

RESEARCH PAPER

Effect of quality management systems framework specifically ISO 9001, ISO 45001, ISO 14001 and ISO 31000 standards on operational performance: an investigation of Nigeria's manufacturing sector

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ABSTRACT

Goal: This study investigated the effect of quality management systems (QMS), with an emphasis on International Organization for Standardization (ISO) standards, in enhancing operational performance within Nigeria's manufacturing sector. The primary objective is to examine how QMS frameworks, specifically ISO 9001, ISO 45001, ISO 14001, and ISO 31000 standards, influence key operational metrics, including efficiency, defect reduction, customer satisfaction, and process improvement.

Methodology: This research used a quantitative method and regression analysis to analyze data from 320 manufacturing company employees in Southwest Nigeria. The data was collected through a structured survey of participants in the Nigerian manufacturing sector.

Findings: Results revealed that operational performance is positively enhanced by the combined effect of the quality management metrics. However, ISO 31000 risk management practices show the strongest impact on the Nigerian manufacturing sector. The combined metrics, which incorporate ideas from ISO standards such as ISO 9001 (quality management), ISO 45001 (occupational health and safety), and ISO 14001 (environmental management), create a solid foundation for operational improvement.

Limitations: This research is limited to the use of the cross-sectional method and centers on specific QMS practices.

Implications: The implications of this study are significant for both practitioners and researchers in the field of quality management, particularly within the context of Nigeria's manufacturing sector.

Originality: There have been previous studies that talked about the role of the quality management systems, however, none of them combined role played by ISO 9001, ISO 45001, ISO 14001, and ISO 31000. Moreover, the study served as an addition to the existing literature.

Keywords: Quality, Management, Systems, Organization, Standardization, Operational, Performance.

1 INTRODUCTION

Operational performance is fundamentally rooted in the principles of resource optimization. Efficient operations minimize waste and redundancies, enabling businesses to reduce costs without compromising on quality or service delivery. For example, manufacturing firms achieve better performance by adopting ISO manufacturing principles, which streamline processes, reduce unnecessary steps, and enhance value for the customer. According to Andrade *et al.*, (2020), service-based organizations focus on workflow optimization and

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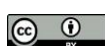
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customer-centric strategies to boost performance. At its core, operational performance reflects the ability of a business to transform input such as labor, materials, and capital into outputs that meet customer expectations. This transformation process relies heavily on systems, people, and technology working in harmony. Bakhtiar *et al.*, (2023) opined that any inefficiency in this chain can disrupt productivity, increase costs, or compromise quality, negatively impacting overall performance. In an era characterized by globalization and rapid technological advancements, organizations must continuously monitor and improve their operational performance to remain competitive. Operational performance, as a measure of how effectively and efficiently an organization achieves its objectives, is deeply influenced by the adoption and implementation of quality management systems (QMS) (Murmura *et al.*, 2024; Marire *et al.*, 2014). Companies formulate and implement strategic management processes that satisfy the groups that have an interest, claim or right in the organization, (Marques *et al.*, 2018).

A critical role of QMS is streamlining operational processes. By identifying inefficiencies and redundancies, QMS allows organizations to optimize workflows, leading to faster production cycles and reduced operational costs (Okokpuije & Tartibu, 2023). For instance, Fahmi *et al.*, (2021) asserted that automotive industries implementing ISO 9001, 45001, 14001 and 13000 often report enhanced productivity due to standardized processes and better coordination across departments. Adopting strong strategies is necessary to ensure operational efficiency due to the growing complexity and competitiveness of global marketplaces, especially in emerging nations like Nigeria (Adegbite & Govender, 2021; Olumoh, 2024). A key framework for enhancing organizational procedures, cutting waste, and satisfying customer expectations is provided by quality management systems (Psomas & Antony, 2019). ISO 9001, 45001, 14001 and 13000 are a well-known global standard for quality assurance and continuous improvement among QMS standards, which help manufacturing companies become more resilient (Princewill & Needorn., 2022).

QMS frameworks are instrumental in ensuring that products consistently meet predefined quality standards. This not only reduces defect rates but also minimizes rework and waste, directly impacting cost efficiency (Princewill & Needorn, 2022). Improved quality fosters customer trust and loyalty, which are essential for sustaining competitive advantage. Risk-based thinking, a core tenet of modern QMS like ISO 9001, 45001, 14001 and 13000, enable organizations to identify potential operational risks early and implement preventive measures. Engaged employees are more likely to adhere to quality standards and contribute to process improvements, enhancing overall organizational performance (Sampaio *et al.*, 2009; Fahmi *et al.*, 2021).

