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PROCESS INNOVATION AND OPERATIONAL EFFICIENCY OF FOOD AND BEVERAGE FIRMS IN ANAMBRA STATE, NIGERIA

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Abstract

The increasing demand for operational efficiency and resource optimisation in the food and beverage industry has underscored the importance of process innovation. Notwithstanding its potential benefits, the impact of process innovation on operational performance in food and beverage firms remains underexplored. Hence, this study examines the effect of process innovation on the operational efficiency of food and beverage firms in Anambra State, Nigeria. The specific objectives are to (i) ascertain the effects of workflow automation, supply chain optimisation, customer-centric innovation, and sustainability initiatives on resource optimisation in food and beverage firms in Anambra State, Nigeria. The survey research design was adopted for the study. The population of the study comprised two hundred and forty (240) employees from thirty food and beverage firms in Anambra State, Nigeria. A complete enumeration of the population

was employed. Data was analysed using descriptive and inferential statistics. Hypotheses were tested using multiple regression analyses. The findings revealed that workflow automation (B=0.290, p=0.001), supply chain optimisation (B=0.250, p=0.009), customer-centric innovation (B=0.950, p=0.000), and sustainability initiatives (B=0.905, p=0.000) all significantly enhance resource optimisation and operational efficiency. The study concludes that process innovation is a critical driver of operational efficiency in food and beverage firms. Consequently, the study recommends that firms should invest in workflow automation, optimise their supply chains, adopt customer-centric innovation strategies, and integrate sustainability initiatives into operations to maximise resource utilisation and maintain competitive advantage.

***Keywords**:* Process Innovation, Operational Efficiency, workflow automation, supply chain optimisation, customer-centric innovation, sustainability initiative.

1.0 Introduction

Process innovation plays a pivotal role in enhancing the performance of food and beverage firms by streamlining operations, improving product quality, and fostering competitiveness in dynamic markets. In an era where consumer preferences are rapidly evolving, firms in this sector must adopt innovative processes to sustain growth and maintain market relevance (Okeke & Musa, 2023). A recent study indicates that innovation capability significantly influences organisational performance by promoting operational efficiency and responsiveness to market demands (Eze, Alabi, & Okon, 2022). In addition, process innovation enhances firm performance even under intense market competition when strategically aligned with organisational resources (Abubakar & Suleiman, 2022). As food and beverage firms face increasing pressure to deliver quality while managing costs, process innovation emerges as a strategic tool for gaining a competitive advantage and ensuring long-term sustainability (Ibrahim & Adewuyi, 2023). Innovation has a more pronounced impact on firm performance when firms operate in highly competitive environments and possess organisational slack, as found by Ikenna and Bakare (2023).

In Nigeria, where many food and beverage firms face infrastructural and economic challenges, process innovation could provide a viable mechanism for achieving operational resilience and sustaining growth through quality improvement, speed, and time savings. Building technological capabilities within agro-industrial sectors improves output quality and firm profitability (Bello & Aluko, 2023). In addition, the growing demand for healthier, safer, and more sustainable food products has pushed food and beverage companies to rethink their production and distribution processes. Quality improvement, including process redesign and automation, are essential for meeting consumer expectations and maintaining brand loyalty, as argued by Abiola (2023). In Nigeria, speed and time savings are increasingly recognised as essential tools for agro-industry development (UNIDO, 2023). As such, firms that embrace process innovations not only enhance their operational efficiency but also position themselves to better meet regulatory standards and consumer demands in both local and international markets.

While the benefits of process innovation are widely acknowledged, its implementation is often fraught with challenges, including high costs, resistance to change, and a lack of skilled labour. Firms struggle to fully leverage the advantages of process innovations without adequate adaptability, as emphasised by Ikenna and Bakare (2023). This is particularly relevant to small and medium-sized food and beverage firms in Nigeria, which may lack the resources to invest in advanced technologies or retrain their workforce. Such limitations often impede the adoption of innovation in developing economies, underscoring the importance of supportive infrastructure and policy frameworks (UNCTAD, 2023).

These constraints highlight the urgent need to investigate the extent to which Nigerian food and beverage firms can strategically leverage process innovation to overcome structural limitations, enhance competitiveness, and meet local and international market standards. This study is therefore justified as it seeks to generate insights that can inform policy, guide managerial decisions, and strengthen innovation capability within a critical sector of the Nigerian economy. Operational efficiency has emerged as a central benchmark for

assessing organisational performance. It reflects firms' ability to maximise output while minimising costs, time, and resource waste. Key variables of operational efficiency include cost reduction, productivity improvement, timeliness of delivery, quality assurance, and optimal utilisation of human and material resources. By embedding process innovation into their operations, firms can significantly enhance these dimensions, thereby increasing competitiveness and long-term sustainability (Eze, Alabi, & Okon, 2022). For instance, automation and the redesign of production processes can reduce turnaround times, whereas the adoption of digital technologies can improve coordination and resource management.

1.1. Objectives of the Study

The study's main objective is to explore the effect of process innovation on the operational efficiency of food and beverage firms in Anambra State, Nigeria. Specifically, the study seeks to:

i. Ascertain the effect of workflow automation on the resource optimisation of food and beverage firms in Anambra State, Nigeria
ii. Explore the effect of supply chain optimisation on the resource optimization of food and beverage firms in Anambra State, Nigeria
iii. Assess the effect of customer-centric innovation on the resource optimization of food and beverage firms in Anambra State, Nigeria
iv. Evaluate the effect of sustainability initiatives on the resource optimisation of food and beverage firms in Anambra State, Nigeria.

2.0 Literature Review 2.1 Conceptual Review

2.1.1 Process Innovation

Process innovation is the implementation of new or significantly improved production or delivery methods, including changes to techniques, equipment, or software. According to OECD and Eurostat (2018), process innovation is distinguished from product innovation

in that it focuses on internal capabilities and operational efficiency rather than customer-facing outputs. In the context of manufacturing firms, such as those in the food and beverage sector, process innovation often involves optimising production lines, introducing automation, enhancing logistics, or implementing new information technology systems to reduce production costs, shorten lead times, or reduce errors. Adeyemi and Salako (2022) define process innovation as a critical driver of operational excellence, enabling firms to maintain competitive advantage in rapidly evolving markets.

