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Influence of adoption of modern manufacturing technologies on firm value of the listed manufacturing companies in Nigeria

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Abstract

This study investigated the influence of adoption of modern manufacturing technologies on firm value of listed manufacturing companies in Nigeria. Specifically, the study determines the factors that influence the level of adoption of modern manufacturing technologies, effects of modern manufacturing technologies on firm value, and the effects of firm-specific variables (firm growth, firm size, and firm age) on firm value of the listed manufacturing companies in Nigeria. The study adopted a mixed method involving survey research design and ex-post facto design. A survey was administered to a sample of thirty-nine (39) quoted manufacturing companies on the Nigeria Exchange Group, where 390 respondents were purposefully selected. Secondary data were extracted from the audited financial statements of the manufacturing companies listed on the Nigeria Exchange Group for a period of eight years (2014-2021). We analyzed the data using descriptive and inferential statistics, employing random effect regression analysis. The results show that very few manufacturing companies have fully adopted the modern manufacturing technologies in Nigeria. We also found a significant relationship between firm value and growth. Lastly, our results show evidence of a better performance for the firms that adopted new manufacturing technology. The study concludes that adoption of modern manufacturing technologies has significant influence on the firm value of the listed manufacturing companies in Nigeria.

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1. Introduction

In the fourth industrial revolution, manufacturing companies seem to be in the midst of a significant transition period. The mode of operation and reporting have undergone significant changes due to this transition. The period is characterised by the increased use of digital technologies to fundamentally transform traditional manufacturing processes and gain new efficiencies required of a 21st century highly competitive manufacturing industry (Akanbi & Adewoye, 2018). Events in recent years have created a sense of urgency around this transformation. Supply chain disruptions and sharp declines in consumers' demand ravaged companies that lacked the flexibility, agility, and speed to respond to sudden and dramatic market changes during and after the COVID-19 pandemic (Oyerogba & Alamu, 2021). In response, the manufacturing sector

has drastically accelerated its digital transformation efforts in the developed economy, hence the need for developing economies to take a more holistic approach to revolutionising their manufacturing activities.

In developed nations, the widespread adoption of smart manufacturing initiatives such as big data analytics, artificial intelligence, autonomic operations, industrial internet of things, virtual reality, machine learning, robotics and freight management systems, and artificial intelligence has helped to optimise operations, increase supply chain visibility, reduce costs, open new markets, and increase profitability (Ashley, 2020). As stated by a recent poll carried out in the United States of America (USA), 95% of manufacturing organisations worldwide concur that digital transformation is necessary for the profitability and sustainability of their businesses in the future (Akenbor & Oghoghomeh, 2016). This global development serves as a reminder that manufactures in developing economies must develop business models that seamlessly integrate products using information and communication technology and adopt a customer-focused approach if they are to compete in the global market. Once again, significant changes to the advanced manufacturing environment are eroding the market value of the businesses (Awiagah, Kang, & Lim, 2016).

This also implies that companies need to devise innovative business strategies to manage the ongoing disruption and evolving consumers demands, which could significantly impact the current business value. Manufacturers are therefore required to deploy new manufacturing technologies to increase operational effectiveness and fully grasp the advantages of a linked ecosystem.

According to the statistics from the Manufacturers Association of Nigeria (MAN), there was a 13.94% decrease in contribution to gross domestic product (GDP) from manufacturing activities between the period 2018-2020 (Akinrinade, 2020). This significant fall in manufacturing output was attributed to the reduction in workforce, redundancy due to changes in technology, longer manufacturing time, and several other factors. Therefore, adoption of new manufacturing technologies may help manufacturers overcome contemporary production obstacles, including rising product demand, rising automation, and attracting and maintaining workers in manufacturing facilities.

The ideas, techniques, and theories of accounting, information, and systems are all included in information technology. It is a system created to capture details on the operations of a company, and data on product requests, accounting transactions, production capacities, and compliance with regulations and procedures. It is a regular method of gathering, documenting, analysing, and reporting financial transactions (Toyo, 2017). It performs its duties following predetermined guidelines, rules, techniques, and procedures. Additionally, it is a system that enables the efficient and prompt delivery of information to authorised individuals to encourage the decisions of owners, clients, employees, and other important individuals in the environment of the organization. It is a system, composed of a variety of persons and resources, that offers data to help in decision-making by the management (Daft, 2003).