Notwithstanding its potential for industrialization and economic expansion, Nigeria's manufacturing sector has long struggled with issues like inadequate product quality, ineffective production methods, and a lack of competitiveness in international markets (Uko, 2018). This is not unconnected to either lack awareness of international standards such as ISO 9001, ISO 45001, ISO 14001, and ISO 31000, or failure to integrate them successfully into their operations. This results in high defect rates, workplace dangers, wasteful practices, low customer retention, and an inability to adjust to risk or market instability. The cumulative effect is poor operational performance, low consumer trust, and limited access to international markets. However, by promoting innovation, enhancing adherence to legal requirements, and establishing a culture of quality, QMS adoption can significantly improve these problems (Heras-Saizarbitoria & Boiral, 2021). Some companies, when possible, established contact with their customers in a virtual way to ensure that customers are satisfied (Anholon *et al.*, 2022). According to Ayuba *et al.*, (2022), manufacturing companies that implement quality management systems (QMS), particularly ISO 9001, experience measurable improvements in operational performance, including enhanced customer satisfaction, reduced operational costs, and greater process efficiency, as evidenced in their study of the effect of quality management on organizational performance of Berger Paints Nigeria PLC.

The main objective of this paper is to examine how QMS frameworks specifically ISO 9001, ISO 45001, ISO 14001 and ISO 31000 standards influence key operational metrics, including efficiency, defect reduction, customer satisfaction, and process improvement of the Nigeria's manufacturing sector. The specific objectives are:

1. To examine the influence of the structured and standardized processes advocated by ISO 9001 on efficiency
2. To study the impact of the implementation of safety-centric principles outlined in

- ISO 45001 on the defect reduction
3. To ascertain the influence of the adoption of sustainable practices promoted by ISO 14001 on the customer satisfaction
 4. *To know the impact of strategic foresight and risk management principles embedded in ISO 31000 on the process improvement*

2 LITERATURE REVIEW

2.1 Quality Management Systems

Quality management systems (QMS) is a codified system that records duties, processes, and procedures for accomplishing quality goals and policies (Andrade *et al.*, 2020). The beginning of quality control in manufacturing in the early 20th century marked the beginning of the development of QMS. However, frameworks like ISO 9001, which was originally presented in 1987, helped modern QMS gain popularity. With an emphasis on risk-based thinking, stakeholder participation, and integration with other management systems, ISO 9001 updates over time have improved the system to meet global business issues (Bakhtiar *et al.*, 2023). QMS reduces waste, rework, and inefficiencies, leading to significant cost savings. According to Adegbite & Govender, (2021) companies implementing ISO 9001 experienced a 15-20% reduction in operational costs due to process optimization and enhanced resource utilization. Ayuba *et al.*, (2022) affirmed that internationally recognized standards such as ISO 9001 (Quality Management), ISO 45001 (Occupational Health and Safety), ISO 14001 (Environmental Management), and ISO 31000 (Risk Management) serve as pivotal frameworks that enhance operational performance in areas such as efficiency, defect reduction, customer satisfaction, and process improvement.

ISO 9001

ISO 9001 provides a comprehensive structure for managing quality across organizational processes, ensuring that resources are optimized to produce consistent outcomes. The standard emphasizes efficiency through its principles of process-based approaches and continual improvement (Fahmi *et al.*, 2021). By adopting ISO 9001, organizations identify inefficiencies, redundancies, and bottlenecks within their workflows. This leads to optimized use of time, labor, and materials, reducing waste and improving throughput (Hunt *et al.*, 2021). For instance, ISO 9001's focus on monitoring and measuring key performance indicators (KPIs) ensures that inefficiencies are promptly identified and addressed. Efficiency gains result from standardizing processes, fostering better coordination between departments, and using data-driven insights to refine operations (Khan *et al.*, 2021). In manufacturing, for example, this might translate into shorter production cycles and reduced operational costs, directly impacting operational performance.

ISO 45001

ISO 45001, which focuses on occupational health and safety, contributes to defect reduction by creating safer working environments that minimize errors caused by fatigue, stress, or unsafe conditions (Marire *et al.*, 2014; Okokpuije & Tartibu, 2023; Samuel *et al.*, 2022). Operational performance is significantly enhanced when workers operate in environments designed for their safety and well-being (Senarath *et al.*, 2020). Defects in production processes are often linked to human errors, equipment malfunctions, or procedural lapses (Ajayi, 2021). ISO 45001 mitigates these risks by establishing robust safety protocols, conducting regular hazard assessments, and ensuring compliance with occupational safety standards (Uşar, 2024; Fahmi *et al.*, 2021). By addressing the root causes of workplace incidents and errors, ISO 45001 reduces disruptions in operations and ensures the production of defect-free outputs, contributing to both operational stability and quality.

ISO 14001

Customer satisfaction is a critical dimension of operational performance, and ISO 14001 directly influences it by emphasizing environmental responsibility (Khan *et al.*, 2020). Modern

consumers increasingly prioritize businesses that demonstrate sustainable practices. ISO 14001 helps organizations align their operations with environmental standards, fostering trust and goodwill among customers. Adopting ISO 14001, organizations minimize their environmental footprint through efficient waste management, reduced emissions, and energy conservation (Hunt *et al.*, 2021). These practices not only enhance public perception but also improve cost efficiency, which can be redirected toward improving product quality and service delivery. The alignment of environmental goals with operational processes ensures that customer expectations for ethical and sustainable practices are met, leading to higher satisfaction levels and loyalty (Dewi *et al.*, 2020).