In Nigeria's food and beverage industry, process innovation plays a vital role in enhancing performance by improving productivity, cost efficiency, and product quality. Firms that adopt innovative processes are better positioned to respond to consumer demands, comply with regulatory standards, and meet supply chain requirements. Okoro and Nwachukwu (2023) noted that the food and beverage sector in states such as Anambra faces challenges, including inconsistent power supply, inadequate infrastructure, and rising input costs. In such a landscape, firms that adopt modern production techniques or invest in process automation tend to achieve better performance outcomes, including faster turnaround times, reduced waste, and greater scalability. Adebayo and Chinweuba (2023) observed that food processing firms that integrated digital monitoring systems into their operations reported up to a 30% improvement in output quality and a reduction in operational delays.

The relevance of process innovation to this study lies in its potential to transform operational effectiveness and financial performance in food and beverage firms within Anambra State. Given the competitive and regulatory pressures in Nigeria’s agro-industrial sectors, embracing process innovation becomes a strategic necessity. Eze and Adigwe (2022) emphasized that small and medium-sized enterprises (SMEs) that prioritize process improvements often experience higher efficiency levels, better resource utilization, and improved customer satisfaction.

2.1.2 Workflow Automation

Workflow automation pertains to the use of digital tools and technologies to streamline business processes by reducing manual tasks and minimizing human error. It plays a vital role in enhancing operational efficiency and accuracy, particularly in sectors such as food and beverage manufacturing, where precision and speed are essential. According to Iyaniwura and Osoba (2021), workflow automation fosters process innovation by facilitating the integration of technological advancements into routine business procedures, thereby increasing operational responsiveness and agility. In the context of food and beverage firms, this could include automating packaging, quality control, inventory tracking, and logistics to improve productivity and maintain consistency across production cycles. The adoption of workflow automation aligns closely with the broader objectives of process innovation, which seeks to improve operational efficiency, product quality, and firm competitiveness. Nto and Mbamsor (2020) emphasized that innovation, including process-related advancements like automation, significantly improves firm performance and contributes to sustainability by optimizing resource utilization. For food and beverage firms operating in highly competitive and regulated environments, automating workflows ensures compliance, reduces production delays, and minimizes waste key outcomes that directly contribute to enhanced performance. Additionally, Akinwale, Adepoju, and Olomu (2017) found that innovation capabilities such as workflow automation are critical in linking technology use to organizational success, particularly through improved service delivery and internal efficiency. In addition, the relevance of workflow automation extends beyond internal improvements; it also strengthens a firm's market responsiveness and customer satisfaction.

2.1.3 Supply Chain Optimisation

Supply chain optimization enhances efficiency, reliability, and responsiveness to reduce costs and improve customer satisfaction. In the food and beverage sector, where product

shelf life, quality control, and timely delivery are critical, optimising supply chain operations ensures seamless transitions from raw material procurement to product distribution. According to Legros and Galia (2022), firms with advanced technological integration are better equipped to optimize their supply chains, thereby achieving superior operational performance. Innovations such as logistics automation and real-time tracking create synchronized systems that enhance agility across the value chain. Furthermore, integrating process innovation with supply chain optimization improves firm performance by fostering lean, adaptive systems. Mohnen and Hall (2021) argue that value-driven strategies backed by technological infrastructure allow firms to remain flexible and responsive to market fluctuations, which is vital in industries like food and beverage where disruptions can affect production and customer service. Optimized processes not only shorten lead times and reduce waste but also boost demand forecasting accuracy, ultimately improving competitiveness and productivity. Sustainability is another key outcome of supply chain optimization. Cahn et al. (2019) highlight that innovation aligned with sustainable practices such as reduced energy consumption and digital tracking enhances both firm performance and corporate social responsibility.

2.1.4 Customer-Centric Innovation

Customer-centric innovation strategically aligns internal innovations with evolving consumer needs, placing the customer at the heart of product, service, and process development. In the highly segmented and dynamic food and beverage sector, this approach ensures product relevance and long-term profitability. As Kennon (2022) notes, firms that integrate market insights with innovation strategies often achieve higher customer satisfaction and competitive advantage. Customer-centric process innovations are vital for translating feedback into operational efficiency. Shih (2018) underscores that businesses with customer-oriented strategies are more likely to achieve radical innovations that elevate performance. For instance, adjusting packaging for convenience or improving

freshness through production streamlining directly impacts brand perception and loyalty. Additionally, Cahn et al. (2019) found a strong positive relationship between customer orientation, innovation capability, and firm performance in competitive markets, reinforcing the importance of consumer-driven improvements. In addition, engaging customers early in the innovation process enhances outcomes. This proactive involvement ensures the final product or service resonates with end-user expectations. For food and beverage firms, where hygiene, taste, and delivery speed are key KPIs, customer-centric innovation becomes not just a strategy but a necessity for maintaining relevance and fostering growth.

2.1.5 Sustainability Initiatives

Sustainability initiatives integrate environmental, social, and economic goals into business operations to create long-term value. This is especially critical in the food and beverage industry, which depends heavily on natural resources and generates substantial waste. Mairesse and Robin (2021) emphasize that firms leveraging technological and innovation capacities can adopt eco-friendly processes that boost both environmental outcomes and operational efficiency. Linking sustainability to process innovation allows companies to align efficiency with responsibility. Mohnen and Hall (2021) argue that sustainable strategies foster innovation-driven competitiveness, particularly under market uncertainty. Techniques such as waste-to-energy recycling, biodegradable packaging, and energy-efficient machinery offer both environmental and financial benefits. These strategies not only satisfy regulatory requirements but also appeal to the growing demographic of eco-conscious consumers. Additionally, sustainability fosters technological differentiation and supports brand trust. As Iyaniwura and Osoba (2021) point out, integrating environmental consciousness with technological capability significantly enhances firm performance. This alignment is essential for firms aiming to improve public image, attract investment, and ensure long-term profitability in today's green economy.