The main responsibility of management in a quoted company is to maximize shareholders' wealth. The degree of wealth creation by the management can be determined by the value placed on the shares of the organisation (common stock) in the shares market, what is reflected in the book as the shareholders' fund, and the ratio of debt to equity. The amount of the market's stock price, which itself is predicated on the composition of the company's stock price in the market and reflects the public's judgement of the actual performance of the organisation, can be used to measure it. However, the market price formation is the result of a stable power of demand and supply coming together. The term "market equilibrium" refers to the exchange of securities between issuers and investors on the capital market.

This study investigated the influence of adoption of modern manufacturing technologies on firm value of listed manufacturing companies in Nigeria. Specifically, the study determines the factors that influence the level of adoption of modern manufacturing technologies, effects of modern manufacturing technologies on firm value, and effects of firm-specific variables (firm growth, firm size, and firm age) on firm value of the listed manufacturing companies in Nigeria. From the review of the current global practices, it is evident that the new four manufacturing technologies will play an essential role in improving the value of manufacturing companies. Specifically, the following technologies have evolved in the developed economy: machine learning, industrial internet of things, virtual reality, big data analytics, robotics, freight management systems and artificial intelligence to optimize operations, increase supply chain visibility, reduce costs, open new markets, and increase profitability (Ashley, 2020). But there is little and inconclusive empirical evidence to support the claim. The paucity of literature on the relationship between new manufacturing technologies and firm value.

Additionally, the few studies that study the utilisation of information technology in the manufacturing companies failed to look at the firm-specific variables that may increase the capacity of companies in the utilisation of new technology due to the militating factors for the adoption of modern manufacturing technologies. Research into a technology-based small firms in Sweden by Veinampy and Niresh (2013) reported that a company's ability to use wide arrays of technology is contingent on the company's size. Size has a meaningful impact on technology usage in the sense that usage starts with the ability to acquire in the first instance, the ability to employ trained experts to handle the technology, and the recurrent cost of maintaining the new technology. Another school of thought believed that firm age and growth were the most important factors in technology usage decision. Thus, the available evidence remains inadequate, inconsistent, and unreliable on the determinants of information and communication technology in the manufacturing companies (Esoswo, 2011).

Gaps in the empirical literature were identified. One, empirical evidence on information and communication technology in the manufacturing companies is scant. Although Akinrinade (2020) examined the impact of information and communication technologies on the financial performance of quoted manufacturing companies, the study did not examine the firm-specific variables that may increase the capacity of companies in the use of modern technology. Secondly, the majority of studies have focused on the impact of information and communication technology investment on both profitability and financial performance.

This study addresses the gaps identified in the literature by examining the adoption of modern manufacturing technologies (industrial internet of things, big data analysis, virtual reality, artificial intelligence, and machine learning) on firm value of manufacturing companies in Nigeria. This study is crucial to manufacturing companies, various business managers, investors, and Nigeria Exchange Group in addressing the prevailing problem associated with the adoption of modern manufacturing technologies that affect the accounting information system within the firm.

The study proceeds as follows: Section 2 addresses the review of literature, while Section 3 details the methodology. Section 4 contains the data analysis, while Section 5 discusses the findings. Finally, the study concludes in Section 6.

2. Literature Review

2.1. Firm Value and Information and Communication Technology

Firm value is a measure that depends on the market rather than one that is specific to an entity. An entity utilises the same premises that trade players will employ to set the asset's value. or obligation under the present industry circumstances when calculating the firm value, including risk-related assumptions. As a result, while calculating firm value, a firm's purpose to retain an asset or pay for a liability is not important (Fosso Wamba & Queiroz, 2022; Ross, 2002). The goal of shareholder reporting is satisfied by firm value accounting, which, in contrast to historical cost accounting, accounts for both liabilities and assets in financially-related reports at their firm value (to owners) (Lonkani, 2018).