ISO 31000

ISO 31000, as a framework for risk management, plays a transformative role in process improvement by systematically identifying, assessing, and mitigating risks across operations (Susanto *et al.*, 2024). The standard promotes a culture of proactive management, where risks are anticipated and addressed before they escalate into disruptions. Operational performance improves through ISO 31000 by fostering continuous process refinement (Princewill, S. J., & Needorn, 2022). The standard encourages organizations to integrate risk assessments into decision-making processes, enabling them to identify inefficiencies, potential failures, or vulnerabilities in their workflows (Senarath *et al.*, 2020). For example, in supply chain management, ISO 31000 helps organizations identify and mitigate risks associated with supplier reliability, logistical delays, or fluctuating raw material costs. This proactive approach enhances resilience, ensures uninterrupted operations, and drives continuous improvement in processes.

2.2 Operational Performance

Operational performance refers to how well a company controls its internal operations in order to generate and provide its goods and services (Prajogo *et al.*, 2018). According to Dewi *et al.* (2020), operational performance has a direct impact on the organization's capacity to meet its strategic goals and compete in the market, making it a crucial component of total company performance. This is supported by Marques *et al.*, (2018) who studied tools for the strategic management of stakeholders in civil construction and asserted that companies should formulate and implement strategic management processes that satisfy the groups that have an interest, claim or right in the organization. However, manufacturing firms place a premium on operational performance because of their resource limitations and competitive conditions (Ajayi, 2021). Manufacturing companies can boost their competitiveness and sustainability by optimizing their resources, cutting expenses, improving quality, and raising customer satisfaction through efficient operations (Schaefer *et al.*, 2023).

Samuel *et al.*, (2022) stated that key performance indicators (KPIs) like productivity, efficiency, quality, customer happiness, innovation, and financial performance are frequently used to gauge operational performance in manufacturing sector. Manufacturing firms may use these KPIs to monitor their performance over time, pinpoint areas that need work, and make well-informed decisions to improve their operations (Jannah *et al.*, 2020). Strategic planning, implementation, assessment, process management, technology adoption, human resource management, and supply chain management are some of the elements that affect operational performance in manufacturing sector (Nilsson, 2020; Abodunde, 2020; Mudany *et al.*, 2021; Sylvia, 2021). Manufacturing companies in Nigeria can enhance their operational performance and attain better business results by managing these aspects well (Riofrio *et al.*, 2023). Moreover, the collective application of ISO 9001, ISO 45001, ISO 14001, and ISO 31000 creates a synergistic impact on operational performance by addressing its core dimensions comprehensively (Fahmi *et al.*, 2021). Efficiency as one of the metric of operational performance is driven by the structured, standardized processes advocated by ISO 9001; while defect reduction is ensured by the safety-centric principles of ISO 45001, which eliminate error-inducing workplace conditions (Uşar, 2024). Customer satisfaction is enhanced through ISO 14001's emphasis on sustainable practices, aligning operational outputs with societal and consumer values; and process improvement is achieved through ISO 31000's focus on risk management and strategic foresight, fostering adaptive and resilient operations (Fahmi *et al.*, 2021).

Efficiency

Efficiency measures how effectively an organization uses its resources to produce outputs. It reflects the ratio of inputs, such as labor, capital, and materials, to outputs, including goods and services delivered (Andrade *et al.*, 2020). High efficiency indicates that an organization is minimizing waste, optimizing resource utilization, and achieving cost-effectiveness in its operations. Efficiency is crucial for operational performance because it directly impacts profitability and competitiveness (Gremyr *et al.*, 2021). Inefficient processes often lead to higher costs, delays, and resource wastage, undermining an organization's ability to meet market demands (Marire *et al.*, 2014). For instance, in manufacturing, efficiency can be assessed through metrics such as production cycle time, equipment utilization rates, and overall operational throughput. ISO 9001 methodologies, automation, and process standardization are commonly employed to enhance efficiency and drive operational excellence (Murmura *et al.*, 2024).

Defect Reduction

Defect reduction focuses on minimizing errors and inconsistencies in products or services. It is a critical metric for ensuring quality, as defects can lead to customer dissatisfaction, increased costs, and reputational damage. Reducing defects, organizations not only improve product reliability but also enhance operational stability and reduce the need for rework or waste disposal (Adegbite & Govender, 2021). Defect reduction is often achieved through quality management practices such as ISO 45001 (Bakhtiar *et al.*, 2023). These practices emphasize rigorous monitoring, statistical analysis, and continuous improvement to identify and eliminate the root causes of defects. In service industries, defect reduction might involve minimizing errors in customer interactions or reducing service delivery delays, contributing to a seamless customer experience (Andrade *et al.*, 2020).

Customer Satisfaction

Customer satisfaction measures the extent to which an organization meets or exceeds customer expectations. It is a vital metric of operational performance because satisfied customers are more likely to become repeat buyers, recommend the organization to others, and contribute to long-term revenue growth (Khan *et al.*, 2020). Conversely, dissatisfied customers can result in negative reviews, lost sales, and a tarnished brand image. Operational performance influences customer satisfaction through factors such as product quality, timely delivery, and responsive service (Jannah *et al.*, 2020). According to Fahmi *et al.*, (2020), metrics like ISO 14001 which emphasis on sustainable practices, aligning operational outputs with societal and consumer values are commonly used to gauge satisfaction levels. Initiatives to enhance customer satisfaction often involve improving product consistency, ensuring on-time delivery, and addressing customer feedback promptly. Sustainable practices, such as those promoted by ISO 14001, boost customer satisfaction by aligning operations with societal values and environmental concerns.