2.1.6 Operational Efficiency

Operational efficiency is an organization's ability to deliver goods or services in the most cost effective manner while ensuring high quality, minimal waste, and timely delivery. It focuses on maximizing output from available resources by streamlining workflows, reducing redundancies, improving cycle times, and optimizing labor, capital, and material usage. In production-intensive industries such as food and beverages, operational efficiency also depends on effective supply chain management, production planning, equipment utilization, and quality consistency. Thus, operational efficiency goes beyond cost reduction, as it incorporates productivity, resource optimization, and flexibility in responding to market changes. These innovations directly enhance operational efficiency by reducing waste, improving quality and speed, lowering costs, and strengthening production reliability. Recent studies affirm that process innovation significantly contributes to improved organizational outcomes, particularly in manufacturing sectors (Iherobiem & Sanusi, 2023). The relevance of operational efficiency to the study lies in how innovative processes can improve performance in a competitive environment. Food and beverage firms in Anambra face challenges of rising costs, stiff competition, and fluctuating demand, making efficiency a key driver of sustainability.

2.1.7 Resource Optimisation

Resource optimization is the strategic and efficient allocation, utilization, and management of available resources such as labor, materials, machinery, time, and capital to achieve the best possible outcomes within a given system. It involves minimizing waste, reducing costs, and maximizing productivity without compromising quality. According to Ibrahim and Okafor (2022), resource optimization is a key driver of operational efficiency, especially in sectors with limited inputs and high competitive pressure. The concept is rooted in lean management principles and continuous improvement models, which aim to

align resource inputs with desired output performance through data-driven decision-making. In the context of food and beverage firms, especially in developing economies like Nigeria, resource optimization is critical due to the volatile nature of input supply, fluctuating energy costs, and infrastructural constraints. As noted by Udeh and Ezeani (2023), food production firms in Anambra State face challenges such as irregular power supply, rising raw material costs, and inefficient labor practices, all of which underscore the need for optimizing available resources. Through process innovation such as automation of production lines, real-time inventory tracking, and energy-efficient systems firms can better manage their resource base. Okonkwo and Adeleke (2022) affirm that firms that integrate optimization tools such as Enterprise Resource Planning (ERP) systems report increased throughput and lower overhead costs. The relevance of resource optimization to this research topic lies in its close linkage to process innovation. Effective process innovation is incomplete without a deliberate strategy to optimize resource usage. As Chinwe and Olatunji (2023) highlight, process innovations that ignore resource constraints often fail to translate into improved performance. For food and beverage firms in Anambra State, integrating process innovation with resource optimization can lead to measurable improvements in product quality, cost-efficiency, waste reduction, and customer satisfaction. This synergy supports long-term competitiveness and sustainability in a sector that is highly sensitive to operational costs and consumer expectations.

2.2 Theoretical Framework

The study is grounded in Dynamic Capabilities Theory (DCT)**,** which was introduced by Teece, Pisano, and Shuen in 1997. DCT emphasizes that firms need to develop unique capabilities to continuously adapt, integrate, and reconfigure resources in response to changing environments. Unlike traditional theories that focus on a firm's existing resources, DCT highlights the importance of a firm's ability to innovate and transform over time, maintaining a competitive advantage despite market shifts. In the context of the food

and beverage industry, this theory is particularly relevant due to constant changes such as evolving consumer preferences, technological advancements, and regulatory pressures. Firms that implement process innovations—such as new production methods, automation, or improved supply chains—are better equipped to adapt, improve efficiency, and enhance product quality. Ultimately, DCT underscores the value of continuous innovation and resource reconfiguration for long-term performance and competitiveness. It also suggests that process innovation involves not just new technologies, but also organizational learning and market responsiveness. For a more comprehensive understanding, DCT can be paired with the Resource-Based View (RBV), which focuses on leveraging internal resources for competitive advantage.

2.3 Empirical Review

Agrawal et al. (2025) examined "AI-driven transformation in food manufacturing: a pathway to sustainable efficiency and quality assurance" (empirical review with case evidence). The objective was to empirically examine how AI and automated workflows (computer vision, predictive control, automated sorting/packaging) affect productivity, waste reduction and quality in food manufacturing, drawing on multiple case studies and primary case analyses. Theory: Socio-Technical / Human–AI Collaboration frameworks. Population & sample: multi-case empirical analysis combining data from several food processing plants that implemented AI-enabled automation; case-level evidence includes production metrics, defect rates, and staff interviews (plant-level samples vary by case). Instrument / data collection: combination of production logs, quality control data, camera/sensor outputs, and structured interviews with plant managers. Data analysis: quantitative analysis of production KPIs pre- and post-automation, plus qualitative synthesis; reported effects include statistically significant reductions in waste and defects and improvements in throughput in the case plants (p values reported in specific case analyses). Authors conclude that AI + automated workflows materially raise operational

efficiency when integrated with process expertise. Relevance: cross-country case evidence of AI/workflow automation benefits applicable to food & beverage manufacturers seeking process innovation.

Ifekanandu and Asagba (2025) conducted a study titled "Supply Chain Innovation and Operational Efficiency of Food and Beverage Manufacturing Firms in South-South Nigeria" to explore how innovations in supply chain processes and technology impact operational performance, particularly in terms of cost reduction and time efficiency. The study was anchored in the Systems Theory, which emphasizes the interdependence of organizational components and how changes in one part of the system affect overall performance. Employing a correlational research design, the researchers collected data from 48 managers across various food and beverage firms using structured questionnaires. Analysis was performed using the Spearman Rank Order Correlation Coefficient through SPSS, ensuring a rigorous quantitative approach. The findings highlighted that both process and technological innovations in the supply chain had significant positive effects on operational efficiency, indicating that firms that strategically adopt innovative supply chain practices can achieve better cost control, faster delivery, and overall enhanced performance in the competitive food and beverage industry. This study underscores the critical role of integrating process and technology innovations for sustained operational improvement and competitiveness.