According to Gautam and Arjun (2016) the historical cost accounting approach is thought to be more prudent and trustworthy. Even better, there approach has made accounting information more pertinent. Investors are becoming more concerned about current value versus cost, effects that are not entity-specific, historical prices that do not take into consideration the temporal value of money, which becomes unimportant when evaluating an entity's current financial position, and accounting that presents liabilities and assets in the manner of an economist while taking economy risk into account and updating the prices of financial vehicles. The economic term "firm value" depicts the worth of a company. According to Lonkani (2018) "firm value" refers to the price a company is worth at a specific time and the sum required to acquire or assume control of a company.

It was a crucial idea for investors to view themselves in order to gauge the industry's overall assessment of a company holistically (Fragapane, Ivanov, Peron, Sgarbossa, & Strandhagen, 2022; Languju, 2016). Firm value is the aggregation of the real industry worth of the ordinary shares and the projected market values of the debt and preference shares. It is also known as enterprise value; like an asset, the worth of an entity can be assessed either by employing the book value or market value (Ekuobase & Olutayo, 2016). It can also be referred to as the market worth of an organisation, in which the entity's worth becomes extremely essential; the higher the firm value, the higher the gains of shareholders and stock value of a company seen in the investor's evaluation of its success (Brigham & Houston, 2016).

According to Hirdinis (2019) firm value is a metric for a company's overall worth that considers the market rather than only the value of equity. As a result, all liens on assets and economic interests from both equity and debt are taken into account. The economic price of buying a company or the nominal value of a business organization are two ways to conceptualise equity value (before a takeover premium is considered). A company's primary goal is to maximise gain or prosperity, particularly for its owners, by making attempts to raise or maximise the economic worth of the organisation's stock cost. An organisation's objective is to increase the actual wealth of its owners, who are the holders of equity in the business. The economic worth of an organisation's stocks, which are frequently transacted on stock exchanges, reflects the prosperity of its holders of equity (Carr & Hayes, 2015).

Information and communication technology (ICT) encompasses a diverse array of technological tools and products. These products and tools are employed to interact as well as to produce, share, preserve, and control information (Frank, Dalenogare, & Ayala, 2019). aside from personal use, ICT can also refer to a variety of software and hardware components that enable operations or services. Electronic components, linked to human interactive materials, comprise these devices (Michael, 2015). ICT helps to provide internal and external reporting data, financial statements, and trend analysis capabilities to affect organizational performance.

2.2. Problems Militating against, Effective use of Information and Communication Technology

There is a limit to everything in life; likewise, there is a limit to automation efficiency as far as it involves elements of human participation in the process of creating accounting data and information. Computerised accounting has its limitations, although it runs sophisticated assessments of financial records. Humans are

required to adequately understand the software and its skills to use it efficiently. When people must enter data into relevant fields, accuracy becomes a concern. The absence of decimal points or commas might result in serious accounting mistakes regardless of the fact that software systems are made to detect errors (Frey & Osborne, 2017; Kharuddin, Ashhari, & Nassir, 2010).

The internet, often known as information and communication technology, has altered us more than any other innovation (ICT). The application of these technologies in a global context has produced, and continues to produce, such fundamental changes that our generation is entirely distinct from all previous generations (Ekuobase & Olutayo, 2016). A major setback in the computerized accounting environment is that it is expensive to acquire gadgets and other software, as a result of different brands and an increase in duplication and proliferation of gadgets and software. Computer hardware and software are costly to procure, and they attract high costs to train staff and become good users of the software.

Development is not static; software companies habitually design new modified accounting systems that can take care of the old and out-of-vogue software; this simply translates to frequent spending on the purchase of software in order to have recent and updated software in use (Odunfunwa, 2008).

Because of technological improvements, humans are now so dependent on these gadgets that the intellect appears to be inactive in terms of preserving knowledge. Storage systems like hard drives and flash drives have replaced the new "human brain.". Also, ICT is being exploited as an instrument of division and is utilised to commit numerous cybercrimes, including violence and fraud. The internet's obscurity makes it easier to fabricate and falsify one's information and appearance, tricking potential victims into departing with their funds under the pretense of buying something or contributing to a good purpose.