Process Improvement

Process improvement refers to the systematic efforts to enhance operational workflows, reduce inefficiencies, and adapt to changing market conditions. It is a dynamic metric of operational performance, reflecting an organization's ability to evolve and remain competitive over time, (Uko, 2018). Effective process improvement leads to increased efficiency, reduced costs, and greater agility in responding to customer needs. Process improvement is not only about addressing immediate inefficiencies but also about fostering a culture of innovation and continuous enhancement (Olumoh, 2024). Metrics such as ISO 13000 provide insights into the success of process improvement initiatives.

2.3 Nigerian Manufacturing Sector

In addition to generating goods and services, the manufacturing sector helps the economy's participants create good jobs and reap substantial rewards (Sola, Obamuyi,

Adekunjo, & Ogunleye, 2013). Manufacturing has traditionally been seen as a driving force behind industrialization, progress, and development on a worldwide scale (Afolabi & Laseinde, 2019). After commerce and agriculture, manufacturing ranks as Nigeria's third-largest employment sector (Nigerian Economic Summit Group, NESG, 2021). There are thirteen sub-sectors within Nigeria's manufacturing industry. These consist of basic metal, cement, food, beverages, electrical and electronic devices, chemical and pharmaceutical products, and Products made of plastic and rubber; automobiles and their assembly; oil refining; textiles, clothing, and footwear; tobacco, iron and steel, pulp, paper, and paper products; and non-metallic products (NBS, 2021) Wood and Wood Products and Other Manufacturing. Three of the thirteen sub-sectors made up 87% of the manufacturing output as of 2020. These three industries are cement (18%), textiles, apparel, and footwear (32%), and food, beverage, and tobacco (37%). This suggests that the cumulative contribution of the remaining 10 sub-sectors to the year's manufacturing output was 13%. Nigeria's manufactured goods made up 7.7% of all export earnings in 2020 in terms of exports. Over the last four years (2017–2020), manufactured goods exports accounted for an average of 6.2 percent of the manufacturing sector GDP, according to data from the National Bureau of Statistics (NBS) (2020).

2.4 Theoretical Background and Hypotheses Development

Hypothesis 1

The resource based theory (RBT) posits that unique, valuable, and well-organized internal processes form a sustainable competitive advantage. ISO 9001 advocates standardized processes, enabling organizations to reduce inefficiencies, optimize resources, and improve output consistency. Efficiency gains are achieved by eliminating redundancies, enhancing coordination, and adopting a systematic approach to quality assurance.

(H1): Efficiency is positively influenced by the structured and standardized processes advocated by ISO 9001.

Hypothesis 2

The TQM framework emphasizes the integration of organizational processes to achieve zero defects. ISO 45001 contributes to this by addressing workplace safety, a critical factor in reducing operational errors. A safe working environment minimizes disruptions and human-induced errors, directly contributing to defect reduction and ensuring consistent quality.

(H2): Defect reduction is positively impacted by the implementation of safety-centric principles outlined in ISO 45001.

Hypothesis 3

Stakeholder Theory suggests that aligning organizational goals with societal and environmental values enhances stakeholder trust and satisfaction. ISO 14001's emphasis on sustainability integrates environmental considerations into operational processes, aligning with customer expectations for ethical and eco-friendly practices. This alignment fosters customer satisfaction and loyalty.

(H3): Customer satisfaction is positively influenced by the adoption of sustainable practices promoted by ISO 14001.

Hypothesis 4

Dynamic Capabilities Theory underscores the importance of adaptability and strategic foresight in navigating complex and volatile environments. ISO 31000 focuses on risk management and resilience, enabling organizations to identify inefficiencies, anticipate challenges, and implement proactive improvements in processes.

(H4): Process improvement is positively driven by the strategic foresight and risk management principles embedded in ISO 31000.

The study's theoretical model, as shown in Figure 1.1, captured the relationship between the quality management systems (QMS) and operational performance in the Nigerian manufacturing sector. Each ISO standard is mapped to a specific performance metric, and the

model hypothesizes that ISO 9001 will influence efficiency through structured and standardized processes, ISO 45001 will impact defect reduction by integrating safety-centric principles into workplace practices, ISO 14001 will link to customer satisfaction through sustainable environmental practices that align with global expectations and consumer satisfaction, and ISO 31000 will affect process improvement through the application of risk management and strategic foresight.