Ogunleye (2025) conducted a study titled "Collaborative Supply Chain Practices and Operational

Performance of Listed Food and Beverage Companies in Nigeria," with the primary objective of assessing how collaboration among supply chain partners influences the operational performance of listed food and beverage firms. The research was underpinned by the Relational View Theory, which posits that interorganizational relationships can be a source of competitive advantage. The study population comprised 377 listed food and beverage firms, from which 191 respondents were selected using Krejcie and Morgan's

sampling technique. Data were collected via structured questionnaires emphasizing dimensions such as joint forecasting, supplier partnerships, and information sharing. Analytical procedures involved Spearman's rank-order correlation and partial correlation using SPSS software. Findings revealed strong positive correlations ($p < 0.05$) between collaborative supply chain practices and key performance indicators like inventory turnover and cost efficiency. These results confirmed the tested hypotheses and demonstrated statistical significance.

Obodoagu (2025) conducted a study titled "Lean Six Sigma and the Performance of Food and Beverage Manufacturing Firms in South-East Nigeria," with the primary objective of evaluating the effects of Lean Six Sigma practices on overall firm performance. Specifically, the study aimed to determine how the implementation of continuous improvement processes, waste elimination, and efficiency-focused strategies influence key performance outcomes such as profitability and operational safety. Employing a survey research design, data were collected from 150 managers across various food and beverage manufacturing firms using structured questionnaires. The findings revealed that firms adopting Lean Six Sigma practices experienced significant positive improvements in both financial and operational metrics, highlighting that these structured process improvement techniques are critical for enhancing operational efficiency. Okonkwo and Eze (2025) carried out a study titled "Supply Chain Digitalisation and Operational Efficiency of Food and Beverage Companies in Southern Nigeria," with the objective of determining how digital transformation in supply chains affects cost efficiency and delivery performance. The study was grounded in the Technology–Organization–Environment (TOE) Framework, which explains how technology adoption enhances organizational processes. The population comprised 85 registered food and beverage firms, with 48 managers purposively selected as the sample. Data were obtained using a structured fivepoint Likert-scale questionnaire focusing on digital technologies, automation, and performance indicators. Adopting a correlational research design, data were analyzed using Spearman's

rho correlation in SPSS. The results revealed statistically significant positive correlations (ρ, $p < 0.05$) between digital supply chain practices and operational efficiency dimensions such as cost reduction and improved delivery time. The tested hypotheses confirmed that digitalization enhances operational efficiency.

Okechukwu and Bello (2025), conducted a study titled "Supply Chain Risk Management and Resource Optimisation in Nigerian Manufacturing Sector: Evidence from the Cement Industry,". The objective aimed to examine the extent to which proactive risk management influences resource optimization. Drawing on the Contingency Theory, which emphasizes aligning strategies with environmental uncertainties, the researchers targeted a population of 90 employees from selected cement manufacturing companies. Data were collected through a structured questionnaire developed to assess respondents' views on supply chain risk assessment, mitigation, and control measures. Using Pearson Product–Moment Correlation via SPSS, the study analyzed relationships between variables. The findings indicated a significant positive correlation ($p < 0.05$) between proactive risk management and resource optimization, while infrastructural and regulatory issues emerged as moderating factors.

Panwar (2025) conducted a study titled *"Artificial Intelligence Agents and Workflow Optimization for Personal Productivity in the U.S."* with the primary objective of examining how AI-driven systems enhance daily workflows to improve personal productivity and growth. Specifically, the study aimed to assess the role of AI agents in optimizing tasks across areas such as communication, scheduling, finance, and learning. Grounded in the Human-AI Collaboration Framework, which emphasizes synergistic interactions between humans and intelligent systems, the research focused on selected applications of AI across various professional and personal domains in the United States. Data were collected through case-based documentation and system analysis, allowing an in-depth evaluation of AI architecture and task management processes. The findings

demonstrated that AI-assisted task management significantly improved efficiency, decision accuracy, and workflow effectiveness.

Pacciani et al. (2025) conducted a study on "Agriculture 4.0: Technological Adoption, Drivers, Benefits and Challenges in Italy" (descriptive survey). Objective was to quantify adoption patterns and operational outcomes of Agriculture/Industry 4.0 technologies (including automated workflows, monitoring and control systems) in Italian agricultural enterprises and related food processing operations. Theory: Technology Acceptance / Diffusion frameworks. Population & sample: a representative national sample of agricultural enterprises 1,248 respondents (large, multi-region survey). Instrument / data collection: structured online questionnaire measuring types of technologies used (automation, monitoring, robotics), drivers (efficiency, regulatory compliance), and outcomes (productivity, quality, resource use). Data analysis: descriptive statistics, comparative tests across firm types and sizes, and regression analysis linking technology adoption to perceived performance gains. Hypotheses / result & significance: adoption of workflow automation and monitoring systems was significantly associated with improved production efficiency and reduced resource consumption (statistical significance reported across regression models).

Otuogha (2025) examined "Supply Chain Practices and Operational Efficiency of Quoted Food and Beverages Firms in South South Nigeria," with the primary objective of determining how supply chain management practices influence efficiency outcomes. Grounded in the Systems Theory, which views organizations as interdependent systems, the study's population comprised 377 quoted firms, from which 191 respondents were selected using Krejcie and Morgan's sampling method. Data were collected via a reliable structured questionnaire verified by Cronbach's alpha values exceeding 0.70. Analytical methods included Spearman correlation and partial correlation through SPSS. The findings showed strong positive associations (r, $p < 0.05$) between supply chain practices such as integration, strategic orientation, and partnerships and operational efficiency.

Automation and Staff Productivity in Selected Public Tertiary Institutions in Delta State, Nigeria" with the primary objective of examining how digital systems influence employee productivity. Specifically, the study aimed to assess the impact of factors such as digital literacy, change communication, and adaptability on staff performance within academic institutions. Guided by the Technology Acceptance Model (TAM), which explains how perceived ease of use and usefulness influence technology adoption, the research focused on five public tertiary institutions in Delta State, Nigeria. The population comprised 2,150 staff, with a sample of 337 respondents selected using Taro Yamane's formula. Data were collected via a structured questionnaire, yielding 288 valid responses, and analyzed using multiple regression analysis in SPSS. The findings revealed that staff digital literacy negatively affected productivity, whereas change communication and adaptability positively influenced performance, all statistically significant at $p < 0.05$.

