Capacity Buffering and Demand Uncertainty of Manufacturing Firms in Rivers State, Nigeria

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Abstract
This study examined the relationship between capacity buffering and demand uncertainty of manufacturing firms in Rivers State, Nigeria. The measures of demand uncertainty used are demand forecasting accuracy and inventory turnover. The study adopted a cross-sectional survey research design. The target population was the 34 manufacturing firms registered with the Manufacturing Association of Nigeria, as obtained from the 2023 updated Directory of Rivers State zone of the association. However, the study elements were 80 which comprised managers from the production, marketing and operations departments of the respective 34 manufacturing firms. Data for the study was collected through structured questionnaire. The five-point Likert scale was used to measure the responses from the respondents. Data was analyzed using mean and standard deviations with charts for the primary analysis of the study variables, while inferential statistics such as the Spearman Rank Order Correlation Coefficient was used to test the hypotheses. The results of the study showed that there is moderate positive relationship between capacity buffering and demand forecasting accuracy. The study also revealed a strong positive relationship between capacity buffering and inventory turnover. The study concludes that capacity buffering has a significant relationship with demand forecasting accuracy and inventory turnover of manufacturing firms in Rivers State, Nigeria. The study therefore recommends that manufacturing firms should integrate capacity buffering strategies such as overtime shifts, flexible labor and machine redundancy into their demand forecasting models. Again, this alignment enables firms to better accommodate fluctuations in customer demand, thereby improving the accuracy and reliability of forecasting results.

Key words: *Capacity, Inventory Turnover, Demand Forecasting Accuracy*

Introduction

In today's dynamic business environment, demand uncertainty remains a critical challenge for manufacturing firms. Demand uncertainty refers to the unpredictability in customer demand patterns, which affects firms' ability to plan production, manage inventory, and meet customer expectations (Fisher, Gallino & Li, 2021). When demand fluctuates unpredictably, firms face difficulties in accurately forecasting future demand and maintaining optimal inventory levels (Tang & Tomlin, 2022). Demand forecasting accuracy, which measures how closely demand predictions align with actual market demand, is essential for minimizing excess inventory and stockouts (Chopra & Meindl, 2020). Similarly, inventory turnover, which assesses how efficiently inventory is managed and replenished, is a key indicator of operational performance (Lee & Whang, 2019). Low forecasting accuracy and poor inventory turnover often result in increased holding costs, stock shortages, and inefficiencies in production planning (Christopher & Holweg, 2017). Despite various studies on demand forecasting techniques and inventory control strategies, there is still limited research on how proactive capacity management strategies, such as capacity buffering, can mitigate demand uncertainty in manufacturing firms.

Capacity buffering is a strategic approach used by firms to manage uncertainties in production by maintaining excess capacity to accommodate unexpected fluctuations in demand (Hopp & Spearman, 2021). This approach ensures that firms have the flexibility to scale production up or down without significant disruptions (Ketokivi & Jokinen, 2020). Capacity buffering can take various forms, including excess labor capacity, reserve machinery, and additional production shifts, all of which enable firms to respond swiftly to demand variations (Slack, Brandon-Jones & Johnston, 2019). While previous research has focused on the role of inventory management and demand planning in addressing demand uncertainty, there is a gap in understanding how capacity buffering can enhance demand forecasting accuracy and improve inventory turnover. Addressing this gap is particularly relevant for manufacturing firms in Rivers State, Nigeria, where unpredictable market conditions and supply chain disruptions pose significant challenges to efficient production planning.

Therefore, this study seeks to bridge this gap by examining the relationship between capacity buffering and demand uncertainty, with a focus on its effects on demand forecasting accuracy and inventory turnover in manufacturing firms in Rivers State, Nigeria.

The purpose of this research was therefore to empirically examine the relationship between capacity buffering and demand uncertainty of manufacturing firms in Rivers State, Nigeria.

The specific objectives of the study include.
1. To examine the relationship between capacity buffering and demand forecasting accuracy of manufacturing firms in Rivers State, Nigeria.
2. To determine the relationship between capacity buffering and inventory turnover of manufacturing firms in Rivers State, Nigeria.

The Research questions are as follows
1. What is the relationship between capacity buffering and demand forecasting accuracy of manufacturing firms in Rivers State, Nigeria?
2. What is the relationship between capacity buffering and inventory turnover of manufacturing firms in Rivers State, Nigeria?

The research hypotheses are as follows
1. There is no significant relationship between capacity buffering and demand forecasting accuracy of manufacturing firms in Rivers State, Nigeria.

2. There is no significant relationship between capacity buffering and inventory turnover of manufacturing firms in Rivers State, Nigeria.

Literature Review

Theoretical Foundation

The Theory of Constraints (TOC) is a management philosophy developed by **Eliyahu M. Goldratt** in the 1980s, which focuses on identifying and managing bottlenecks in production and business processes to improve overall efficiency and performance (Goldratt, 1984). The core principle of TOC is that any system has at least one constraint that limits its ability to achieve higher performance. By systematically addressing these constraints, organizations can optimize productivity, reduce inefficiencies, and enhance profitability (Goldratt & Cox, 2016). TOC has been widely applied in manufacturing, supply chain management, healthcare, and project management. Its relevance extends to capacity buffering, as organizations use buffering strategies to mitigate the effects of constraints and maintain steady operations despite demand fluctuations (Simatupang, Wright, & Sridharan, 2004).

TOC is built upon five key principles that guide organizations in identifying and addressing constraints (Goldratt & Cox, 2016): Identify the Constraint: The first step is to pinpoint the specific bottleneck that restricts the system's performance. This could be a machine, labor shortage, inefficient process, or supply chain issue (Dettmer, 1997). Exploit the Constraint: Once identified, the constraint should be optimized to maximize its efficiency without making significant capital investments. This involves eliminating waste, reducing downtime, and ensuring uninterrupted operations at the constraint point (Rahman, 1998). Subordinate Other Processes to the Constraint: All other operations should be adjusted to support and align with the identified constraint, ensuring that no resources are wasted in non-bottleneck areas (Cox & Schleier, 2010). Elevate the Constraint: If the constraint still limits system performance after optimization, organizations should invest in additional capacity, resources, or process improvements to eliminate or reduce its impact (Goldratt, 1990). Repeat the Process: Once a constraint is resolved, another bottleneck may emerge. The process should be repeated continuously to ensure ongoing efficiency improvements (Gupta & Boyd, 2008).