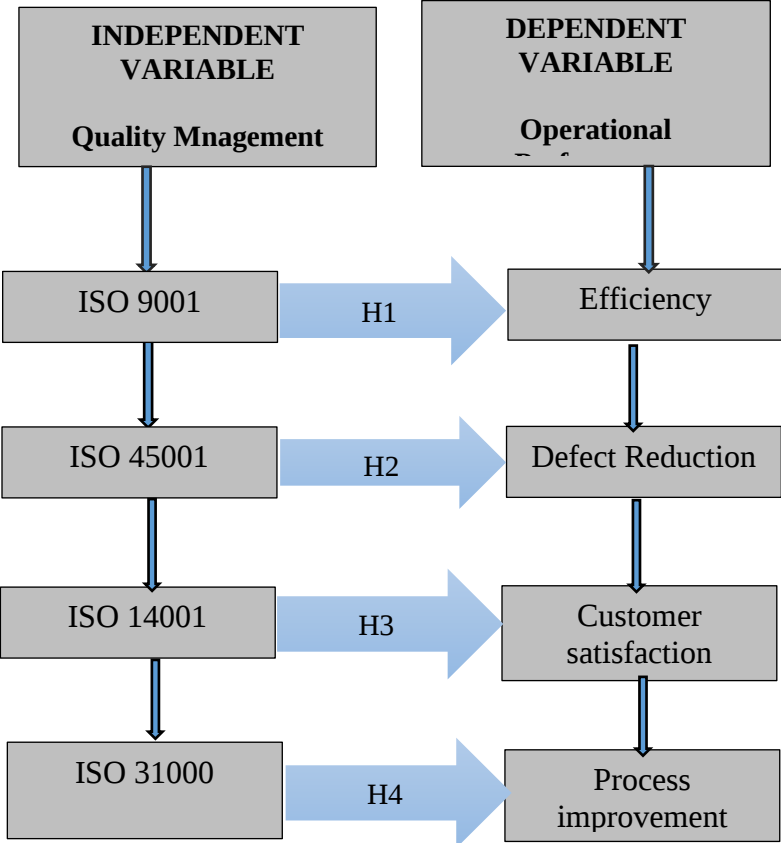


Figure 1.1 - Theoretical Model
Source: The Author's Concept (2024).

3 RESEARCH METHODOLOGY

3.1 Research Design

Descriptive quantitative survey approach was adopted in this study. This involved the use of primary data that was collected using questionnaire from the staff members of the manufacturing sector in Southwest Nigeria. The manufacturing firms include Cadbury Nigeria Plc, Nestle Nigeria Plc, Rite Foods Limited, Yale Foods Nigeria Limited, Ok food Nigeria Industry. The population of the study comprises 1785 staff members of the selected manufacturing firms.

3.2 Sampling Technique

Convenience sampling was employed to gather data, allowing the author to collect it efficiently and conveniently (Sekaran, 2000). This method involves selecting samples that are easily accessible, whether due to proximity to a specific location or availability via internet services. Furthermore, convenience sampling was deemed most suitable for this study as the data was collected from the manufacturing industry, where this technique is frequently used by researchers to obtain information from accessible employees within organizations. Instead of selecting a fully representative sample, the approach focuses on participants who were readily available.

3.3 Sample Size

The sample size of the study was determined using the sample size formular developed by Taro Yamane (Anokye, 2020). Using Taro Yamane's formula, the calculated sample size for a population of 1,785 with a margin of error of 0.05 is approximately 327 participants. Therefore, the sample size of the study consisted of 327 employees conveniently drawn from Cadbury Nigeria Plc, Nestle Nigeria Plc, Rite Foods Limited, Yale Foods Nigeria Limited, Ok food Nigeria Industry. Data was collected from the 327 employees drawn from the various Nigerian manufacturing firms as indicated above, in the month of August, year 2024.

3.3 Research Instruments Construction

A well-structured questionnaire was adopted (Hunt *et al.*, 2020; Sampaio *et al.*, 2009) and divided into 5 sections. The first section focused on the demographic characteristics of the employees, including their gender, age and educational qualifications. The second section of the questionnaire contained 4 questions addressing ethical ISO 9001 (Independent variable) and efficiency (Dependent variable), the third section also comprised 4 questions related to ISO 45001 (Independent variable) and defect reduction (Dependent variable) while section four contained 4 statements relating to ISO 40001 (Independent variable) and customer satisfaction (Dependent variable); the fifth section contained 4 statements relating to ISO 13000 (Independent variable) and process improvement (Dependent variable). The questionnaire was distributed to the respondents via emails and other social media platforms. Data generated in the study was analyzed quantitatively and conducted at a 0.05 level of significance, representing the probability threshold at which a Type I error would be considered acceptable.

3.4 Model Specification

To evaluate the Effect of quality management systems (QMS) practices on Operational Performance (OP) in the Nigerian manufacturing sector, the study adopts a functional relationship of the form:

$$Y = f(X)$$

Where

Y = Dependent variable = Operational Performance (OP)

X = Independent variable=quality management systems (QMS)

The variables are further broken down as follows:

$$Y = (y_1, y_2, y_3, y_4)$$

[y₁- Efficiency (E); y₂- Defect Reduction (DR); y₃- Customer Satisfaction (CS); y₄- Process Improvement (PI)]

$$X = (x_1, x_2, x_3, x_4)$$

$$[x_1\text{-ISO 9001 (ISN); } x_2\text{-ISO 45001 (ISF); } x_3\text{ = ISO 40001 (ISZ); } x_4\text{ = ISO 13000 (IST)}]$$

These result to an expanded functional model of:

