

MODERATING ROLE OF TECHNOLOGY ADOPTION ON THE RELATIONSHIP BETWEEN INVENTORY PLANNING AND OPERATIONAL EFFICIENCY OF MANUFACTURING FIRMS IN NORTHEAST NIGERIA

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ABSTRACT

The inadequacy of global inventory planning practices in the manufacturing industry leads to decreased productivity, increased production costs, and the frequent appearance and disappearance of products in the market, ultimately hampering economic development. This study investigated the moderating role of technology adoption on the relationship between inventory planning and operational efficiency in the manufacturing firms of Northeast Nigeria. Inventory planning, encompassing demand forecasting and safety stock management, plays a crucial role in meeting consumer demands and averting operational disruptions. Using a survey research design, data were collected from manufacturing firms in Northeast Nigeria. Descriptive statistics, regression analysis, and hypothesis testing were employed to analyze the data. The findings reveal a significant positive relationship between demand forecasting, safety stock inventory management, and operational efficiency. Moreover, technology adoption mediates the effects of demand forecasting and safety stock inventory on operational efficiency, amplifying their effect. The study concludes that integrating advanced technological solutions with effective inventory planning strategies can enhance operational efficiency in the manufacturing sector. The study recommends prioritizing the adoption of technology, refining demand forecasting techniques, and optimizing safety stock inventory levels.

Keywords: Inventory Planning, Technology Adoption, Operational Efficiency, Manufacturing Industry, Northeast Nigeria

INTRODUCTION

Inventory planning, an integral aspect of operations management, is indispensable for orchestrating resource inputs effectively to sustain smooth business operations. It encompasses crucial elements such as demand forecasting and safety stock management, essential for meeting consumer demands and averting operational disruptions. Globally, businesses recognize the significance of

inventory planning in optimizing production processes, driving growth, and maintaining competitiveness in the market (Ogah et al. 2022; Abomaye-Nimenibo et al., 2020).

Inventory planning aims to organize the entire manufacturing process and meet demand by utilizing low-cost production components (Noegraheni&Nuradli, 2016) and improve growth. Some of the variable used in this study as adapted from (Ogah, et al.,

2022; Abomaye-Nimenibo, et al., 2020) include; demand forecasting and safety stock. Demand forecasting utilizes historical data and existing market trends to predict the future sales volume of a product. Safety stock refers to the extra inventory that a corporation maintains as a precautionary measure to address sudden increases in demand or disruptions in the supply chain. (Lai & Cheng, 2016). By utilizing these inventory planning components, businesses can achieve better inventory planning, leading to more efficient and effective manufacturing processes.

Technology adoption in this study is used as the Moderating variable from the work of Kwak (2013), Technology, such as inventory management systems, data analytics tools, and supply chain automation solutions, can significantly influence the effectiveness of inventory planning practices. These technological innovations enable firms to gather real-time data, improve demand forecasting accuracy, and enhance decision-making capabilities, thereby optimizing inventory levels and operational processes.

The Nigerian manufacturing sector, particularly in Northeast Nigeria, grapples with the challenge of inadequate inventory planning, posing significant obstacles to profit maximization and cost minimization objectives within organizations (Okunade, 2020). Despite the government's push for local production and the availability of inventory planning tools, such as demand forecasting and material requirement planning, many firms fail to effectively utilize these resources, resulting in fluctuating product availability and compromised operational efficiency (Ovunda et al., 2019; Adeyemi & Olufemi, 2016). This deficiency not only undermines production growth but also hampers Nigeria's broader economic development goals, as evidenced by the recurrent appearance and disappearance of products in the market and the closure of many manufacturing firms over recent years (World Bank Survey, 2020).

This study seeks to address this gap by examining how technology adoption interacts with inventory planning processes to influence operational efficiency in selected manufacturing firms in Northeast Nigeria. By delving into the interplay between inventory planning, technology adoption, and operational outcomes, the research endeavors to provide nuanced insights that can inform strategic decision-making and promote sustainable growth within the manufacturing sector.