TOC is particularly relevant to manufacturing firms dealing with demand uncertainty, as it helps optimize production processes and minimize inefficiencies. The role of TOC in capacity buffering includes: Managing Production Bottlenecks: TOC helps identify critical capacity constraints and implement buffering strategies (such as adding extra labor shifts or machinery) to prevent disruptions (Watson, Blackstone, & Gardiner, 2007). Optimizing Inventory Levels: Instead of excessive stockpiling, TOC emphasizes strategic inventory placement at critical points in the supply chain to ensure continuous production flow (Rand, 2000). Enhancing Demand Responsiveness: By focusing on system constraints, TOC enables firms to adjust production schedules and resource allocation based on real-time demand conditions (Mabin & Balderstone, 2003).

Several methodologies have been developed within the TOC framework to enhance organizational efficiency: The Five Focusing Steps: As outlined earlier, these steps provide a structured approach for identifying and addressing constraints. The Drum-Buffer-Rope (DBR) System: A scheduling and production control system used in TOC that ensures a steady flow of work to the constraint (the "drum"), maintains a protective inventory ("buffer"), and synchronizes production with demand through a scheduling mechanism ("rope") (Schragenheim & Dettmer, 2001). Throughput

Accounting (TA): Unlike traditional cost accounting, which focuses on cost reduction, TA emphasizes increasing throughput (sales revenue minus direct variable costs), reducing inventory, and controlling operating expenses to improve profitability (Corbett, 1998). Critical Chain Project Management (CCPM): A TOC-based approach to project management that focuses on resource constraints to reduce project completion time and prevent delays (Herroelen & Leus, 2001).

TOC provides several benefits to organizations, including: Improved Operational Efficiency: By addressing constraints, firms can maximize output without unnecessary resource expansion (Goldratt & Cox, 2016). Cost Savings: Focusing on the most critical bottlenecks allows firms to avoid unnecessary investments in non-bottleneck areas (Watson et al., 2007). Enhanced Production Flow: TOC facilitates smoother workflows, reducing delays and improving overall productivity (Mabin & Balderstone, 2003). Better Decision-Making: The structured approach of TOC provides clear guidelines for management to prioritize improvements and allocate resources effectively (Cox & Schleier, 2010).

Despite its benefits, TOC has several limitations: Narrow Focus on Constraints: Critics argue that TOC places too much emphasis on a single constraint, potentially overlooking other operational inefficiencies (Woeppel, 2001). Short-Term Perspective: The approach may offer immediate solutions but may not always align with long-term strategic planning (Gupta & Boyd, 2008). Limited Applicability in Complex Systems: In highly dynamic environments with multiple interacting constraints, TOC may be challenging to implement effectively (Rahman, 1998).

Concept of Capacity Buffering

Capacity buffering can be defined as "the strategic planning and management of excess production capacity to absorb variations in demand and supply, ensuring uninterrupted production flow" (Hopp & Spearman, 2020). Another definition describes it as "the allocation of additional production resources, such as machinery or labor, to create flexibility within the production system, allowing it to adapt to unforeseen fluctuations in the production process" (Chopra & Meindl, 2019).

Capacity buffering can be categorized into several types, including strategic capacity buffering, operational capacity buffering, and tactical capacity buffering. Strategic capacity buffering involves long-term planning and investment in additional capacity to handle future growth or demand surges. Operational capacity buffering is concerned with short-term adjustments, such as adding extra shifts or temporarily increasing labor to meet immediate production needs. Tactical capacity buffering, on the other hand, focuses on mid-term capacity adjustments that balance cost and flexibility, such as leasing additional machinery or facilities during peak seasons (Chopra & Meindl, 2019). Key characteristics of capacity buffering include its focus on flexibility, responsiveness, and the ability to scale operations up or down depending on demand.

The concept of capacity buffering has evolved alongside advancements in manufacturing and production management. Historically, capacity planning was more reactive, with firms often struggling to adapt to demand fluctuations. The development of Just-in-Time (JIT) manufacturing and lean production techniques in the late 20th century introduced more proactive approaches to capacity management, emphasizing the need for flexibility and adaptability in production processes (Hopp & Spearman, 2020). These advancements led to the integration of capacity buffering strategies within broader operational frameworks, allowing firms to better manage production variability and uncertainty.

Several theoretical frameworks explain the concept of capacity buffering, with the Just-in-Time (JIT) theory and the Theory of Constraints (TOC) being particularly relevant. The JIT theory emphasizes minimizing waste and improving efficiency by producing only what is needed when it is needed, thereby reducing the reliance on large capacity buffers. However, it also recognizes the importance of having some buffer capacity to deal with unexpected demand spikes (Hopp & Spearman, 2020).

The concept of capacity buffering is not without its debates and controversies. One of the main debates centres around the cost implications of maintaining excess capacity. While some argue that capacity buffers are essential for maintaining production stability, others contend that the costs associated with excess capacity—such as idle machinery, underutilized labor, and increased operational expenses—can outweigh the benefits (Snyder et al., 2020). Additionally, there is ongoing discussion about the balance between maintaining sufficient capacity to meet demand and the risks of overcapacity, which can lead to inefficiencies and reduced profitability.

The proxies or indicators for capacity buffering include production lead time, machine downtime, and capacity utilization rate. Production lead time measures the total time taken from the initiation to the completion of a production process, reflecting the efficiency of capacity management. Machine downtime tracks the amount of time machinery is out of operation, indicating the reliability and maintenance of production capacity. Capacity utilization rate measures the extent to which a firm's productive capacity is being used, providing insights into the balance between capacity and demand. The measurement techniques for capacity buffering are justified by their ability to provide critical insights into the effectiveness of a firm's capacity management strategies. For instance, the capacity utilization rate is a key indicator of how well a firm is managing its resources, with high utilization suggesting efficient use of capacity and low utilization indicating potential underperformance or overcapacity (Snyder et al., 2020). Similarly, tracking machine downtime and production lead time helps firms identify bottlenecks and areas for improvement in their production processes, ultimately leading to more effective capacity management.