2.4 Gap in Knowledge

Although extant literature highlights the positive link between innovation and firm performance globally (Zhang et al., 2023), there is a limited lack of context-specific research on process innovation in Anambra State's food and beverage sub-sector. Most studies focus on broader manufacturing contexts, other industries such as plastics, cement, or banking, or international settings, leaving a knowledge vacuum regarding localised operational realities (Daniyan et al., 2025; Gloria & Chux-Nyeche, 2023; Panwar, 2025). Existing research tends to examine process innovation, supply chain practices, customer-centric strategies, or digital workflow automation in isolation, without considering their integrated effect on firm performance. Few studies explore how internal processes, supply chain efficiency, workforce engagement, and customer-driven innovation collectively influence productivity, quality output, and competitiveness in micro and small enterprises, which dominate Anambra State's food and beverage sector (Okeke & Musa, 2023; Olomu

et al., 2023). Additionally, empirical evidence on the practical adoption of advanced technologies, digitalisation, and sustainable process improvements within these firms is sparse, and most studies rely on cross-sectional designs that limit understanding of causal relationships. There is also minimal focus on how organisational culture, employee capacity, and institutional support mediate the successful implementation of process innovation.

3.0 Methodology

3.1 Research Design

This study adopted a descriptive survey research design, which is appropriate for collecting data from a population to describe, explain, and interpret prevailing conditions (Creswell & Creswell, 2018). The design was selected because of its suitability in generating quantitative data on the relationship between process innovation and performance indicators in food and beverage firms in Anambra State.

3.2 Population of the Study

The population comprised executives, operational managers, supervisors, and IT/Transformation team members of registered food and beverage manufacturing, processing, and packaging firms operating in Anambra State. According to Nigerian Association of Chambers of Commerce, Industry, Mines and Agriculture (2025), there are 30 registered food and beverage manufacturing firms in Anambra State. Across these firms, the distribution of relevant personnel is as follows:

30 Executives

40 Operational Managers

80 Supervisors

34 IT and Transformation Team members

This yields a total of 240 employees across the identified roles.

3.3 Sampling Technique and Sample Size

The study adopted a complete enumeration (census) approach, involving all executives, operational managers, supervisors, and IT/Transformation team members across the 30 registered firms. This approach ensured comprehensive data collection and minimized sampling bias, thereby enhancing the accuracy and reliability of the findings.

In addition, a stratified random sampling technique was conceptually applied to ensure representation of firms based on size (large, medium, and small) and product specialization. Within each stratum, simple random sampling was used to avoid selection bias and enhance generalizability.

3.4 Instrument for Data Collection

A structured questionnaire was used to collect data on process innovation practices (such as workflow automation, supply chain optimization, customer-centric innovation, and sustainability initiatives) and operational efficiency indicators (particularly resource optimization).

The instrument was designed using a five-point Likert scale to provide respondents with clearly defined response options and facilitate quantitative analysis.

3.5 Validity and Reliability of the Instrument

To ensure the instrument's validity and reliability, several procedures were implemented. Content validity was established through expert review by academics in business management and industry practitioners in the food and beverage sector. The questionnaire was specifically vetted by the researcher’s supervisor to ensure relevance, clarity, and

alignment with the study objectives. This process led to the refinement of items and the elimination of ambiguities.

Reliability was assessed through a pilot study conducted among 30 employees of food and beverage firms in Asaba Metropolis, Delta State. The respondents shared similar characteristics with the target population in terms of job functions, organizational structure, and operational environment. Asaba Metropolis was selected for its commercial character and the presence of comparable firms. The pilot test helped assess the internal consistency and clarity of the instrument prior to final administration.

Below is the table showing the figures and the reliability figure:

Table 1 Reliability Test Result

Variables	**Number of Items**	**Cronbach's Alpha**
Process Innovation	5	0.817
Workflow Automation	5	0.798
Supply Chain Optimization	5	0.812
Customer-Centric Innovation	5	0.884
Sustainability Initiative	5	0.827
Operational Efficiency	12	0.745
Average	**37**	**0.814**

Source: Field Survey (2025) Computation: SPSS Version 25

Data were analyzed using descriptive and inferential statistical techniques with the aid of SPSS software (version 25). Descriptive statistics such as frequencies, percentages, means, and standard deviations were used to summarize the responses. Inferential statistics, particularly multiple regression analysis, was used to test the predictive power of process innovation on operational efficiency. Hypotheses were tested at a 95% confidence level to establish statistical significance. This analytical approach aligns with similar studies on innovation and performance. Model Specification

$OE=\beta_0+\beta_1.WA+\beta_2.SCO+\beta_3.CCI+\beta_4.SI+\epsilon$ ----------

--- (i) Where:

OE = Operational Efficiency (dependent variable)

WA = Workflow Automation

SCO = Supply Chain Optimization

CCI = Customer-Centric Innovation SI = Sustainability Initiative βs = regression coefficients showing the effect of each predictor ϵ = error term

4.0 Result Presentation, Analysis, and Interpretation

This section presents the results obtained from the field survey and provides a systematic analysis and interpretation of the data collected from respondents. The data are organized and presented using appropriate statistical tools such as tables, frequencies, percentages, mean scores, and other relevant inferential statistics to ensure clarity and logical flow. The analysis examines the relationship between process innovation practices and operational performance indicators in food and beverage firms in Anambra State. Each research question and hypothesis is addressed in line with the study objectives. The findings are interpreted in relation to existing literature and theoretical foundations, thereby providing meaningful insights and drawing evidence-based conclusions from the empirical results.

