is a significant positive relationship between technological variables (Robotic Machines) and innovativeness in the selected aluminum companies in Idu industrial area of FCT. Findings from the studies of Zhang, et al., (2021); Polas and Raju, (2021); Singhai, et al., (2021); Parra and Guerrero, (2020) and others supported the finding from the study that there are strategic and operational significant effects of modern digital technological infrastructures on the performance of aluminium manufacturing companies in Nigeria and global manufacturing industries. From the first hypothesis tested, finding is in alignment with the findings of Zhang, et al., (2021) and Brazil. Kiani, et al., (2021) that concluded that technological variables fast track innovativeness in organization's operations and innovativeness expanse customer expectations and increase customer satisfaction.

The analysis in hypothesis 2, the regression result for hypothesis one which indicates that the selected aluminum companies in Idu industrial area of FCT in terms of competitive advantage will increase by 51% for every 1% increase in technological variables (Adoption of Artificial Intelligence). The coefficient (0.511) of technological variables (TV) is positive and significant at 5% with p-value of (0.00) in achieving competitive advantage. This implies that technological variables (Adoption of Artificial

Intelligence) significantly impact on competitive advantage in the selected aluminum companies in Idu industrial area of FCT. Therefore, the null hypothesis is rejected and we accept the alternative hypothesis that there is a significant positive relationship between technological variables (Adoption of Artificial Intelligence) and competitive advantage in the selected aluminum companies in Idu industrial area of FCT. And the study finding is in support with the finding from the work of Ghobakhloo, et al., (2021) which concluded in their finding that technological variables give companies strengths of competitiveness and competitive advantage.

The analysis in hypothesis 3, the findings were that three indicates that the selected aluminum companies in Idu industrial area of FCT in terms of customer satisfaction will increase by 50% for every 1% increase in technological variables (Internet of Things). The coefficient (0.501) of technological variables (TV) is positive and significant at 5% with p- value of (0.00) in achieving customer satisfaction. This implies that technological variables (Internet of Things) significantly impact on customer satisfaction in the selected aluminum companies in Idu industrial area of FCT. Therefore, the null hypothesis is rejected and we accept the alternative hypothesis that there is a significant positive relationship between technological variables (Internet of Things) and customer satisfaction in the selected aluminum companies in Idu industrial area of FCT. The study is in alignment with the study of Polas and Raju, (2021) and Singhai, et al., (2021) which stated that technological infrastructures enhance customer satisfaction in modern manufacturing companies.

5.0 Conclusions and Recommendations

Conclusions

The current trends in modern manufacturing companies cannot attain sustainability and profitability without the adoption and implementation of trending modern technological variables to enhance their operational activities and performance holistically Most of the findings of the research are consistent with previous normative and empirical works as it has provided empirical evidence pertaining to the perception of technological variables and sustainable performance of aluminum manufacturing companies in Abuja, Nigeria and globally. The findings of this study show vividly that technological variables (Robotic Machines, Adoption of Artificial Intelligence and Internet of Things) adoption and implementation in manufacturing companies enhances innovativeness, competitiveness and prudent improvement in customer satisfaction and the finding has been supported by previous findings from other studies.

Recommendations

From the research findings and conclusions drawn from the study, the following recommendations were determined:

i. The top management and managers of the aluminum manufacturing companies in Abuja, Nigeria should be proactive in adopting strategic thinking in their operational activities in alignment with growing new technological variables (Robotic Machines) from the business context. This will

enhance innovativeness in their operations.

ii. More financial budget and resource's structure should be set aside to invest in modern digital technologies implementation such as the Adoption of Artificial Intelligence in order to enjoy competitive advantage and boost competitive strengths in aluminum companies.

iii. Internet of Things (IOT) should be adopted as strategic tool to attract information sharing culture and mechanism to boost strategic objective improvement and customer satisfaction of the aluminum companies in Abuja.

Contribution to Further Studies

Further studies can be traced from the major findings of this study as the case study has pave way for more research to be continuous in the field of technology and the effect operational performance in manufacturing companies' industry and other industries that are profit oriented. New study from this research work can emanate from comparative investigation and analysis of technological strengths between aluminum manufacturing companies and iron still manufacturing companies in Nigeria.

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