This study examined the Moderating role of technology adoption on the relationship between inventory planning and operations efficiency in the manufacturing industry in North-Eastern Nigeria as its broad objective. The specific objectives are to:

- i. Ascertain the relationship between demand forecasting and operations efficiency in the manufacturing industry in North-Eastern Nigeria;
- ii. Access the relationship between safety stock inventory and operations efficiency in the manufacturing industry in North-Eastern Nigeria.
- iii. Access if technology adoption mediate the effect of demand forecasting on operations efficiency in the manufacturing industry in North-Eastern Nigeria.
- iv. Determine if technology adoption mediate the effect of safety stock on operational operations efficiency in the manufacturing industry in North-Eastern Nigeria.

HYPOTHESES DEVELOPMENT AND THEORETICAL FOUNDATION

Management Science theory, pioneered by figures such as Frederick W. Taylor, William Cooper, George Dantzig, and Herbert A.

Simon in the mid-20th century, marked a significant evolution in management practices, particularly during the 1940s and 1950s. This approach emerged as a distinct field of study with the integration of quantitative techniques into management processes (Jeanty, 2019). Originating from Britain during World War II, the Management Science approach, also known as Operations Research, aimed to address complex war-related challenges by assembling multidisciplinary teams of scientists, including mathematicians and physicists (Jeanty, 2019). This period saw the utilization of operations research methodologies and quantitative tools, such as economic order quantity (EOQ), linear programming, and game theory, to optimize resource utilization and decision-making in organizational settings (Schutts, 2011; Hussain, 2019).

The practical application of Management Science theory during World War II laid the groundwork for its adoption in post-war industrial contexts, where the efficient allocation of resources became paramount for economic growth and technological progress (Jeanty, 2019). Management Science focuses on technical aspects rather than behavioral issues, employing quantitative models to represent relationships between variables and solve operational problems (Schutts, 2011; Hussain, 2019). Drawing parallels to scientific management theory, Management Science utilizes scientific methods and procedures to identify workplace issues, propose solutions, and analyze outcomes, akin to how scientists develop and test hypotheses through empirical observation (Sridhar, 2017). This approach aligns with the broader objective of improving organizational effectiveness and efficiency by leveraging rigorous quantitative analysis to inform resource allocation, information system design, and policy decisions.

In the context of this study, Management Science theory holds relevance in investigating the relationship between inventory planning and operational efficiency.

By advocating for the application of quantitative analysis and modeling techniques, Management Science seeks to optimize resource allocation and decision-making processes, thereby enhancing organizational performance (Jeanty, 2019). Through the integration of operations research methodologies, such as demand forecasting and inventory optimization, with management practices, firms can improve their ability to meet customer demands, streamline production processes, and achieve operational excellence. Thus, Management Science theory offers valuable insights into enhancing operational efficiency and effectiveness through evidence-based decision-making and resource management strategies.

Inventory Planning

Inventory planning is a multifaceted process crucial for ensuring that businesses have the right products or services available to meet customer demands. It involves coordinating various functions such as purchasing, production, and distribution to align with marketing and organizational objectives. Key components of inventory planning include managing lead times, replenishment, returns, carrying costs, and demand forecasting. Achieving optimal inventory levels requires a continuous balancing act among these factors, as businesses must adapt to changing external environments (Miller, 2010). Effective inventory planning ensures materials are available when and where needed, utilizing suitable quantities and types of stock while maximizing resource utilization and minimizing costs (Smaros, 2003 as cited in Ayodele, et al., 2020).

Efficient inventory planning holds significant importance for manufacturing businesses, as it directly impacts profitability, customer satisfaction, and operational efficiency (Ogbu, 2008; Mohammed, 2016). By minimizing waste of time, resources, and idle capacity, businesses can maximize profits. Employing optimal order quantities helps minimize holding costs and ordering expenses, thus maximizing profitability. Additionally,

maintaining adequate inventory levels ensures customer satisfaction by avoiding stock outs and disruptions in production, thereby fostering long-term customer relationships and loyalty.