Capacity buffering is a strategic approach used by organizations to manage uncertainties in demand and supply by maintaining excess capacity to accommodate fluctuations. It serves as a cushion against variability in production, demand surges, and supply chain disruptions, enabling firms to sustain smooth operations despite unpredictable conditions (Hopp & Spearman, 2021). The concept is widely applied in manufacturing, healthcare, and service industries where demand fluctuations can significantly impact efficiency and performance (Slack et al., 2019).

The concept of capacity buffering is multidimensional, encompassing various operational aspects, including: Labor Capacity Buffering: Maintaining a flexible workforce by employing temporary workers, cross-training employees, or implementing overtime arrangements to handle demand fluctuations (Bourgeois & Eisenhardt, 2020). Equipment and Facility Buffering: Keeping additional machinery, production lines, or storage space to accommodate unexpected increases in production requirements (Slack et al., 2019). Supplier and Material Buffering: Establishing strong supplier relationships and maintaining safety stock of critical raw materials to prevent supply chain disruptions (Christopher & Holweg, 2017). Financial Buffering: Allocating financial reserves to absorb the costs associated with demand spikes, unexpected maintenance, or investment in additional capacity (Lee & Whang, 2019).

Implementing capacity buffering strategies can lead to several operational advantages: Improved Demand Responsiveness: Firms can quickly adjust to sudden increases in demand without disrupting production schedules (Ketokivi & Jokinen, 2020). Enhanced Production Efficiency: Capacity buffers help prevent bottlenecks and maintain steady workflow, reducing downtime and inefficiencies (Slack et al., 2019). Risk Mitigation: By maintaining excess capacity, organizations reduce the impact of supply chain disruptions, equipment failures, and labor shortages (Tang & Tomlin, 2022). Competitive Advantage: Firms with flexible capacity strategies can capitalize on market opportunities and outperform competitors with rigid production structures (Hopp & Spearman, 2021).

Despite its advantages, capacity buffering also presents several challenges: High Operational Costs: Maintaining excess capacity requires investment in labor, equipment, and storage, leading to increased fixed costs (Christopher & Holweg, 2017). Inefficient Resource Utilization: If demand remains stable, unused capacity can result in wasted resources and financial inefficiencies (Lee & Whang, 2019). Complexity in Implementation: Managing capacity buffers requires accurate demand forecasting, supply chain coordination, and financial planning, making execution challenging (Ketokivi & Jokinen, 2020).

Manufacturing firms in Rivers State face significant challenges related to demand uncertainty, unreliable supply chains, and infrastructure limitations. Capacity buffering can serve as a crucial strategy to mitigate these challenges by ensuring production flexibility and reducing operational risks. However, firms must balance the costs of maintaining buffer capacity with the need for efficiency and competitiveness in a dynamic economic environment (Adebayo & Adebola, 2021).

Concept of Demand Uncertainty

Demand uncertainty pertains to the lack of predictability in consumer demand for products, posing significant challenges for manufacturing firms—particularly those operating in dynamic environments like Rivers State, Nigeria. Effectively managing this uncertainty is vital for enhancing production planning, inventory control, and overall operational efficiency (Behrooz & Boozarjomehry, 2017). Rosienkiewicz (2021) defines demand uncertainty as “the level of unpredictability associated with customer demand, potentially leading to mismatches between forecasted and actual demand.” Torrico and Oyola (2021) similarly describe it as “variations in customer demand that complicate planning efforts, increasing the chances of inventory shortages or overstock.”

Demand uncertainty manifests through various factors, including seasonal demand fluctuations, market volatility, and inconsistent consumer preferences. Its core features include its unpredictability, which complicates accurate forecasting, and its broad impact on supply chain operations—from production efficiency to customer satisfaction. Essential elements in managing demand uncertainty involve the ability to respond flexibly, recognize irregular patterns, and utilize advanced forecasting tools to reduce its effects. Two principal metrics used to evaluate demand uncertainty are demand forecasting accuracy and inventory turnover. These indicators help organizations gauge the level of unpredictability and devise strategies to address it effectively. Demand forecasting accuracy evaluates how precisely future demand is predicted, while inventory turnover reflects how often inventory is cycled within a particular timeframe, shedding light on how well a firm manages fluctuating demand.

These metrics are crucial for understanding a company’s responsiveness to changing market conditions. High forecasting accuracy minimizes stockouts and overproduction, promoting more streamlined inventory management (Verstraete et al., 2019). Similarly, a well-managed inventory turnover rate indicates the firm’s ability to adapt to demand variations and maintain efficient stock levels (Gonçalves et al., 2020). As global supply chains have become more intricate, the approach to managing demand uncertainty has also evolved. Early strategies relied heavily on traditional inventory techniques. However, the growing complexity of markets has driven the adoption of more sophisticated tools, including machine learning algorithms and predictive analytics, to enhance forecasting accuracy and responsiveness.

Two influential theoretical frameworks that address demand uncertainty are the Just-in-Time (JIT) model and the Adaptive Expectation theory. JIT emphasizes maintaining low inventory levels and producing only as needed to avoid surplus and reduce waste (Rosienkiewicz, 2021). The Adaptive Expectation theory explains how companies refine their future demand projections based on historical data and patterns (Torrico & Oyola, 2021). Debates around demand uncertainty management often center on the reliability of different forecasting techniques. While some researchers argue that traditional models are inadequate for today's dynamic markets, favoring artificial intelligence-based models for their superior accuracy (Gonçalves et al., 2020), others caution that such approaches require substantial data and technical infrastructure, which may be inaccessible for smaller firms.