Efficiency Model: $E = f(\text{ISN})$

Defect Reduction Model: $\text{DR} = f(\text{ISF})$

Customer Satisfaction Model: $\text{CS} = f(\text{ISZ})$

Process Improvement Model: $\text{PI} = f(\text{IST})$

Multiple Regression

To determine the combined effect of all ISO standards on operational performance, the following multiple linear regression model is specified:

$$\text{OP} = f(\text{ISN}, \text{ISF}, \text{ISZ}, \text{IST})$$

$$\text{OP}_i = \beta_0 + \beta_1 \text{ISN}_i + \beta_2 \text{ISF}_i + \beta_3 \text{ISZ}_i + \beta_4 \text{IST}_i + \varepsilon_i$$

Where:

OP_i = Operational Performance for firm i

β₀ = Intercept (baseline operational performance)

β₁, β₂, β₃, β₄ = Coefficients for each ISO variable

ε_i = Error term

This model reflects the aggregate Effect of quality management practice on operational

performance, based on employee responses from five sampled Nigerian manufacturing enterprises.

4 DATA ANALYSIS AND DISCUSSION OF RESULTS

4.1 Demographic Data Analysis

The gender distribution is almost equal, with a slight majority of males (50.2%). This indicates a balanced representation of genders in the sample, which is important for minimizing gender bias in the study. The majority of participants fall into the 36–40 years age group, representing 37.6% of the sample. This indicates that this age group is most heavily represented in the study. The majority of participants have Graduate (41.6%) or Postgraduate (33.6%) qualifications. This shows a relatively high level of education within the sample, which could reflect the study's focus on individuals with a higher level of education, likely contributing to a more informed perspective on the quality management systems to enhance operational performance.

Table 4.1 - Demographic Data (N=327)

Variables	Category	Frequency	Percentage (%)
Gender	Male	164	50.2
	Female	163	49.8
Age	25–30 years	42	12.6
	31–35 years	82	25.1
	36–40 years	122	37.6
	41 years and above	81	24.7
Educational Qualifications	Primary	27	8.3
	Secondary	54	16.5
	Graduate	136	41.6
	Postgraduate	110	33.6

Source (Field Survey, 2024).

4.2 Simple Linear regression

Simple linear regression is used in the study to test the hypothesis one, two, three and four. Simple linear regression, consisting of one independent variable and one dependent variable is used.

4.2.1 Hypothesis 1

(H1): Efficiency is positively influenced by the structured and standardized processes advocated by ISO 9001.

$E = f(\text{ISN})$

$\text{Efficiency} = \beta_0 + \beta_1(\text{ISO 9001 processes}) + \epsilon$

Table 4.2 - Influence of structured and standardized processes of ISO 9001 on efficiency

Variable	Coefficient (B)	Standard Error	t-value	p-value	R ²
Intercept (β_0)	45.67	3.25	14.06	<0.001	0.42
ISO 9001 Processes (β_1)	0.53	0.08	6.63	<0.001	

Source: SPSS 24.0 Output.

Table 4.2 presents SPSS 24.0 result of the influence of structured and standardized processes of ISO 9001 on efficiency The **intercept (β_0) = 45.67** which indicate the baseline value for **Efficiency** when **ISO 9001** are not implemented (i.e., ISO 9001 = 0). For every **unit increase** in the implementation of **ISO 9001**, **Efficiency** increases by **0.53** units. This positive coefficient suggests that **Efficiency** is positively influenced by the standardized processes of ISO 9001. The t-value is the ratio of the coefficient to its standard error. A high t-value indicates that the coefficient is statistically significant while R-squared value is 0.42, it means that 42% of the variation in Efficiency can be explained by the implementation of ISO 9001 processes. The p-

value is less than the typical significance level (0.05), indicating that the **relationship between ISO 9001 and efficiency** is statistically significant. In other words, the implementation of ISO 9001 processes significantly influences **efficiency**.

4.2.2 Hypothesis 2

(H2): Defect reduction is positively impacted by the implementation of safety-centric principles outlined in ISO 45001.

$$DR = f(ISF)$$

$$\text{Defect reduction} = \beta_0 + \beta_1(\text{ISO 45001}) + \epsilon$$

Table 4.3 - Impact of implementation of safety-centric principles outlined in ISO 45001 on the defect reduction

Variable	Coefficient (B)	Standard Error	t-value	p-value	R ²
Intercept (β_0)	38.4	3.45	11.12	<0.001	0.50
ISO 45001 Safety Principles (β_1)	0.72	0.1	7.2	<0.001	

Source: SPSS 24.0 Output.

Table 4.3 presents result on the impact of implementation of safety-centric principles outlined in ISO 45001 on the defect reduction. The implementation of ISO 45001 principles significantly reduces defects in the organization. The positive coefficient of 0.72 shows a meaningful association between safety measures and defect reduction, supporting the hypothesis that safety principles directly impact the reduction of defects. The baseline measurement of defect reduction in the absence of safety measures (ISO 45001) is 38.40. For each unit increase in the implementation of ISO 45001 safety principles, defect reduction increases by 0.72 units while the positive coefficient suggests that defect reduction is positively influenced by the adoption of ISO 45001 safety-centric principles.