Furthermore, inventory planning plays a critical role in maintaining production continuity, managing liquidity, and optimizing operational processes (McKay & Wiers, 2003). Effective inventory management prevents production disruptions due to resource unavailability and minimizes the risk of overinvestment in stock, which can strain capital resources. A robust inventory management system provides visibility into stock levels, enables accurate demand forecasting, and facilitates timely ordering and delivery processes. Ultimately, inventory planning serves as a cornerstone for efficient business operations, ensuring smooth production processes, financial stability, and customer satisfaction.

Measures of Inventory Planning

In the realm of inventory planning, various measures are employed to ensure efficient management of stock levels. In this study, two essential measures, namely demand forecast and safety stock, are adopted, drawing upon the research of Ogah, et al. (2022) and Abomaye-Nimenibo, et al., (2020). The selection of these variables is based on their critical significance in mitigating uncertainties and optimizing inventory levels. Demand forecasting is a crucial aspect of a company's operations. It involves analyzing historical data, current market trends, and other relevant factors to anticipate the future demand for a product or service (Chase, 2013).

This key planning and decision-making tool (Abdeldayem & Aldulaimi, 2020) aids in the efficient allocation of resources, management of inventories, and optimization of production schedules. Businesses across various industries, such as retail, manufacturing, healthcare, and finance, can enhance their

operational efficiency, product availability, and customer service by accurately predicting demand (Nenni et al., 2013; Blackburn et al., 2015; Fattah et al., 2018). The demand forecasting process involves analyzing historical data, current market trends, seasonality, and utilizing various forecasting tools such as statistical methods and machine learning algorithms (Acar & Yilmaz, 2014).

In addition, demand forecasting offers several benefits to firms, including improved financial performance, competitive edge, enhanced customer service, increased efficiency, and better planning and decision-making (Ramanathan, 2014; Hofmann & Rutschmann, 2018; Seyedan & Mafakheri, 2020). Demand forecasting enables firms to optimize their operations and save costs by identifying patterns in future demand. This, in turn, facilitates efficient production, inventory management, and resource allocation. Effective demand forecasting ensures that businesses remain competitive and capitalize on growth opportunities in dynamic marketplaces by ensuring the availability of the right things when consumers want them. Consequently, this enhances client satisfaction, allegiance, and the act of keeping customers.

HO1: There is no significant relationship between demand forecasting and operations efficiency in the manufacturing industry in North-Eastern Nigeria.

Safety stock inventory: In order to mitigate the risk of stockouts caused by unpredictable changes in demand or disruptions in the supply chain, it is crucial to maintain safety stock inventory as a fundamental aspect of inventory management (Korponai, et al., 2017). This safety net ensures that companies can effectively endure variations in supplier deliveries or unforeseen surges in demand. To mitigate the risk of supply shortages and delays in delivery, firms can enhance customer service by maintaining a safety stock inventory (Tempelmeier & Bantel, 2015). Additionally, safety stock helps to minimize lead time variability and increases

flexibility, allowing companies to respond more effectively to changes in demand or supply chain conditions (Wisner et al., 2014). Despite its advantages, managing safety stock inventory presents challenges such as increased carrying costs, difficulty in determining optimal degrees, and the complexity of supply chain dynamics (Dhoka& Choudary, 2015). Therefore, while safety stock inventory offers several benefits in inventory planning, careful consideration and strategic management are essential to optimize its use and mitigate associated challenges.

HO2: There is no significant relationship between safety stock inventory and operations efficiency in the manufacturing industry in North-Eastern Nigeria.

In the contemporary landscape of manufacturing operations, technology adoption stands as a pivotal determinant of firms' competitiveness and operational efficiency. The integration of advanced technological solutions into inventory planning processes has revolutionized traditional practices, offering unprecedented opportunities for optimization and innovation. As elucidated by recent studies (Fosso Wamba et al., 2021), the adoption of technology in inventory planning encompasses a spectrum of tools and systems, including inventory management software, Internet of Things (IoT) sensors, artificial intelligence (AI), and block chain technology. These digital innovations enable firms to enhance the accuracy of demand forecasting, streamline supply chain processes, and optimize inventory levels in real-time, thereby facilitating more agile and responsive operations. Moreover, the proliferation of cloud computing and big data analytics has further empowered firms to harness vast amounts of data for informed decision-making, enabling them to anticipate market trends, mitigate risks, and capitalize on emerging opportunities.