Measures of Demand Uncertainty

Demand Forecasting Accuracy

Accurate demand forecasting is essential for effective supply chain and inventory management, particularly for manufacturing firms in regions like Rivers State, Nigeria, where market volatility and disruptions are common. Reliable forecasts help firms anticipate customer needs, optimize resource allocation, and reduce the risks of overstocking or running out of stock (Bagshaw, 2014). This literature review examines the concept of demand forecasting accuracy—its definitions, classifications, historical evolution, and significance in mitigating demand uncertainty within operational processes. Demand forecasting accuracy refers to the degree to which predicted demand corresponds with actual demand, thereby minimizing the variance between projected and actual outcomes (Jaouhari et al., 2022). It is also described as the effectiveness of forecasting models in predicting future demand based on historical data and relevant influencing variables (Gonçalves et al., 2020).

There are various forms of demand forecasting accuracy, shaped by the forecasting techniques employed—ranging from traditional statistical models to advanced machine learning and hybrid approaches. Key features of accurate forecasts include high precision, adaptability to evolving data, and robustness in handling demand fluctuations. Accurate forecasting is typically characterized by low error margins, stable trend predictions, and the ability to analyze large datasets while identifying complex relationships among influencing factors. The understanding of demand forecasting accuracy has advanced over time in line with improvements in forecasting methods and computational technologies. Early approaches, such as moving averages and exponential smoothing, have given way to more sophisticated techniques like multiple regression, neural networks, and machine learning algorithms. These advances highlight the growing importance of precise forecasting in today's interconnected global marketplace (Adhikari et al., 2018).

Theoretical models such as the Bayesian framework and machine learning paradigms underpin the concept of demand forecasting accuracy. The Bayesian model enhances forecast reliability by merging prior information with newly acquired data, thus continuously improving prediction accuracy (Bergman et al., 2017). In contrast, machine learning models—like artificial neural networks and support vector machines—extract patterns from extensive datasets, refining their predictions through continuous learning from previous errors (Aktepe et al., 2021). A central debate surrounding demand forecasting accuracy concerns the trade-off between model complexity and ease of interpretation. While complex machine learning models often offer superior accuracy, they may lack transparency, making it difficult for decision-makers to understand the basis of predictions. Furthermore, their dependability in unstable markets is questioned, as rapid shifts in demand may diminish the usefulness of historical data for future projections (Dou et al., 2021).

Inventory Turnover

Inventory turnover is a vital indicator used to evaluate how effectively manufacturing firms manage their stock. It reflects how frequently inventory is sold or used within a specific timeframe, offering valuable insights into the performance of a company's supply chain and overall operational efficiency. In areas like Rivers State, Nigeria—where market dynamics can be unstable—understanding and managing inventory turnover is crucial for maximizing resource efficiency, minimizing storage costs, and boosting profitability (Okwu, Bagshaw & Wilson, 2024). This review discusses the concept of inventory turnover, including its theoretical background, various classifications, and its function in mitigating operational uncertainty in the manufacturing industry. Inventory turnover is commonly defined as "the cost of goods sold divided by the average inventory during a given period, indicating how often inventory is replenished" (Alnaim & Kouaib, 2023). Another perspective describes it as "a metric that evaluates a firm's proficiency in managing inventory by comparing sales volume to stock levels" (Kwak, 2019). This concept can be broken down into types based on inventory segments: raw materials, work-in-progress, and finished goods. Important features of inventory turnover include its role in measuring inventory fluidity, supply chain performance, and the sufficiency of stock in relation to demand. High turnover typically suggests efficient inventory handling, while low turnover may point to overstocking or poor sales performance. These metrics are influenced by demand variability, seasonal trends, and industry-specific dynamics.

Over time, the role of inventory turnover has evolved, especially with the rise of advanced inventory systems. Initially seen as a financial ratio in retail and manufacturing, it has become a central operational metric thanks to systems like just-in-time (JIT) inventory and lean manufacturing. As supply chains become more intricate, inventory turnover has become increasingly important for ensuring operational stability and financial health (Jayawardane et al., 2022). Several theories support the concept of inventory turnover, notably the Economic Order Quantity (EOQ) model and Lean Manufacturing principles. EOQ helps determine the most cost-effective order quantity by minimizing total inventory-related expenses, directly impacting turnover rates (Akpoviroro & Varečková, 2023). Lean Manufacturing, with its focus on reducing waste and improving process efficiency, encourages maintaining minimal inventory levels and frequent restocking, thereby improving turnover (Jayawardane et al., 2022).

There is ongoing discussion about the correlation between inventory turnover and profitability or efficiency. While high turnover is often desirable, it may result in stock shortages or missed opportunities if not managed properly. Moreover, the impact of turnover on profitability can vary depending on the industry, firm size, and market conditions (Ali et al., 2022). Volatile markets, in particular, present challenges in maintaining optimal turnover rates, prompting continued debate about the best inventory management practices. Inventory turnover is assessed through key metrics such as turnover rate, frequency of stockouts, and variations in lead time. These can be tracked using internal company data like sales figures, inventory records, and production timelines. The turnover rate is calculated by dividing the cost of goods sold by average inventory within a set period, while stockout frequency can be derived from sales and customer order records. These indicators are valuable for evaluating inventory performance and identifying areas needing improvement. A high turnover rate implies robust sales and efficient inventory practices, whereas a low rate may signal overstocking or slow sales. By analyzing these metrics, companies can enhance their inventory strategies and operational outcomes (Podile et al., 2020).

Empirical Review

Olhager and Rudberg (2002) examined the role of capacity strategies, including capacity buffering, in managing demand fluctuations in manufacturing firms in Swedeen. The study adopted a survey-based study of 200 manufacturing firms using structured questionnaires and statistical analysis (regression analysis). The study revealed firms that implemented flexible capacity buffering strategies, such as using temporary labor and subcontracting, were more resilient to demand variability. The study concluded that capacity buffering enhances a firm's responsiveness and helps maintain stable operations under uncertain demand conditions.