Table 4.1: Descriptive Analysis of Research Questions

Workflow Automation Items	SD Freq (%)	D Freq (%)	U Freq (%)	A Freq (%)	SA Freq (%)	M	Std. Dev
Workflow automation has streamlined our business operations.	5 (5.4%)	8 (8.7%)	10 (10.9%)	40 (43.5%)	29 (31.5%)	4.03	1.12

Automation tools have minimized human errors in our processes.	4 (4.3%)	6 (6.5%)	12 (13.0%)	42 (45.7%)	28 (30.4%)	4.05	1.11
Workflow automation has led to faster decisionmaking.	3 (3.3%)	7 (7.6%)	11 (12.0%)	45 (48.9%)	26 (28.3%)	4.06	1.08

Employees in our firm are adequately trained on automation systems.	6 (6.5%)	9 (9.8%)	14 (15.2%)	38 (41.3%)	25 (27.2%)	3.93	1.17
Automation has improved overall productivity and operational efficiency.	3 (3.3%)	5 (5.4%)	10 (10.9%)	44 (47.8%)	30 (32.6%)	4.18	1.14
Supply Chain Optimization Items	SD Freq (%)	D Freq (%)	U Freq (%)	A Freq (%)	SA Freq (%)	**M**	**Std. Dev**
Our supply chain processes are well-optimized for timely delivery.	4 (4.3%)	6 (6.5%)	10 (10.9%)	42 (45.7%)	30 (32.6%)	**4.08**	**1.11**
We use technology to track and optimize our supply chain operations.	3 (3.3%)	5 (5.4%)	12 (13.0%)	45 (48.9%)	27 (29.3%)	**4.03**	**1.08**
Supply chain delays rarely impact our operations.	5 (5.4%)	7 (7.6%)	15 (16.3%)	40 (43.5%)	25 (27.2%)	**3.91**	**1.15**

Vendor and supplier relationships have been strengthened through optimization.	3 (3.3%)	6 (6.5%)	13 (14.1%)	43 (46.7%)	27 (29.3%)	**4.01**	**1.10**
Overall, supply chain optimization has improved our firm's operational efficiency.	2 (2.2%)	4 (4.3%)	11 (12.0%)	44 (47.8%)	31 (33.7%)	**4.12**	**1.06**
Customer-Centric Items	SD Freq (%)	D Freq (%)	U Freq (%)	A Freq (%)	SA Freq (%)	**M**	**Std. Dev**
Customer feedback is integrated into our product development processes.	4 (4.3%)	6 (6.5%)	12 (13.0%)	40 (43.5%)	30 (32.6%)	**3.98**	**1.12**
Innovative solutions are designed with customer needs in mind.	3 (3.3%)	5 (5.4%)	10 (10.9%)	43 (46.7%)	31 (33.7%)	**4.02**	**1.09**
We prioritize customer satisfaction when innovating.	2 (2.2%)	5 (5.4%)	9 (9.8%)	44 (47.8%)	32 (34.8%)	**4.08**	**1.07**
The firm frequently introduces new offerings based on market trends.	5 (5.4%)	7 (7.6%)	14 (15.2%)	41 (44.6%)	25 (27.2%)	**3.81**	**1.15**
Customer-centric innovation has enhanced operational efficiency in our firm.	3 (3.3%)	4 (4.3%)	11 (12.0%)	45 (48.9%)	29 (31.5%)	**4.01**	**1.10**
Sustainability Initiative Items	SD Freq (%)	D Freq (%)	U Freq (%)	A Freq (%)	SA Freq (%)	**M**	**Std. Dev**

Our firm actively implements environmental sustainability practices.	3 (3.3%)	5 (5.4%)	11 (12.0%)	43 (46.7%)	30 (32.6%)	**4.00**	**1.10**
Sustainable sourcing of raw materials is a priority.	4 (4.3%)	6 (6.5%)	10 (10.9%)	42 (45.7%)	30 (32.6%)	**3.96**	**1.12**
The firm has clear sustainability goals that align with operations.	3 (3.3%)	7 (7.6%)	12 (13.0%)	40 (43.5%)	30 (32.6%)	**3.94**	**1.13**
Energy efficiency initiatives have reduced operational costs.	2 (2.2%)	5 (5.4%)	13 (14.1%)	44 (47.8%)	28 (30.4%)	**3.99**	**1.09**
Sustainability initiatives have improved our operational efficiency.	2 (2.2%)	4 (4.3%)	10 (10.9%)	46 (50.0%)	30 (32.6%)	**4.07**	**1.06**
Operational Efficiency	SD Freq (%)	D Freq (%)	U Freq (%)	A Freq (%)	SA Freq (%)	**M**	**Std. Dev**
Process innovation in my organization has significantly reduced production time.	2 (2.2%)	4 (4.3%)	9 (9.8%)	45 (48.9%)	32 (34.8%)	**4.10**	**1.07**
The adoption of innovative processes has led to a reduction in operational costs.	3 (3.3%)	5 (5.4%)	11 (12.0%)	43 (46.7%)	30 (32.6%)	**4.00**	**1.10**
Our firm's production systems operate with minimal resource wastage due to improved processes.	3 (3.3%)	6 (6.5%)	10 (10.9%)	42 (45.7%)	31 (33.7%)	**4.00**	**1.09**

Process improvements have enhanced the quality and consistency of our products.	2 (2.2%)	5 (5.4%)	8 (8.7%)	46 (50.0%)	31 (33.7%)	**4.12**	**1.06**
The firm's innovative processes enable quick adaptation to changes in customer demand.	3 (3.3%)	4 (4.3%)	9 (9.8%)	44 (47.8%)	32 (34.8%)	**4.07**	**1.08**

The results indicate a generally high level of agreement among respondents regarding the positive impact of process innovation on operational efficiency. Across all constructs, the mean scores are above the benchmark of 3.00, signifying agreement with the statements presented.

For workflow automation, the mean scores range from 3.93 to 4.18, demonstrating that respondents perceive automation as significantly improving business operations. Automation is viewed as enhancing productivity and operational efficiency (M = 4.18), minimizing human errors (M = 4.05), and enabling faster decision-making (M = 4.06). Although employee training on automation systems recorded the lowest mean (M = 3.93), it still reflects agreement, suggesting that training efforts are adequate but may benefit from further strengthening. The relatively moderate standard deviations indicate a reasonable level of consensus among respondents.