However, while technology adoption holds immense potential for driving operational

efficiency, its successful implementation hinges upon various factors, including organizational readiness, resource availability, and technological infrastructure. Recent research (Koch, 2022) underscores the significance of organizational culture and leadership in fostering a conducive environment for technological innovation and adoption. Moreover, the digital divide, particularly prevalent in developing regions like Northeast Nigeria, poses challenges to widespread technology adoption, necessitating targeted interventions to bridge existing gaps in access to technology and digital literacy. Nonetheless, with the right strategic approach and investment in human capital development, manufacturing firms in Northeast Nigeria can leverage technology adoption as a catalyst for enhancing operational efficiency, fostering sustainable growth, and navigating the complexities of today's dynamic business environment.

HO3: Technology does not mediate the effect of demand forecasting on operations efficiency in the manufacturing industry in North-Eastern Nigeria.

HO4: Technology does not mediate the effect of safety stock on operations efficiency in the manufacturing industry in North-Eastern Nigeria.

Operational efficiency is a fundamental factor in the success of a business. It refers to the capacity of a company to achieve maximum output while using minimal input, resulting in the optimal use of resources and increased production. This idea incorporates several facets of organizational performance, such as manufacturing processes, supply chain management, and resource allocation. An important factor that affects how efficiently a business operates is the skillful handling of resources, including manpower, materials, and technology, in order to accomplish desired results while minimizing waste and expenses (Jones & Kato, 2023). Furthermore, operational efficiency refers to the ongoing enhancement of procedures and systems by using superior methods, fostering innovation,

and integrating technology (Bhatti et al., 2022). Organizations may achieve a competitive advantage, increase profitability, and better respond to changing market conditions by improving operational efficiency.

In addition, operational efficiency encompasses not just internal procedures but also client satisfaction, responsiveness, and value delivery. Promptly, correctly, and cost-effectively meeting client needs is crucial for a business to retain a competitive position in the marketplace (Van der Vorst et al., 2021). Efficient operating strategies may improve the quality of items, save activity time, and raise the level of service provided by businesses. Customers are inclined to develop loyalty and continue making purchases from the business as a consequence (Smith & Brown, 2024). González (2023) asserts that operational efficiency promotes agility and resilience by facilitating firms to swiftly adjust to evolving customer preferences and market trends. Therefore, by giving priority to operational efficiency, firms may attain sustainable development, profitability, and enduring success in the current dynamic business landscape.

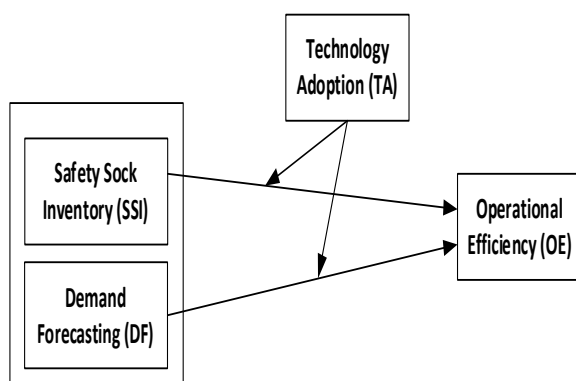


Figure 1: Conceptual Framework

Source: Authors Conceptualization (2024)

The conceptual framework depicted in Figure 1 illustrates the relationships among key variables investigated in this study: inventory planning, technology adoption, and operational efficiency in manufacturing firms in Northeast Nigeria. At the left of the

framework lies inventory planning, represented by components such as demand forecasting and safety stock management. The next component in the conceptual framework is technology adoption, which mediates the relationship between inventory planning and operational efficiency. By leveraging technological innovations, manufacturing firms can enhance the accuracy of demand forecasting, optimize inventory levels, streamline production processes, and improve decision-making capabilities. Technology adoption acts as a catalyst for improving operational efficiency by enabling real-time data analysis, process automation, and performance monitoring.