Also, Gaur, Fisher and Raman (2005) examined the relationship between capacity buffering and inventory turnover across retail supply chains experiencing demand uncertainty in retail chains in the United State. The study adopted a quantitative analysis of secondary data (inventory turnover ratios, financial reports) from 311 firms; regression models were used. The study revealed retailers using dynamic capacity management strategies achieved higher inventory turnover and better demand responsiveness. Capacity buffering plays a key role in managing inventory and matching supply with volatile demand.

In addition, Singh and Garg (2009) examined the effectiveness of capacity buffering in improving lead times and managing demand variability in the Indian auto parts industry. The study adopted a case study analysis involving structured interviews and production data from five auto parts companies. The study revealed buffering through overtime labor and equipment redundancy significantly reduced lead time variability and stockouts. Strategic capacity buffering improves service levels and supports continuous flow in uncertain demand environments.

Again, Syntetos, Babai and Boylan (2010) examined the impact of safety capacity and capacity buffers on forecast accuracy and production stability in the manufacturing firms in UK. The study adopted simulation modeling and forecasting error analysis using time-series data. The study revealed capacity buffering improves responsiveness but must be balanced with accurate forecasting to avoid overproduction. Capacity buffering mitigates demand uncertainty but must be aligned with forecast improvement techniques for optimal performance.

Also, Cheng, Podolsky and Jarvis (2012) examined how capacity flexibility affects the handling of uncertain demand in global electronics manufacturing in China. The study adopted a mixed-method (interviews, performance metrics, and survey data from 14 multinational firms). The study revealed capacity buffering through workforce cross-training and subcontracting allowed firms to scale production quickly during demand surges. Capacity buffering enhances competitive advantage by aligning production capabilities with unpredictable market demand.

Furthermore, Akinyemi & Awolusi (2020) examined the role of capacity planning and buffering in managing supply-demand fluctuations in Nigerian cement manufacturing firms. The study adopted a descriptive survey design; 120 operations managers were surveyed using questionnaires. Data were analyzed using SPSS and regression models. The study revealed firms using proactive capacity buffering strategies (extra shifts, machine availability, contractor flexibility) managed demand variability more effectively and reported higher production efficiency. Capacity buffering enhances organizational adaptability and mitigates demand uncertainty in emerging economies like Nigeria.

Capacity Buffering and Demand Forecasting Accuracy

Volling and Spengler (2011) examined how capacity flexibility and buffering strategies influence forecast accuracy and production reliability in manufacturing firms in Germany. The study adopted simulation and optimization modeling combined with empirical data from production lines; data collected from 8 firms. The study revealed capacity buffering significantly improved production responsiveness and reduced forecast error effects on operations. Integrating capacity buffering with forecasting systems increases the reliability of production schedules and output stability.

Waller, Fawcett and Johnson (2010) examined the role of operational flexibility, including capacity buffering, in enhancing demand forecasting processes in the consumer goods and food manufacturing companies in the United States. The study adopted a survey and structural equation modeling (SEM) of 150 firms. The study revealed firms with higher capacity flexibility reported improved forecast accuracy due to better alignment of production with demand signals. Capacity buffering acts as a supportive mechanism for effective demand forecasting by absorbing deviations from forecasted volumes.

Gunessee & Subramanian (2015) examined how operational capabilities such as capacity buffering influence forecast accuracy under supply chain disruptions in Sri Lankan textile and apparel industries in India. The study adopted a case study and regression analysis involving 12 firms and interviews with supply chain managers. The study revealed capacity buffering (through overtime and temporary labor) enabled firms to maintain higher forecast fulfillment rates even with volatile demand. Forecast accuracy is improved when capacity buffers are used to absorb variability, especially in disruption-prone industries.

Sun, Wang and Li (2016) examined how different capacity strategies impact forecast accuracy in high-tech production environments in semiconductor manufacturing firms in China. The study adopted an empirical analysis using archival data and simulation modeling on production volumes vs. forecast projections. The study revealed capacity buffering via idle machine capacity and on-call labor improved short-term forecast adherence and minimized production variance. In high-tech sectors with fluctuating demand, capacity buffering enhances short-term forecast accuracy and stabilizes planning.

Nwokoro & Chukwuemeka (2021) examined the role of capacity buffering in improving demand forecasting accuracy among manufacturing SMEs in Rivers State, Nigeria. The study adopted a descriptive survey method using structured questionnaires from 95 operations managers. Data analyzed using SPSS (correlation and regression analysis). The study revealed positive and significant relationship between use of flexible capacity buffers (extra shifts, subcontracting) and accurate demand forecasts. Capacity buffering enhances SMEs' ability to manage demand forecasts, thereby improving decision-making and operational efficiency.

The following null hypotheses were formulated to validate the relationship between the variables:

Ho1: There is no significant relationship between capacity buffering and demand forecasting accuracy in the manufacturing firms in Rivers State, Nigeria.

Capacity Buffering and Inventory Turnover

Gaur, Fisher and Raman (2005) examined the drivers of inventory turnover and the role of capacity strategies in retail supply chains in retail industries in the United States. The study adopted econometric analysis of secondary data from 311 publicly traded retail firms using regression models. The study revealed capacity buffering through flexible labor and distribution capabilities significantly improved inventory turnover by aligning supply with real-time demand. Firms with strong capacity buffering strategies had higher inventory turnover, reduced stockouts, and lower holding costs.

Koumanakos (2008) examined how inventory management and buffering practices affect firm performance, focusing on inventory turnover in manufacturing firms in Greece. The study adopted a quantitative analysis using cross-sectional survey data and financial statement review. The study revealed firms with moderate capacity buffers (flexible shifts and machine redundancy) achieved better inventory turnover and responsiveness to demand variability. Efficient use of capacity buffers leads to optimized inventory levels and improved turnover ratios, avoiding overstocking and understocking.

Hendricks, Singhal and Stratman (2007) examined operational flexibility, including capacity buffering, as a strategy to improve inventory performance after supply chain disruptions in manufacturing firms North American. The study adopted an event study and regression analysis using archival financial data and press reports of operational disruptions. The study revealed companies with built-in capacity buffers (such as excess capacity and temporary labor contracts) recovered faster and achieved stable inventory turnover. Capacity buffering supports continuity of supply and enables faster inventory turnover even after disruptions.