4.2.3 Hypothesis 3

(H3): Customer satisfaction is positively influenced by the adoption of sustainable practices promoted by ISO 14001.

$$CS = f(ISZ)$$

$$\text{Customer satisfaction} = \beta_0 + \beta_1(\text{ISO 14001}) + \epsilon$$

Table 4.4 - Influence of the adoption of sustainable practices promoted by ISO 14001 on customer satisfaction

Variable	Coefficient (B)	Standard Error	t-value	p-value	R ²
Intercept (β_0)	60.2	4.5	13.38	<0.001	0.48
ISO 14001 Sustainable Practices (β_1)	0.85	0.12	7.08	<0.001	

Source: SPSS 24.0 Output

Table 4.4 indicate result on the **influence of the adoption of sustainable practices promoted by ISO 14001 on customer satisfaction**. The intercepts (60.2) represents the baseline of customer satisfaction when no ISO 14001 sustainable practices are implemented (i.e., ISO 14001 = 0). This indicates a customer satisfaction level of 60.2 in the absence of sustainable practices **promoted by ISO 14001**. For every unit increase in the implementation of ISO 14001 sustainable practices, customer satisfaction increases by 0.85 units. This positive coefficient supports the hypothesis that adopting ISO 14001 practices positively influences customer satisfaction. A high t-value indicates a statistically significant relationship between ISO 14001 sustainable practices and customer satisfaction. The relationship between ISO 14001 practices and customer satisfaction is statistically significant, as the p-value is well below the 0.05 threshold. R-squared value is 0.48, meaning 48% of the variance in Customer Satisfaction is explained by the adoption of ISO 14001 sustainable practices.

4.2.4 Hypothesis 4

(H4): *Process improvement is positively driven by the strategic foresight and risk*

management principles embedded in ISO 31000.

$$PI = f(IST)$$

$$\text{Process improvement} = \beta_0 + \beta_1(\text{ISO 31000}) + \epsilon$$

Table 4.5 - Impact of strategic foresight and risk management principles embedded in ISO 1000 on the Process improvement

Variable	Coefficient (B)	Standard Error	t-value	p-value	R ²
Intercept (β_0)	55.3	5.4	10.24	<0.001	0.54
ISO 31000 Strategic Foresight & Risk Management (β_1)	1.1	0.15	7.33	<0.001	

Source: SPSS 24.0 Output.

The results of the regression analysis in table 4.5 shows the impact of strategic foresight and risk management principles embedded in ISO 31000 on the Process improvement. The result support the hypothesis, showing that the strategic foresight and risk management principles embedded in ISO 31000 significantly drive process improvement. The strong positive coefficient highlights the value of implementing these principles to enhance organizational processes. The baseline Process Improvement score when no ISO 31000 principles are implemented (ISO 31000 = 0). Reflects a process improvement level of 55.30 in the absence of risk management practices. For every unit increase in the adoption of ISO 31000 principles, Process Improvement increases by 1.1 units. This positive coefficient indicates a significant positive impact of ISO 31000 on process improvement. The low p-value signifies that the relationship between ISO 31000 principles and process improvement is statistically significant.

4.3 Multiple Regression

The essence of conducting the multiple regression as formulated in the model specification earlier is to examine the numerical impact of quality management systems in enhancing operational performance. This represented the real objective of the study (to examine the role of quality management systems in enhancing operational performance of Nigeria's manufacturing sector). To do this, the combined effect of the quality management metrics, that is, ISN, ISF, ISZ, IST were regressed against the operational performance. The model is restated as follows:

$$OP = f(\text{ISN, ISF, ISZ, IST})$$

$$OP_i = \beta_0 + \beta_1 \text{ISN}_i + \beta_2 \text{ISF}_i + \beta_3 \text{ISZ}_i + \beta_4 \text{IST}_i + \epsilon_i$$

Operational performance is positively enhanced by the combined effect of the quality management metrics, that is, ISN, ISF, ISZ, IST

Table 4.6 - Combined effect of the quality management metrics, that is, ISN, ISF, ISZ, IST on operational performance

Variable	Coefficient (B)	Standard Error	t-value	p-value	R ²
Intercept (β_0)	50.3	6	8.38	<0.001	0.62
ISN (β_1)	0.25	0.07	3.57	<0.001	
ISF (β_2)	0.3	0.09	3.33	0.001	
ISZ (β_3)	0.2	0.08	2.5	0.013	
IST (β_4)	0.4	0.1	4	<0.001	

Source: SPSS 24.0 Output.

The regression analysis in table 4.6 presents result on the combined effect of the quality management metrics, that is, ISN, ISF, ISZ, IST on operational performance. The result supports the hypothesis, indicating that operational performance is positively and significantly enhanced by the combined effects of the quality management metrics. Each metric contributes uniquely to improving operational performance, with ISO 31000 (IST) having the most substantial impact. The intercepts represents the baseline operational performance when none of the quality management metrics are implemented (ISN, ISF, ISZ, IST = 0) which indicates an operational performance level of 50.30 in the absence of these practices. For every unit increase in ISO 9001 quality management practices, operational performance increases by 0.25 units. Every unit increase in ISO 45001 safety management practices leads to a 0.30-unit increase in operational performance. ISO 14001 environmental management

practices contribute 0.20 units to operational performance per unit increase. ISO 31000 risk management practices show the strongest impact, with a 0.40-unit increase in operational performance for each unit increase. All independent variables have p-values below 0.05, indicating statistically significant contributions to operational performance. R^2 value is 0.62, suggesting that 62% of the variance in operational performance is explained by the four ISO metrics (ISN, ISF, ISZ, IST).