Mbah et al. (2019) examine the relationship between inventory management practices and operational performance across publicly traded industrial enterprises in Nigeria's southeast. The objective of the study was to ascertain the specific elements of inventory management that exerted the greatest influence on operational efficiency. Inventory cost, the just-in-time technique, materials requirement planning, and strategic supplier relationships are all components of this framework. We conducted a poll by selecting 538 employees at random from four distinct manufacturing companies. We employed SPSS and Excel to conduct descriptive statistics on the 371 responses we received. Regression analysis was employed to further investigate the assumptions of the study. A study carried out in southern Nigeria revealed a substantial correlation between inventory cost, the just-in-time approach, materials requirement planning, and key supplier connections and the operational success of manufacturing firms. According to the results, industrial enterprises in southeastern Nigeria might enhance their operational efficiency by implementing inventory management methods such as developing strategic supplier connections, adopting the just-in-time approach, implementing materials requirement planning, and implementing inventory cost control measures.

In their study, Nwaiku and Ejechi (2022) examined a representative sample of Nigerian manufacturing enterprises to determine the relationship between their inventory management practices and their operational efficiency. The research analyzed many inventory management solutions, including maintaining comprehensive inventory records, implementing a lean inventory system, managing buffer stock, and utilizing information and communication technology. The assessment of organizational output was based on two criteria: organizational effectiveness and organizational efficiency. Data from five distinct departments at industrial businesses located in Benin City was obtained utilizing a survey research methodology. The framework encompassed commercial, finance, production, distribution, and inventories. The sample consisted of 338 employees from Nigeria German Chemicals, Seven-Up Bottling Company Ltd, Global Horn Industry PVC Ceiling Limited, Integrated Rubber product Nigeria Plc, and Livestock Feeds Plc. We utilized SPSS, a comprehensive statistical software package, to analyze the data collected from the questionnaire. SPSS offers a wide range of valuable functionalities, such as descriptive statistics, correlation analysis, and regression analysis. The research found that the use of information technology, lean inventory methods, and accurate inventory records had a substantial positive impact on organizational efficiency in Nigeria. However, buffer stock management did not provide any benefit in this aspect. The study's findings suggest that manufacturing businesses might enhance their efficiency by prioritizing system-based inventory management solutions that enhance the precision of stock data.

Ogah et al. (2022) conducted an investigation on the impact of raw material management issues on several aspects of operational performance in Nigeria's industrial sector. The research examined critical indicators such as quality, speed, flexibility, dependability, and cost to measure operational performance. A current mixed-methods research conducted in

Nigeria involved surveying 703 inventory and supply chain managers from 22 distinct industrial enterprises. In addition, a total of 25 managers from 9 distinct organizations were interviewed utilizing a semi-structured interview method. Research indicated that Nigerian manufacturing businesses faced significant challenges in terms of speed, flexibility, and quality due to inefficient inventory management systems. The study emphasizes the need of strategic interventions to address identified issues and enhance operational efficiency in the manufacturing industry. Effective management of raw materials is crucial for enhancing overall performance.

Abomaye-Nimenibo et al. (2020) conducted a study to evaluate how different inventory management approaches affect operational efficiency, productivity, and ultimately, organizational profitability. The objective of the study was to examine the inventory management practices of manufacturing organizations, with a specific focus on the approach employed by 7Up Bottling Company in handling both raw materials and finished products. Data was collected through the use of questionnaires, and then evaluated using statistical techniques such as Spearman's rank-order correlation and Pearson product-moment correlation. 7Up Bottling Company was able to increase its profits from manufacturing and selling its final products by effectively decreasing its procurement expenses through the implementation of an inventory management strategy, as indicated by the findings. Efficient inventory management systems are essential for maximizing operational efficiency and profitability. Consequently, controlled procurement emerged as a cost-efficient technique. The authors of the paper recommend that industrial organizations use the Economic Order Quantity (EOQ) model in order to save expenses and enhance operational effectiveness.