Christopher and Peck (2004) examined how resilience strategies such as capacity buffering influence inventory turnover and risk management in global supply chains in UK. The study adopted a multiple case studies and in-depth interviews with logistics and operations managers. The study revealed firms with flexible production capacity reduced reliance on inventory buffers, improved inventory turnover, and maintained service levels under demand uncertainty. Capacity buffering is a more efficient alternative to inventory buffering in achieving high turnover and supply chain agility.

Obasi and Okeke (2022) examined the impact of capacity buffering strategies on inventory turnover in Nigerian manufacturing firms in Fast-moving consumer goods (FMCG) sector in Lagos and Rivers States, Nigeria. The study adopted a survey research design with structured questionnaires distributed to 120 operations managers; data analyzed using regression analysis. The study revealed firms that adopted subcontracting and machine redundancy as capacity buffers experienced higher inventory turnover and fewer stockpile situations. Capacity buffering significantly enhances inventory turnover by allowing firms to produce based on demand signals rather than forecast estimates alone.

The following null hypotheses were formulated to validate the relationship between the variables:

Ho2: There is no significant relationship between capacity buffering and inventory turnover in the manufacturing firms in Rivers State, Nigeria.

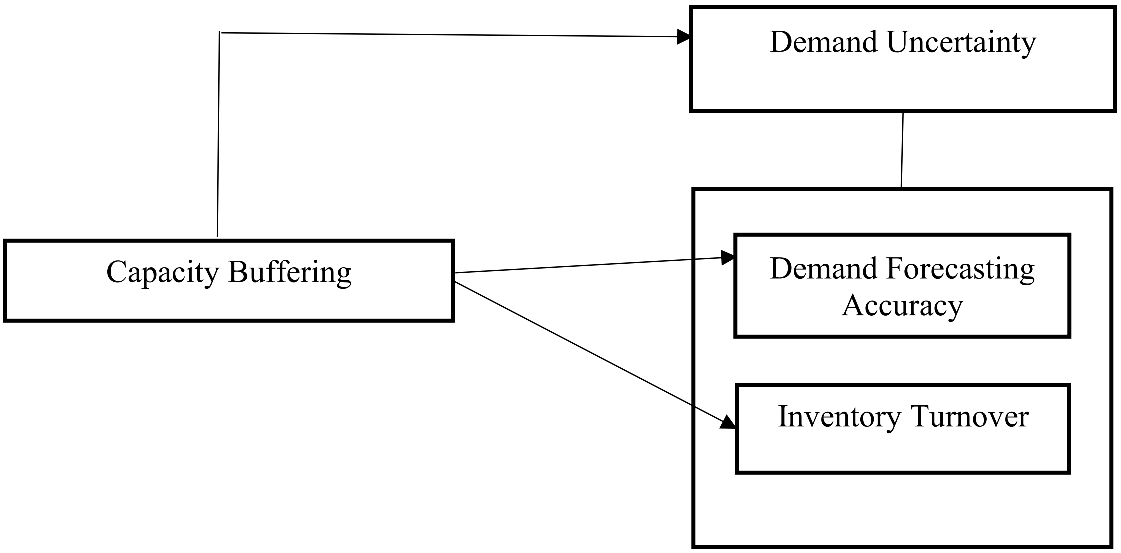

Figure 1: Operational framework for the hypothesized relationship between capacity buffering and demand uncertainty

Methodology

This study adopted a cross-sectional research design to investigate the relationship between supplier quality management and the operational effectiveness of manufacturing firms in Rivers State, Nigeria. The study's target population consisted of thirty-four (34) manufacturing firms registered with the Manufacturing Association of Nigeria (MAN), based on the updated 2022 records. The unit of analysis focused on the organizational level, and participants were selected accordingly. Three (3) representatives were chosen from each of the thirty-four (34) manufacturing firms, specifically managers from the production, marketing, and operations departments. These individuals were selected due to their expertise, knowledge, and decision-making authority, which ensured the provision of relevant and accurate responses to the research instrument. Since the study required insights from key decision-makers rather than general staff, the total study elements comprised 102 managers from the identified departments across the selected firms.

Given the relatively small target population, a census sampling technique was applied. The study utilized a structured questionnaire as the primary data collection instrument. Of the 102 questionnaires distributed, 84 were retrieved, while 18 were not returned. Furthermore, four (4) questionnaires were deemed invalid, resulting in a final total of 80 valid responses for analysis. The data analysis incorporated descriptive statistics, including mean and standard deviation, along with charts to represent key study variables. For hypothesis testing, inferential statistical methods such as the Spearman Rank Order Correlation Coefficient and Partial Correlation Coefficient were employed. The analysis was conducted using the Statistical Package for Social Sciences (SPSS) version 27.0 to determine the nature and strength of the proposed relationships.

Scatter Plot Diagram

The scatter diagram explains the summary of the correlation of capacity buffering and demand uncertainty. The evidence on the analysis shows that approximately 74.7% of the changes and manifestations of demand uncertainty can be linked to actions that reflects capacity buffering in the manufacturing firms in Rivers State, Nigeria.