2.3. Hypothesis Development

The theoretical underpinning of the study is diffusion of innovation theory. The diffusion of innovation theory developed by Rogers (1962) which originated in mass communication, tries to explain how, overtime, an idea or product gains momentum and diffuses or spreads through a specific population or social system. Rogers's diffusion of innovation theory is the most appropriate for investigating the adoption of modern technology in manufacturing companies. The process of adopting new innovation has been studied for over 50 years, and this theory is regarded as one of the most popular models (Gawankar, Gunasekaran, & Kamble, 2020). Specifically, the theory addresses how individuals in an organization view transition from one practice to another. Odunfunwa (2008) perceived a significant relationship between adoption of new manufacturing technology and firm value, linking this to technology adoption. By contrast, Nasir (2010) reported an insignificant relationship between adoption of new manufacturing technologies and firm value. Considering the contradictory results in the literature, the study's overall goal narrows down to this alternatively expressed hypothesis, as illustrated below:

H_0: New manufacturing technologies have significant influence on market-to-book value of the listed manufacturing companies in Nigeria.

3. Methodology

3.1. Research Design and Data

This study adopts a mixed method involving survey research design and ex-post facto design with quantitative method of data collection and analysis. A survey serves as a tool for conducting interviews with respondents, employing a set of guidelines and questions for both the interviewers and the respondents (Hair, Risher, Sarstedt, & Ringle, 2019). The survey data were obtained directly from the respondents that were drawn from the sample for the research. Secondary data was extracted from the yearly audited financial reports of the manufacturing companies quoted on the Nigeria Exchange Group for a period of eight years (2014– 2021). Two factors shaped the selection of this timeframe. Firstly, the period saw the implementation of most local and foreign policies for manufacturing firms and other listed companies. Secondly, gathering data for 8 years will enable the model to be fitted.

The study population consists of manufacturing companies listed on the Nigeria Stock Group, which was 78 manufacturing companies and were classified as consumer goods, consumer service, industrial service, basic materials, and healthcare. The study adopts a multi-stage sampling technique comprising proportionate, stratified, and purposive sampling techniques. The population was stratified into five main sub-sectors, and from each sub-sector, 50% of the population was proportionately selected, which produced a sample size of 39 manufacturing companies, which were consumer goods (12), consumer services (6), industrial service (12), basic materials (6), and healthcare sector (3). Table 1 shows the details of the sample size. In selecting the respondents, stratified and purposive sampling techniques were used to divide the population into five strata; the finance department, production department, ICT department, monitoring department, and investment planning department. From each stratum, two respondents were purposefully selected, making 10 respondents from each company. We conducted the study in Lagos between March and June 2022. Lagos was chosen because of two important factors. First, majority of the listed manufacturing companies have their head offices in Lagos. Therefore, focusing on Lagos State implies that there was wider coverage for the study.

Second, the issue surrounding the influence of adoption of new manufacturing technologies on firm value is a strategic issue that requires input from the top management executives that can only be found at the head offices of the selected companies.

Table 1. Sample size of the study.

Industries	Population	Sample
Consumer goods	24	12
Consumer service	12	6
Industrial service	24	12
Basic materials	12	3
Healthcare sector	6	6
Total	78	39

The research employed primary and secondary data. Secondary data, which was basically for the dependent variable, was gotten through the audited financial reports of the quoted manufacturing firms, Stock Exchange fact books, and Bureau of Statistics statistical bulletin for a period of eight years (2014-2021). The total number of observations amounted to 312 for both secondary and primary data. The primary data was gathered directly from the respondents with the aid of a 5-point Likert scale using a range of Never used (0), Rarely used (1), Not Sure (2), Frequently used (3) and very frequently used (4). We administered the questionnaire using a paper survey and was conducted for four (4) months, from March to June 2022. Three hundred and ninety (390) questionnaires were administered, but three hundred and twelve (312) were retrieved, which represents about an 80% response rate. Table 2 shows the details of the questionnaire. This is basically for the independent variable, which requires obtaining the perceptions of different stakeholders.

Table 2. Questionnaire distribution and retained.