In terms of supply chain optimization, all items recorded mean values between 3.91 and 4.12, showing positive perceptions of optimized supply chain practices. Respondents agreed that optimization has improved operational efficiency (M = 4.12), enhanced timely delivery (M = 4.08), and strengthened vendor and supplier relationships (M = 4.01). While the mean for supply chain delays rarely impacting operations (M = 3.91) is slightly lower, it still indicates agreement, suggesting that although delays may occur, they are largely controlled through optimization strategies.

Customer-centric innovation also received favorable responses, with mean scores ranging from 3.81 to 4.08. Firms are perceived to prioritize customer satisfaction in their innovation processes (M = 4.08) and design solutions based on customer needs (M = 4.02). The

integration of customer feedback into product development (M = 3.98) and the enhancement of operational efficiency through customer-focused innovation (M = 4.01) further reinforce this positive perception. However, the relatively lower mean for the frequent introduction of new offerings (M = 3.81) suggests that while firms are customer-oriented, the pace of introducing new products may be moderate rather than aggressive.

Regarding sustainability initiatives, the findings show consistent agreement that sustainability contributes to operational performance. Mean scores range from 3.94 to 4.07, indicating that firms actively implement environmental sustainability practices and align sustainability goals with operational processes. The result that sustainability initiatives have improved operational efficiency (M = 4.07) underscores the strategic value of environmentally responsible practices in enhancing firm performance.

Finally, the operational efficiency construct recorded high mean scores between 4.00 and 4.12. Respondents strongly agreed that process innovation has reduced production time (M = 4.10), lowered operational costs (M = 4.00), minimized resource wastage (M = 4.00), improved product quality and consistency (M = 4.12), and enhanced adaptability to changes in customer demand (M = 4.07). These findings collectively demonstrate that process innovation is strongly associated with improved operational outcomes.

Overall, the consistently high mean scores across all variables indicate that workflow automation, supply chain optimization, customer-centric innovation, and sustainability initiatives significantly contribute to enhanced operational efficiency in the studied firms. The relatively low standard deviations further suggest a shared perception among respondents, thereby strengthening the reliability of these findings.

4.2 Test of Hypotheses

H0: Process innovation has no significant effect on resource optimization of food and beverage firms in Anambra State, Nigeria.

Table 3 Test of Hypotheses Model Summary

Model	R	R Squared	Adjusted R Squared	Std. Error of the Estimate
1	.722[a]	.521	.509	.635

a. Predictors: (Constant), workflow automation, supply chain optimization, customercentric innovation, sustainability initiatives

The model summary indicates a strong positive relationship between the independent variables and operational efficiency (R = 0.722). The R^2 value of 0.521 indicates that approximately 52.1% of the variation in operational efficiency is explained by workflow automation, supply chain optimisation, customer-centric innovation, and sustainability initiatives. The adjusted R^2 of 0.509 confirms the model's stability after accounting for the number of predictors. The standard error of the estimate (0.635) suggests a reasonable level of predictive accuracy, indicating good explanatory power.

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	49.705	4	49.705	30.822	.000[b]
	Residual	45.557	88	.403		
	Total	95.263	92			

a. Dependent Variable: Resource optimization

b. Predictors: (Constant), workflow automation, supply chain optimization, customer-centric innovation, sustainability initiatives

The ANOVA results indicate that the regression model is statistically significant. The regression sum of squares (49.705) compared to the residual sum of squares (45.557) shows that a substantial portion of the total variation in operational efficiency (95.263) is

explained by the independent variables. With an F-value of 30.822 and a significance level of 0.000 ($p < 0.05$), the overall model is highly significant. This means that workflow automation, supply chain optimisation, customer-centric innovation, and sustainability initiatives jointly have a statistically significant effect on operational efficiency, and the model provides a good fit for the data.

Coefficients[a]

Model	Variables	Unstandardized Coefficients (B)	Std. Error	Standardized Coefficients (Beta)	t	Sig.
1	Constant	0.332	0.149	—	2.228	0.027
	Workflow Automation	0.164	0.095	0.164	1.726	0.021
	Supply Chain Optimisation	0.282	0.097	0.277	2.701	0.008
	Customer-Centric Innovation	0.285	0.091	0.299	3.132	0.002
	Sustainability Initiatives	0.290	0.085	0.304	3.412	0.001

a. Dependent Variable: Resource optimization **Source: SPSS Output 2025**

The multiple regression results show that process innovation dimensions collectively contribute positively to operational efficiency. The constant term (B = 0.332, p = 0.027) is statistically significant, indicating that even in the absence of the explanatory variables, operational efficiency maintains a baseline positive value.

Workflow automation has a positive and statistically significant effect on operational efficiency (B = 0.164, β = 0.164, p = 0.021). This implies that an increase in workflow automation leads to a corresponding improvement in operational efficiency. However, compared to the other predictors, its standardized beta coefficient is the lowest, suggesting that while important, it has a relatively smaller influence on operational efficiency than the other innovation dimensions.

Supply chain optimisation demonstrates a stronger positive and significant effect (B = 0.282, β = 0.277, p = 0.008). This indicates that improvements in supply chain practices substantially enhance operational efficiency. The standardized coefficient shows that it is one of the major contributors among the independent variables.

Customer-centric innovation also has a significant positive impact (B = 0.285, β = 0.299, p = 0.002). The relatively higher beta value suggests that aligning innovation efforts with customer needs plays a critical role in improving efficiency outcomes. Firms that prioritize customer-driven innovation tend to achieve better operational performance.

Sustainability initiatives exhibit the strongest effect among the predictors (B = 0.290, β = 0.304, p = 0.001). The standardized beta coefficient indicates that sustainability practices have the greatest relative influence on operational efficiency. This suggests that integrating environmental and energy-efficient practices into operations significantly enhances overall performance.

Overall, all four predictors are statistically significant at the 5% level, confirming that workflow automation, supply chain optimisation, customer-centric innovation, and sustainability initiatives each contribute meaningfully to operational efficiency. The

positive coefficients indicate that improvements in these areas lead to corresponding improvements in operational outcomes.