Kwak (2013) examines the relationship between the deployment of IT systems and

operational performance by utilizing inventory turnover as a measure in his research. The primary objective of this study is to determine the impact of information technology use on inventory turnover. By utilizing a regression model, this approach identifies organizations with exceptional IT implementation through the use of a dummy variable. Based on a thorough empirical investigation that utilized publically accessible data, it was shown that the utilization of IT by organizations did not have a noteworthy effect on inventory turnover. Utilizing information technology (IT) solutions to enhance operational efficiency, particularly in terms of inventory turnover, may not have as significant of an effect as commonly believed. Exercising prudence is crucial while incorporating these technologies. Overall, our findings support the notion that improved inventory management might result in significant improvements in operational efficiency for Nigerian manufacturing firms.

METHODOLOGY

In this study, a survey research design was adopted to investigate the relationship between inventory planning and operations control in manufacturing firms in Northeast Nigeria and the moderating role of technology adoption. The choice of this design was influenced by the need to capture real-life situations and dynamics within the organizational context (Harrison, Birks, Franklin, & Mills, 2017). Through the use of structured questionnaires, data were collected from various staff members representing different organizational levels and departments, allowing for a comprehensive examination of inventory planning practices and their impact on operations control. The study area encompassed major manufacturing firms in each state of Northeast Nigeria, including Mambila Beverages Nigeria Ltd., Ashakka Cement Gombe, Borno Plastic Industry Limited, Nigerian Bag Manufacturing Company Limited, Bauchi

Flour Mill, and Yobe Flour and Feed Mills Limited.

The study population encompassed manufacturing firms across six states in Northeast Nigeria, with a total population size of 1154 employees. To determine the sample size, the Taro Yamane sampling determination technique was utilized, resulting in a sample size of 297 respondents. The Borley proportional sampling technique was then employed to determine the sample size from each organization, ensuring adequate representation from all selected firms. Data analysis involved descriptive statistics, hierarchical regression analysis conducted using SPSS software.

The validity of the instrument was established through expert examination, while reliability was assessed using Cronbach's alpha, yielding values 0.78, 0.72, 0.81 and 0.82, for demand forecasting, safety stock inventory, technology adoption and operational efficiency respectively indicating acceptable reliability. Data analysis techniques included, mean, and standard deviation, with regression analysis employed to test hypotheses at a significance level of 0.05. Overall, the study provided a comprehensive framework for investigating the relationship between inventory planning and operations control in Northeast Nigerian manufacturing firms, shedding light on the Moderating role of technology adoption in enhancing operational efficiency.

Model of the Study

$$OE = \beta_0 + \beta_1 DF + \beta_2 SSI + \beta_4 DF * TA + \beta_5 SSI * TA + \epsilon$$

Where:

OE = Represents the dependent variable, which measures the level of efficiency in the manufacturing operations.

DF = Demand forecasting practices

SSI = Safety stock inventory

TA = Represents the moderating variable, indicating the level of technology adoption in inventory planning and its moderating effect on the relationship between demand forecasting/safety stock inventory and operations efficiency.

$\beta_0, \beta_1, \beta_2, \beta_3, \beta_4$: Represents the regression coefficients for the intercept, each independent variable, and the interaction terms, indicating the magnitude and direction of their impact on operations efficiency.

ϵ : Represents the error term, capturing unobserved factors that influence operations efficiency but are not included in the model.

In this model, the interaction terms (Demand Forecasting * Technology Adoption and Safety Stock Inventory * Technology Adoption) capture the moderating effect of technology adoption on the relationships between demand forecasting/safety stock inventory and operations efficiency. The regression analysis will estimate the coefficients (β) and assess their statistical significance to determine the strength and significance of the moderating effects.

RESULTS AND DISCUSSIONS

The study distributed 297 questionnaires to the respondents out of which 192 were returned and used for the data analysis.