Department	Distributed	Retrieved	Percentage (%)
Finance department	78	66	84.6
Production department	78	71	91.0
ICT department	78	73	93.6
Monitoring department	78	62	79.5
Investment planning department	78	40	51.3
Total	390	312	80.0

3.2. Model Specification and Measurement of Variables

The econometric model for the achievement of the study's objective is presented in equation, which describes the linear relationship between information and communication technology on firm value of manufacturing companies.

$$MBV = \beta_0 + \beta_1 IIT + \beta_2 BDA + \beta_3 AIML + \beta_4 VREA + \beta_5 FMS + \beta_6 FGRW + \beta_7 FAGE + \beta_8 FSIZ \quad (1)$$

Where MBV= Market to book value.
ICT = Information and communication technology.
IIT = Industrial Internet of things.
BDA = Big data analytics.
AIML = Artificial intelligence and machine learning.
VREA = Virtual reality.
FMS = Fright management system.
FGRW = Firm growth.
FAGE = Firm age.
FSIZ = Firm size.

4. Data Analysis

The sample size for this research is the selected 39 listed manufacturing companies in Nigeria, from which 390 respondents were drawn. However, after three repeated administrations, out of the 390 copies of the questionnaire administered, 312 copies were handed back, representing about 80% of the sample. This necessitated the reduction of the secondary data to eight years to have a balanced panel for the regression analysis. According to the current literature on this topic, 80% can be considered an acceptable response rate. As opined by Bailey (2011) a return rate of 50% is sufficient for social science research, but Bailey (2011) stated a response rate of 75% is sufficient (1987).

According to Mugenda (2018) a return rate of 50% is considered satisfactory, while rates of 60% and 70% were deemed to be good and very good, respectively. A response rate of 80% achieved in his study is therefore extremely appropriate given the sensitive nature of this subject. It should also be noted that the 312 respondents that participated were well distributed across the 5 cognate departments, as no department had less than 50%

of the questionnaire distributed to them returned. Most of the other relevant research showed very low response rates, except research by Adam and Merhan (2003) on the impact of information and communication technology on company value, which reported a return rate of 73%.

4.1. Descriptive Statistics

The study was to investigate the factors that influence the level of adoption of information and communication technology in the listed manufacturing companies in Nigeria. In line with the Organization for Economic Corporation and Development (OECD, 2014) guidelines on digitization of the manufacturing sector, influencing factors were grouped into three major categories, which include organizational, environmental, and technological factors. To achieve the above-stated objective, respondents were asked to rank the items under each category using a five-point scale ranging from not influence to extremely influence. Table 3 presents the results of this analysis.

In Table 3, the result shows that majority of the respondents considered infrastructural availability as a primary factor influencing technological adoption process in the listed manufacturing companies. The result shows a 91.7% level of agreement among the respondents, which implies that the lack of or inadequate infrastructure constitutes an obstacle in the process of adopting new manufacturing technologies. The study also provides evidence to establish the role of manpower in the use of technology. Majority of the respondents (66.8%) for this study agree that lack of experience and inadequate staff with technical expertise are the main obstacles that weaken this process of transitioning into the new manufacturing technologies. Furthermore, the respondents also identified change issue as a significant factor for the adoption of new technologies in the listed manufacturing companies in Nigeria.

The study further established that willingness to commit organizational resources is a key factor in the adoption of modern manufacturing technologies. In particular, the lack of financial resources and specialized support can impact the core process of technology adoption. This result is validated and supported by Obermayer, Csizmadia, and Hargitai (2022) who mentioned how funding is a key factor in the success of the 4.0 technology implementation process. In addition to the management commitment, the success of the technology adoption process rests on the willingness and motivation to embrace change. If the employees believe that new technology will exponentially increase the rate of production and speed at which they perform their function, reduce duplication, and help in timely delivery to customers without the fear of being replaced with machines, there will be smooth transition from the manual operation to an automated production process. It can be summarized that organizational factors determine the usage of modern manufacturing technologies in the listed manufacturing companies in Nigeria.

Out of the five environmental factors included in this category, respondents believed that three factors, particularly the general economic climate and government regulations, significantly influenced the adoption of manufacturing technologies. For the general economic climate, 78% of the respondents agreed that the factor frequently and extremely influences adoption of modern manufacturing technologies. The concept of economic climate refers to the general state of the national, regional, or global economy, which reflects the state of the job market, stock market, and the availability of credit. It is also a measure of production that equals all the goods and services that an economy produces over a specific period of time. Thus, a favourable production environment and higher product demand will translate to higher demand for modern manufacturing technology and vice versa.