Figure 1: Scattered Diagram Showing the Relationship Between Capacity Buffering and Demand Uncertainty

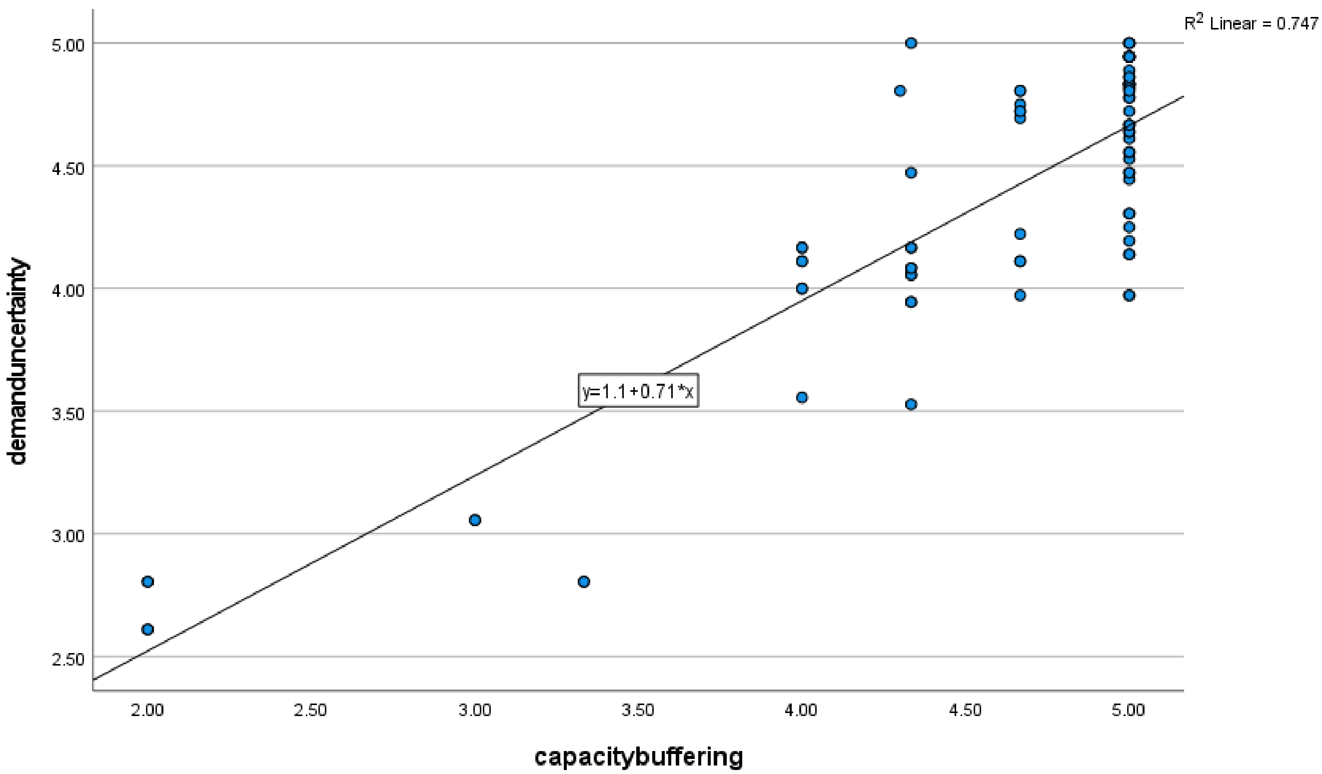

Table 1: Correlation Between Capacity Buffering and Demand Uncertainty

Correlations

			capacitybuffering	demandforecastingaccuracy	inventoryturnover
Spearman's rho	capacitybuffering	Correlation Coefficient	1.000	.598**	.767**
		Sig. (2-tailed)	.	<.001	<.001
		N	80	80	80
	demandforecastingaccuracy	Correlation Coefficient	.598**	1.000	.576**
		Sig. (2-tailed)	<.001	.	<.001
		N	80	80	80
	inventoryturnover	Correlation Coefficient	.767**	.576**	1.000
		Sig. (2-tailed)	<.001	<.001	.
		N	80	80	80

**. Correlation is significant at the 0.05 level (2-tailed).

Source: SPSS Output, 2025

Interpretation of Results: Table 1 presented the Spearman's rank order correlation matrix for the relationship between capacity buffering and the measures of demand uncertainty (demand forecasting accuracy and inventory turnover) in the Manufacturing firms in Rivers State, Nigeria. From the data given in the table 1, the correlation results for **Ho1** and **Ho2** were given as:

Ho1 There is no significant relationship between capacity buffering and demand forecasting accuracy in the manufacturing firms in Rivers State, Nigeria.

From the analysis, the result showed the correlation coefficient of r = 0.598 which shows the direction and strength of this relationship. The coefficient represents a moderate positive correlation between capacity buffering and demand forecasting accuracy in the manufacturing firms in Rivers State, Nigeria. The test of significance shows that this relationship is significant at p = .001 < 0.01which makes possible to the generalization of our findings to the study population. Therefore, based on observed findings, the null hypothesis earlier stated is hereby rejected and the alternate upheld. Thus, there is a significant relationship between capacity buffering and demand forecasting accuracy in the manufacturing firms in Rivers State, Nigeria.

Ho2: There is no significant relationship between capacity buffering and inventory turnover in the manufacturing firms in Rivers State, Nigeria.

From the analysis, the result showed the correlation coefficient of r = 0.767 which shows the direction and strength of this relationship. The coefficient represents a high positive correlation between capacity buffering and inventory turnover in the manufacturing firms in Rivers State, Nigeria. The test of significance shows that this relationship is significant at p = .001 < 0.01which makes possible to the generalization of our findings to the study population. Therefore, based on observed findings, the null hypothesis earlier stated is hereby rejected and the alternate upheld. Thus, there is a significant relationship between capacity buffering and inventory turnover in the manufacturing firms in Rivers State, Nigeria.

Discussion of Findings

The first and second hypotheses sought to examine the relationship between capacity buffering and demand uncertainty in manufacturing firms in Rivers State, Nigeria. Hence it was hypothesized that there is no significant relationship between capacity buffering and demand uncertainty of manufacturing firms in Rivers State. These hypotheses (**Ho1** and **Ho2)** were tested using the Spearman Rank Order Correlation Coefficient partial order Correlation Coefficient. The study findings reveal that capacity buffering has a strong positive relationship with demand forecasting accuracy and inventory turnover in the manufacturing firms in Rivers State, Nigeria.