Table 1: Descriptive Statistics

	Mean	Std. Deviation	Tolerance	VIF
OE	3.0263	.33309		
SSI	3.0226	.31037	.975	1.026
DF	3.0753	.33219	.988	1.012
SSI.TA	3.0148	.36530	.975	1.025
DF.TA	3.0012	.35350	.981	1.019

Source: SPSS V25, 2024

In Table 1, descriptive statistics provide insights into the central tendency and variability of the variables included in the regression model. The mean values represent the average scores for each variable, with "OE" (Operations Efficiency) exhibiting a mean of 3.0263, indicating a moderate level of efficiency on average. Standard deviations quantify the dispersion of data points around the mean, revealing the extent of variability within each variable. For instance, "DF" (Demand Forecasting) has a standard deviation of .33219, suggesting relatively consistent forecasts across the sample. Tolerance and VIF (Variance Inflation Factor) values assess multicollinearity among predictor variables. Tolerance values close to 1 and VIF values around 1 indicate minimal multicollinearity, which is confirmed in this table. Overall, the descriptive statistics provide a preliminary understanding of the distribution and relationships among the variables, serving as a foundation for further regression analysis and interpretation.

Table 2: Model Summary^b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.726 ^a	.528	.506	.23410

a. Predictors: (Constant), DF.TA, DF, SSI.TA, SSI

b. Dependent Variable: OE

Source: SPSS V25, 2024

Table 2 presents the model summary statistics for the regression analysis conducted. The multiple correlation coefficient ($R = .726$) indicates a strong positive relationship between the predictor variables (Demand Forecasting, Safety Stock Inventory, and their interactions with Technology Adoption) and the dependent variable (Operations Efficiency). Approximately 52.8% of the

variance in operations efficiency can be explained by the predictor variables included in the model, as indicated by the R Square value (.528).

Table 3: ANOVAa

Model	Sum of Squares	Df	Mean Square	F	Sig.
1 Regression	5.385	4	1.346	24.566	.000b
Residual	4.822	188	.055		
Total	10.207	192			

a. Dependent Variable: OE

b. Predictors: (Constant), DF.TA, DF, SSI.TA, SSI

Source: SPSS V25, 2024

The ANOVA findings for the regression model can be seen in Table 3. The ANOVA table assesses the overall statistical significance of the regression model by comparing the residual variance (unaccounted for) with the regression-explained variation. The results indicate that the regression model has a substantial influence on the dependent variable, operations efficiency, with at least one predictor variable that significantly accounts for the variance ($F = 24.566, p < .05$).

Test of Hypotheses and Discussion

Table 4: Coefficients

Model	Unstandardized Coefficients		T	Sig.
	B	Std. Error		
1 (Constant)	2.459	.492	5.002	.000
SSI	.423	.080	5.288	.000
DF	.689	.074	8.833	.000
SSI*TA	.311	.068	4.574	.006
DF*TA	.597	.070	8.568	.000

Source: SPSS V25, 2024

The findings underscore the significance of demand forecasting, safety stock inventory

management, and technology adoption in driving operations efficiency within the manufacturing industry in North-Eastern Nigeria. Embracing advanced technological solutions alongside effective inventory planning strategies can enable companies to optimize their operations, meet customer demand more effectively, and gain a competitive edge in the marketplace.

HO1: There is no significant relationship between demand forecasting and operations efficiency in the manufacturing industry in North-Eastern Nigeria.

The coefficient for demand forecasting (DF) is statistically significant ($t = 8.833, p < .05$), indicating that demand forecasting has a significant positive relationship with operations efficiency. Therefore, we reject HO1.

HO2: There is no significant relationship between safety stock inventory and operations efficiency in the manufacturing industry in North-Eastern Nigeria.

The coefficient for safety stock inventory (SSI) is statistically significant ($t = 5.288, p < .05$), suggesting a significant positive relationship between safety stock inventory and operations efficiency. Thus, we reject HO2.

HO3: Technology does not mediate the effect of demand forecasting on operations efficiency in the manufacturing industry in North-Eastern Nigeria.

The coefficient for the interaction term (SSI.TA) is statistically significant ($t = 4.574, p < .05$), indicating that technology mediates the relationship between demand forecasting and operations efficiency. Hence, we reject HO3.

HO4: Technology does not mediate the effect of safety stock on operations efficiency in the manufacturing industry in North-Eastern Nigeria.

Similarly, the coefficient for the interaction term (DF.TA) is statistically significant ($t = 8.568$, $p < .05$), suggesting that technology mediates the relationship between safety stock inventory and operations efficiency. Therefore, we reject H_0 .