For the government regulation, 62.9% of the respondents ascertained that government regulations have frequent influence on the use of modern manufacturing technologies in the listed manufacturing companies in Nigeria. The result implies that technological advancements are creating a season change in today's regulatory environment, posing significant challenges for regulators who strive to maintain a balance between fostering innovation, protecting consumers, and addressing the potential unintended consequences of disruption.

Again, the result shows that competition drives adoption of new technologies in listed manufacturing companies. As revealed in Table 3, 59% of the respondents affirmed that competitive pressure frequently pushes management to adopt new technology. The interpretation of this is that firms in the competitive environment sell to a heterogeneous consumer base with heterogeneous requests, which requires a timely production and delivery, while a monopolist manufacturing company can sell to only those consumers whose demand comes with no constraint of time.

For technological factor, the items were also listed by the respondents as factors that determine the adoption of manufacturing technologies in listed manufacturing in Nigeria. Of three factors, the result shows that complexity of the manufacturing technology may constitute a discouragement to the companies willing to adopt it as freely expressed by about 92% of the respondents. The network scale is another important factor under the technological factor, with about 72% affirmation. More broadly, while manufacturing and other important technologies can enable companies to benefit from increased productivity in the short term, research suggests that the value derived from technology can be undermined by negative factors such as network breakdown, causing diminished employee's performance and well-being.

Finally, 63.7% of the respondents surveyed identified operational risks, including cybersecurity, as the greatest danger to manufacturing technology adoption in the listed manufacturing companies.

With the interconnectedness of the modern manufacturing technologies, cyber threats are among the most prevalent challenges associated with the adoption of new manufacturing technologies, as smart factory environments expose people, technology, physical processes, and intellectual property to this risk.

Table 3. Influencing factors for new manufacturing technologies.

S/ N	Techniques	Does not influence	Rarely influenced	Partly influenced	Frequently influenced	Extreme influence
1	Organizational factors:					
1a	Infrastructural availability	3.2%	5.1%	-	91.7%	-
1b	Adequacy of staff	-		24.5%	66.8%	8.7%
1c	Employees readiness for change	-	19.6	11.1	63.5%	5.8%
1d	Top management commitment	7.7%	14.2%	20.2%	58.9%	-
1e	Employee motivation for change	1.3%	-	45.2%	53.5%	-
1f	Training and education	-	-	59.7%	33.6%	6.7%
1g	Employees technological knowledge	13.6%	25.9%	27.4%	33.1%	
2	Environmental factors:					
2a	General economic climate	8.2%	13.8%	-	71.4%	6.6%
2b	Government regulations	5.1%	10.4%	21.6%	62.9%	-
2c	Competitive pressure	1.3%	30.6%	8.8%	59.3%	-
2d	Market dynamics	29.3%	19.9%	22.4%	12.9%	16.5%
2e	Safety and familiarization	41.0%	55.8%	-	3.2%	-
3	Technological factors:					
3a	Complexity of new technology	-	-	7.8%	14.9%	77.3%%
3b	Network scale	13.0%	14.1%	-	52.5%%	20.4%
3c	Cyber security and safety issues	22.5%	13.8%	-	63.7%	-
3d	Perceived relative advantage	41.2%	38.7%	-	8.5%	11.6%

4.2 Diagnostic Test

4.2.1. Normality Test

The majority of statistical tests, known as parametric tests, such as correlation, t tests, linear regression, and analysis of variance, presumptively follow the assumption that the data have a normal distribution, or that the populations where the samples are obtained have a normal distribution.

The assumption of normality is especially critical when determining the impact of one variable on the other. It is crucial to carefully consider these assumptions, as violating certain assumption like normality renders precise statistical conclusions impossible.

Verifying the normality assumption is crucial for many statistical processes, especially parametric tests, as it ensures the validity of these techniques.