The finding agrees with previous finding by Volling and Spengler (2011) who examined how capacity flexibility and buffering strategies influence forecast accuracy and production reliability in manufacturing firms in Germany. The study revealed capacity buffering significantly improved production responsiveness and reduced forecast error effects on operations. Integrating capacity buffering with forecasting systems increases the reliability of production schedules and output stability. Also, the study agrees with Waller, Fawcett and Johnson (2010) who examined the role of operational flexibility, including capacity buffering, in enhancing demand forecasting processes in the consumer goods and food manufacturing companies in the United States. The study revealed firms with higher capacity flexibility reported improved forecast accuracy due to better alignment of production with demand signals. The study also agrees with Gunessee and Subramanian (2015) who examined how operational capabilities such as capacity buffering influence forecast accuracy under supply chain disruptions in Sri Lankan textile and apparel industries in India. The study revealed capacity buffering (through overtime and temporary labor) enabled firms to maintain higher forecast fulfillment rates even with volatile demand. Forecast accuracy is improved when capacity buffers are used to absorb variability, especially in disruption-prone industries.

The findings also agree with Waller, Fawcett and Johnson (2010) who examined the role of operational flexibility, including capacity buffering, in enhancing demand forecasting processes in the consumer goods and food manufacturing companies in the United States. The study revealed firms with higher capacity flexibility reported improved forecast accuracy due to better alignment of production with demand signals. Capacity buffering acts as a supportive mechanism for effective demand forecasting absorbing deviations from forecasted volumes. The study also agrees with Sun, Wang and Li (2016) who examined how different capacity strategies impact forecast accuracy in high-tech production environments in semiconductor manufacturing firms in China. The study revealed capacity buffering via idle machine capacity and on-call labor improved short-term forecast adherence and minimized production variance. In high-tech sectors with fluctuating demand, capacity buffering enhances short-term forecast accuracy and stabilizes planning. It also agrees with Nwokoro & Chukwuemeka (2021) who examined the role of capacity buffering in improving demand forecasting accuracy among manufacturing SMEs in Rivers State, Nigeria. The study revealed positive and significant relationship between use of flexible capacity buffers (extra shifts, subcontracting) and accurate demand forecasts. Capacity buffering enhances SMEs' ability to manage demand forecasts, thereby improving decision-making and operational efficiency.

The study also agrees Gaur, Fisher and Raman (2005) who examined the drivers of inventory turnover and the role of capacity strategies in retail supply chains in retail industries in the United States. The study revealed capacity buffering through flexible labor and distribution capabilities significantly improved inventory turnover by aligning supply with real-time demand. Firms with strong capacity buffering strategies had higher inventory turnover, reduced stockouts, and lower holding costs. It also agrees with Koumanakos (2008) examined how inventory management and buffering practices affect firm performance, focusing on inventory turnover in manufacturing firms in Greece. The study revealed firms with moderate capacity buffers (flexible shifts and machine redundancy) achieved better inventory turnover and responsiveness to demand variability. It also agrees with Hendricks, Singhal and Stratman (2007) who examined operational flexibility, including capacity buffering, as a strategy to improve inventory performance after supply chain disruptions in manufacturing firms North American. The study revealed companies with built-in capacity buffers (such as excess capacity and temporary labor contracts) recovered faster and achieved stable inventory turnover. The study agrees with Christopher and Peck (2004) who examined how resilience strategies such as capacity buffering influence inventory turnover and risk management in global supply chains in UK. The study revealed firms with flexible production capacity reduced reliance on inventory buffers, improved inventory turnover, and maintained service levels under demand uncertainty.

It also agrees with Obasi and Okeke (2022) who examined the impact of capacity buffering strategies on inventory turnover in Nigerian manufacturing firms in Fast-moving consumer goods (FMCG) sector in Lagos and Rivers States, Nigeria. The study revealed firms that adopted subcontracting and machine redundancy as capacity buffers experienced higher inventory turnover and fewer stockpile situations. Also, it agrees with Sun, Wang and Li (2016) who examined how different capacity strategies impact forecast accuracy in high-tech production environments in semiconductor manufacturing firms in China. The study revealed capacity buffering via idle machine capacity and on-call labor improved short-term forecast adherence and minimized production variance. Furthermore, Nwokoro and Chukwuemeka (2021) who examined the role of capacity buffering in improving demand forecasting accuracy among manufacturing SMEs in Rivers State, Nigeria. The study revealed positive and significant relationship between use of flexible capacity buffers (extra shifts, subcontracting) and accurate demand forecasts.

The study agrees with Hendricks, Singhal and Stratman (2007) who examined operational flexibility, including capacity buffering, as a strategy to improve inventory performance after supply chain disruptions in manufacturing firms North American. The study revealed companies with built-in capacity buffers (such as excess capacity and temporary labor contracts) recovered faster and achieved stable inventory turnover. It also agrees with Christopher and Peck (2004) who examined how resilience strategies such as capacity buffering influence inventory turnover and risk management in global supply chains in UK. The study revealed firms with flexible production capacity reduced reliance on inventory buffers, improved inventory turnover, and maintained service levels under demand uncertainty. Furthermore, the study agrees with Obasi and Okeke (2022) who examined the impact of capacity buffering strategies on inventory turnover in Nigerian manufacturing firms in Fast-moving consumer goods (FMCG) sector in Lagos and Rivers States, Nigeria. The study revealed firms that adopted subcontracting and machine redundancy as capacity buffers experienced higher inventory turnover and fewer stockpile situations.

Conclusions and Recommendation

The basis of the findings of this study concludes that capacity buffering has a significant relationship demand forecasting accuracy and inventory turnover in the manufacturing firms in Rivers State, Nigeria. From the findings, we make the following recommendations:

1. Manufacturing firms should integrate capacity buffering strategies such as overtime shifts, flexible labor and machine redundancy into their demand forecasting models. This alignment enables firms to better accommodate fluctuations in customer demand, thereby improving the accuracy and reliability of forecasting results.
2. Firms should strategically invest in capacity buffers (e.g., subcontracting options, modular equipment, on-call labor) instead of maintaining excess inventory. This reduces holding costs and increases inventory turnover by allowing production to align closely with actual demand rather than speculative forecasts.

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