4.3 Discussion of Findings

The first objective of the study examined the effect of workflow automation on resource optimization of food and beverage firms in Anambra State. The findings revealed that workflow automation significantly enhances operational efficiency, reduces human errors, and facilitates faster decision-making, with an overall mean score of 4.05. This aligns with the studies of Onojaife (2025) and Kehinde (2023), who reported that digital workflow automation improves staff productivity, enhances task accuracy, and streamlines operations in tertiary institutions and university libraries in Nigeria. The positive effect of workflow automation on resource optimization indicates that the adoption of automated systems allows firms to better allocate resources, reduce waste, and improve output quality.

The second objective assessed the influence of supply chain optimisation on resource optimization. Results indicated a significant positive impact, with an overall mean of 4.03, suggesting that well-coordinated supply chain processes enhance timely delivery, strengthen vendor relationships, and minimize operational delays. This is consistent with the findings of Patel and Singh (2021), who observed that supply chain optimisation improves operational efficiency in food and beverage firms in India by reducing inefficiencies and ensuring smoother production and distribution processes. These results reinforce the critical role of supply chain integration and technological tracking in optimizing resources within firms.

The third objective explored the effect of customer-centric innovation on resource optimization. The study revealed that customer-centric innovation positively influences resource utilization (overall mean = 3.98), as firms that integrate customer feedback and prioritize satisfaction are better able to align production with demand, reduce waste, and enhance efficiency. This finding supports the study of Oyeyemi, Adewale, and Ibraheem

(2023), which reported that customer-centric approaches improve supply chain efficiency and profitability in FMCG SMEs by fostering responsiveness to market trends and consumer preferences. The result underscores the importance of involving customers in the innovation process to maximize operational outcomes.

The fourth objective evaluated the effect of sustainability initiatives on resource optimization. The findings showed a very strong positive effect (overall mean = 3.99), indicating that environmental practices, energy efficiency, and sustainable sourcing significantly improve operational efficiency. Firms that implement sustainability initiatives are able to optimize resource utilization, reduce operational costs, and maintain long-term performance. These results align with existing literature emphasizing the strategic importance of sustainability in enhancing operational efficiency and corporate responsibility, further validating the integration of sustainable practices as a key driver of effective resource management in organizations.

5.0 Conclusion, Recommendations, Contribution to Knowledge, and Suggestions for Further Studies

This study found that workflow automation, supply chain optimization, customer-centric innovation, and sustainability initiatives all significantly enhance resource optimization and overall operational performance. Workflow automation improves decision-making, reduces errors, and streamlines processes. Supply chain optimization ensures timely delivery, strengthens vendor relationships, and optimizes resource use. Customer-centric innovation helps firms align products with market demands, minimizing waste and boosting productivity. Sustainability initiatives focus on energy efficiency, responsible sourcing, and environmentally-friendly practices, further enhancing resource utilization. In conclusion, adopting these process innovation strategies is crucial for improving productivity, reducing costs, and ensuring long-term competitiveness in the food and beverage industry

5.2 Recommendations

Based on the findings of this study, food and beverage firms in Anambra State are encouraged to adopt a holistic approach to process innovation to enhance operational efficiency.

Firms should continue to invest in advanced workflow automation systems to streamline operations, reduce human errors, and support faster decision-making. These efforts should be complemented with regular employee training to ensure effective use of automation tools, thereby maximizing productivity and operational performance.

Supply chain optimisation should also be prioritized. Firms are advised to implement technology-driven tracking systems, strengthen vendor and supplier relationships, and closely monitor delivery schedules. Continuous evaluation of supply chain processes will help reduce delays, improve coordination, and ensure optimal utilization of resources.

Customer-centric innovation should be integrated into organizational strategies by actively incorporating customer feedback into product and process development. Designing solutions with customer needs in mind and adapting offerings based on market trends will enhance customer satisfaction, reduce waste, and improve operational efficiency.

Finally, firms should expand sustainability initiatives by adopting energy-efficient processes, environmentally responsible operations, and sustainable sourcing of raw materials. Integrating these practices into daily operations can reduce operational costs, conserve resources, and strengthen the firm's competitive advantage.

By implementing these strategies, food and beverage firms in Anambra State can significantly enhance operational efficiency, optimize resource utilization, and achieve long-term sustainability and competitiveness in the industry.

5.3 Contributions to Knowledge

This study contributes to the understanding of process innovation and operational efficiency in the food and beverage sector, particularly in Anambra State, Nigeria. It highlights the significant role of workflow automation in improving resource optimization by streamlining operations, reducing errors, and speeding up decision-making. The research also emphasizes supply chain optimization, showing how technologydriven processes and strong vendor relationships enhance operational efficiency. Additionally, the study underscores the importance of customer-centric innovation, demonstrating how aligning products with customer needs improves resource use and reduces waste. Finally, the research highlights the value of sustainability initiatives, such as energy efficiency and sustainable sourcing, in boosting operational performance. Overall, this study offers valuable insights into how these four dimensions, workflow automation, supply chain optimization, customer-centric innovation, and sustainability, collectively drive resource optimization and enhance operational efficiency in the food and beverage industry.

5.4 Suggestions for Further Studies

Building on the findings of this study, future research could examine the impact of process innovation on operational efficiency in different regions of Nigeria or across various industries. This would help assess whether the positive effects of workflow automation, supply chain optimization, customer-centric innovation, and sustainability initiatives observed in the food and beverage sector are consistent in other contexts, thereby broadening the generalizability of the results. Future studies could explore other dimensions of process innovation, such as the role of artificial intelligence, digital transformation, or robotics, in enhancing resource optimization and operational efficiency. Investigating the moderating or mediating effects of organizational factors like culture, employee engagement, or leadership style could offer a deeper understanding of how these innovations influence firm performance. Longitudinal research could track the long-term impact of these process innovations on resource utilization and operational efficiency,

providing valuable insights into the sustainability and enduring effectiveness of these strategies over time.

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