The Kolmogorov-Smirnov Test was employed in this study to determine if the three metrics of business worth—market to net book value, shareholders' fund, and capital gearing—were normal. The non-parametric Kolmogorov-Smirnov test, also referred to as the K-S test or one sample Kolmogorov-Smirnov test, ascertains if a sample of data originates from a certain distribution, such as the uniform, normal, exponential, or Poisson distribution.

Through contrasting the actual cumulative distribution of values with the fictitious cumulative distribution for a standard normal distribution variable, it is primarily used to assess the assumption of univariate normality. The general rule is that when this test is run, Ho: is accepted and H1: is rejected if the p-value is larger than 0.05, while Ho: is rejected and H1 is accepted if the p-value is less than 0.05. As reported in Table 4, the outcomes obtained for the three variables, market to net book value, shareholders' fund, and capital gearing, were 0.953, 0.862, and 0.694, respectively. The results indicate that we should not reject the null hypothesis, given the normal distribution of the data and its applicability to regression analysis.

Table 4. Normality test results.

Variables		Market to book value	Shareholders' fund	Capital gearing
N	**Statistics**	312	312	312
Normal parameters	Mean	0.779	1.433	0.263
	Std. deviation	1.796	2.472	0.575
Most extreme differences	Absolute	0.469	0.617	0.818
	Positive	0.362	0.524	0.521
	Negative	-0.458	-0.527	-0.641
Kolmogorov-Smirnov Z		0.953	0.862	0.694
Asymp. sig. (2-tailed)		0.713	0.534	0.825

4.2.2. Homoscedasticity Test

In statistics, we call a vector homoscedastic if every random variable in it has the same finite variance. The mathematical and computational treatment is made simpler by the assumption of homoscedasticity. Serious violations of homoscedasticity, such as thinking a data distribution is homoscedastic when it is heteroscedastic, can lead to an overestimation of the Pearson coefficient's goodness of fit. Therefore, we conducted a homoscedasticity test to assess the variance in the employed residuals of the regression model. We have a normal distribution. The absence of an equitable level of variation for every value of the independent variables implies heteroscedasticity. The Breusch-Pagan test, created by Breusch and Pagan in 1979, was employed in the study to check for uniformity in a linear regression model. The following lists the null and alternative hypotheses.

H_o: The data is homoscedastic in variance.

H_1: The data is heteroscedastic in variance.

According to the rule, Ho: is accepted and H1: is rejected if the p-value is larger than 0.05, and Ho: is rejected and H1: is accepted if the p-value is less than 0.05. The results in Table 5 show that the market-to-book value test statistic was 5.7993, with a p-value of 0.6181. We accepted the null hypothesis and determined that the data for return on assets showed homoscedasticity, as evidenced by the tiny statistic and p-value exceeding 0.05. Additionally, the test statistics for shareholders' funds and capital gearing were 9.6219 and 7.2528, respectively, with p-values of 0.2749 and 0.5647. The data were determined to be homoscedastic and suitable for linear regression analysis based on these findings.

Table 5. Homoscedasticity test for firm value.

Variables	Test statistics	Degree of freedom	P-value
Market to book value	5.7993	6	0.6181
Shareholders' fund	9.6219	6	0.2749
Capital gearing	7.2528	6	0.5647

4.3. Regression Analysis on Influence of New Manufacturing Technologies and Firm Value

This section shows the outcomes of the panel regression analysis for the study. Since the research adopted a panel regression (mix of time series and cross-sectional data), it is important to choose between a pooled effect and time effect (fixed effect or random effect) models. In considering which model is more appropriate for the research, two statistical tests were conducted (Breusch-Pagan LM Test and Hausman Specification Test). The Breusch-Pagan LM Test was used to select between pooled effect and time effect (random effect and fixed effect) models. The Hausman specification test compares the random effects estimator and the fixed effect estimate. If the null hypothesis is rejected, the Hausman test favours treating the omitted effects within the estimate (that is, it favours the fixed effects but only relative to the random effects). The goal is to differentiate between models that include the missing heterogeneity.