Discussion of Findings

This study corroborates existing knowledge on the correlation between inventory management systems and operational efficiency in the industrial sector, aligning with previous research findings. Our findings corroborate the findings of Mbah et al. (2019) and Nwaiku and Ejechi (2022), who similarly found that effective demand forecasting enhances operational performance. We see a positive and statistically significant association between the two variables. Businesses may enhance their operational efficiency by managing inventory levels and allocating resources according to accurate demand forecasts.

The study's findings corroborate the assertions made by Abomaye-Nimenibo et al. (2020) and Mbah et al. (2019) regarding the positive impact of safety stock inventory on operational efficiency. These researchers argue that maintaining sufficient stock levels safeguards production processes against disruptions in the supply chain and fluctuations in demand, thereby enabling prompt order fulfillment and uninterrupted production. The results emphasize the importance of safety stock inventory and other strategic inventory management techniques in enhancing manufacturing operational performance.

The study's findings support the conclusion that the use of technology enhances the connection between operational efficiency and inventory planning variables. This aligns with Kwak's (2013) research, which found that companies that have advanced technological solutions in their inventory management systems are more likely to achieve superior operational performance. Based on the statistically significant positive

coefficients of the interaction terms, the deployment of technology enhances the impact of demand forecasting and safety stock stocking on operational efficiency.

CONCLUSION AND RECOMMENDATIONS

This study elucidates the interconnections between inventory planning, technology adoption, and operational efficiency in the industrial sector of Northeast Nigeria. The findings indicate that technology functions as a mediator, enhancing the impacts of demand forecasting and safety stock inventory management, which are crucial for enhancing operational efficiency. The findings yielded the below recommendations for enhanced inventory management and increased operational efficiency:

(i) Cutting-edge technology solutions, such as automation systems and inventory management software, should be a top priority for manufacturing companies. Enhanced decision-making skills, more accurate data, and streamlined inventory planning procedures are all ways these technologies may boost operational efficiency. Beyond that, educating workers on data analytics, supply chain best practices, and new technology may help them make better decisions and increase operational efficiency over time.

(ii) By analyzing past data, current market trends, and consumer insights, manufacturing organizations should consistently improve their methods for demand forecasting. To better foresee changes in demand, businesses may work with their supply chain partners and use predictive analytics to fine-tune inventory levels, reducing the likelihood of stockouts and excesses.

(iii) The key for businesses is to find a happy medium between carrying expenses and keeping enough safety stock on hand. To minimize excess inventory holding costs and

maximize inventory availability, businesses should regularly evaluate demand unpredictability, lead times, and service level targets. This will help them identify the ideal safety stock levels.

LIMITATION AND SUGGESTION FOR FUTURE STUDIES

One limitation of this study is the potential for response bias in the survey data collected from industrial businesses in Northeast Nigeria. There is a possibility that the respondents provided distorted or inaccurate responses due to factors such as social desirability bias or difficulty in understanding the questions, despite our efforts to ensure their anonymity and confidentiality. Another further concern regarding the study's validity and reliability arises from its reliance on self-reported data, which introduces the possibility of measurement errors or inconsistencies. The generalizability of the results beyond the unique research site is limited, which is an additional constraint.

The findings of this study may not be applicable to other regions or industries because of variations in socioeconomic conditions, technical infrastructure, or regulatory frameworks. It is important to note that this study only focused on manufacturing businesses in Northeast Nigeria. Therefore, it is crucial to use caution when extrapolating the results to broader populations or different contexts. Finally, the study's breadth was restricted by limited resources such as time, money, and data accessibility. As a result, it is possible that we overlooked some chances to comprehensively examine inventory planning techniques or the use of new technology.

- i. Complement quantitative survey data with qualitative methods such as interviews or focus groups to gain a deeper understanding of the contextual factors influencing inventory planning and technology adoption in Northeast Nigeria
- ii. Compare inventory planning practices and technology adoption strategies

across different regions or industries within Nigeria.

- iii. Investigate how cultural factors influence inventory planning practices and technology adoption in different regions of Nigeria or other countries with similar socio-economic contexts.

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