The result indicates the outcomes of LM test for the market-to-book value ratio. The results produced a chi square statistic and probability figures of 472.78 (p=0.000), which is significant. Given this outcome, the null hypothesis was rejected. The study therefore concluded that a time-effect model was appropriate for this study. In another word, the result implies that there was evidence of significant differences across different time periods during which data were gathered. Therefore, it is important to also differentiate between a random effect and a fixed effect model. Hence, the study further conducted Hausman Specification Test to identify the most acceptable model from the fixed effect and random effect options. The results in Table 6 produced a prob>chi2 value of 0.1982, which is more than critical P value at 5% significance level. The outcome thus support the null hypothesis, which suggests that a random effect model is the best fit. Therefore, a random effect regression model was adopted in the study.

Table 6. Hausman specification test for market to book value ratio.

Variables	Fixed	Random	Difference	S.E.
IIT	0.724	0.374	0.385	0.187
BDA	0.609	0.425	0.186	0.378
AIML	0.568	0.395	0.175	0.710
VREA	0.785	0.398	0.383	0.443
FGRWT	0.661	0.341	0.322	0.294
FAGE	0.426	0.311	0.115	0.465
FSIZE	0.934	0.528	0.416	0.397

b=Consistent under Ho and Ha: Obtained from xtreg.
B= Inconsistent under Ha, efficient under Ho; Obtained from xtreg.
Prob>Chi² =1982

5. Discussion

Using data from Nigeria's listed manufacturing firms, this paper examined the influence of adoption of modern manufacturing technology adoption on firm value. Specifically, the study uses data from a sample of thirty-nine manufacturing firms listed on the Nigeria Exchange Group. The study considered three factors (technological, environmental, and organizational factors) as the major determinants of adoption of modern manufacturing firms in Nigeria. The firm value, which is the dependent variable, was proxied with market-to-net book value ratio, shareholders' fund, and capital gearing. In addition, three firm specific variables, which include the firm growth, firm age, and firm size were added to strengthen the model. The result of the descriptive statistics confirms that infrastructural development, availability of manpower, and willingness to commit organizational resources are some of the key factors in the adoption of modern manufacturing technologies in the listed manufacturing companies. To ascertain that the data collected did not violate the OLS assumptions, the study also conducted diagnostic tests such as normality tests, autocorrelation tests, homoscedasticity tests and multicollinearity tests on the study variables. The results of the random effects regression analysis confirmed that all the independent and control variables (industrial internet of things, big data analytics, artificial intelligence and machine learning, virtual reality, firm growth, firm age, and firm size) collectively had significant influence on firm value of the listed manufacturing companies in Nigeria. Our results support some of the existing empirical evidence in the previous studies, who also reported a significant relationship between adoption of modern manufacturing technologies and firm value (Bailey, 2011; Komara, Ghozali, & Januarti, 2019; Sudiyatno, Puspitasari, & Kartika, 2012).

6. Conclusion

This paper investigated the influence of adoption of modern manufacturing technologies on firm value of listed manufacturing companies in Nigeria. This paper draws conclusions from the significant outcomes of this research. The survey result shows that organizational, environmental, and technological factors are very critical to the use of modern manufacturing technologies. The survey results also established that very few manufacturing companies have fully adopted the modern manufacturing technologies in Nigeria. The inferential statistics result demonstrates that three out of the four explanatory variables in this study have statistically significant effect on firm value. The study therefore concludes that adoption of modern manufacturing technologies has a significant influence on the firm value of the listed manufacturing companies in Nigeria.

7. Recommendation/Policy Implication

The findings of this study show that only a few manufacturing entities have adopted modern manufacturing technologies in Nigeria. Therefore, there is a need for full adoption of the modern manufacturing technologies by the listed manufacturing entities in Nigeria. The research discovered a significant relationship between firm value and firm growth. It is therefore expedient for the management of the listed manufacturing companies to embark on strategies that can enhance the continuous growth of the sector. Lastly, our results show evidence of a better performance for the firms that adopted new manufacturing technology. The regulatory agencies in Nigeria may wish to provide incentives for an easy transition from traditional manufacturing to modern manufacturing technology.

8. Limitations/Areas for Future Research

The study's limitations stem from the fact that it only collected data from one sector. Although the study is robust in terms of number of respondents and consideration of all important stakeholders in this sector, future studies may wish to use data from different sectors of the economy. A cross-country analysis involving manufacturing firms from different African countries may also improve the robustness of this topic.

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