5 DISCUSSION

This study had examined the Effect of quality management systems framework specifically ISO 9001, ISO 45001, ISO 14001 and ISO 31000 standards on operational performance metrics, including efficiency, defect reduction, customer satisfaction, and process improvement of the Nigeria's manufacturing sector. It is evident in the study that efficiency is positively influenced by the structured and standardized processes advocated by ISO 9001. According to Ayuba *et al.*, (2022) who studied the effect of quality management on organizational performance in Berger Paints Nigeria PLC, ISO 9001 enhanced structured and standardized processes, which provide a systematic approach to quality management. These methods improve resource allocation, reduce waste, and streamline manufacturing activities, resulting in increased efficiency. In the context of Nigeria's manufacturing sector, where operational inefficiencies and resource restrictions are common, implementing ISO 9001 standards provides a solid foundation for increasing efficiency. This study looked closely at the impact of quality management systems (QMS) in improving operational performance in Nigeria's manufacturing sector. The findings highlight ISO 9001's strong influence on operational efficiency, particularly its structured and standardized processes. This conclusion is consistent with global perceptions on ISO 9001's efficacy in simplifying organizational procedures, minimizing redundancies, and assuring consistent output quality.

Findings also showed that defect reduction is positively impacted by the implementation of safety-centric principles outlined in ISO 45001. This research underscores the importance of workplace safety and health management systems in improving production quality and reducing faults. ISO 45001 specifies a comprehensive framework for controlling occupational health and safety concerns. Chiarini (2016) claimed that defects in production are frequently caused by human error due to fatigue, stress, or hazardous situations and quality management systems especially ISO 45001 reduce defects. By guaranteeing a safe and well-regulated working environment, this standard prevents workplace incidents that could disrupt operations and contribute to production failures.

Result revealed that customer satisfaction is positively influenced by the adoption of sustainable practices promoted by ISO 14001. ISO 14001 provides a framework for enterprises to successfully manage their environmental responsibilities, ensuring that their operations are consistent with sustainability principles while being efficient and competitive. According to Fahmi *et al.*, (2021), the importance of having an ISO certificate for companies can be seen from several benefits. To gain customer trust, no matter how big a company is, if it has not been ISO certified, then the taste is incomplete. Customers are increasingly valuing businesses that demonstrate a commitment to environmental sustainability. Bakhtiar *et al.*, (2022) emphasized that manufacturing firms that implement ISO 14001 improve their market reputation by aligning with global sustainability trends, which appeal to environmentally sensitive customers and stakeholders. ISO 14001-certified companies demonstrate to their stakeholders that they value lowering environmental effect while generating confidence and loyalty. Sustainable practices frequently result in improved resource management and waste reduction, which leads to higher-quality products and services that meet or exceed client expectations.

It was also observed that process improvement is positively driven by the strategic foresight and risk management principles embedded in ISO 31000. This emphasizes the importance of risk management in streamlining operational procedures and improving organizational performance. ISO 31000 defines a structured framework for recognizing, assessing, and reducing risks, allowing companies to predict possible issues and adjust proactively. In the context of process improvement, including strategic foresight ensures that firms address present inefficiencies while also planning for future uncertainties. Firms that include risk management principles into their operational strategy can make more informed decisions, streamline workflows, and allocate resources more efficiently. This proactive

strategy reduces disruptions, increases consistency, and encourages creativity, all of which are necessary for continuous process improvement. ISO 31000 offers a useful road map for resilience and flexibility for the manufacturing industry, especially in Nigeria, where operational risks such as supply chain interruptions, market volatility, and resource limitations are common. Processes stay effective and in line with organizational objectives when possible risks are anticipated and preventive actions are put in place.

The study finally revealed that operational performance is positively enhanced by the combined effect of the quality management metrics, however, ISO 31000 risk management practices show the strongest impact. The combined metrics, which incorporate ideas from ISO standards such as ISO 9001 (quality management), ISO 45001 (occupational health and safety), and ISO 14001 (environmental management), create a solid foundation for operational improvement. Khan *et al.*, (2020) studied the role of total quality management practices on operational performance of the service industry and affirmed that quality management enhance operational performance. They opined that standards promote streamlined procedures, safer workplaces, and ecologically responsible practices, all of which help to improve performance. ISO 31000 stands out for its risk management focus, which addresses uncertainties and potential interruptions that can jeopardize operational continuity and efficiency. The findings reveal that, while integrating several quality management systems has considerable advantages, the capacity to predict and navigate hazards is critical. ISO 31000 not only strengthens operational processes but also instills a culture of resilience and adaptation, allowing enterprises to maintain high performance levels even in unpredictable situations.

The study concludes that while integrating several quality management systems has considerable advantages in the Nigeria manufacturing sector, the capacity to predict and navigate hazards is critical. ISO 31000 not only strengthens operational processes, but it also fosters a culture of resilience and adaptation, allowing Nigeria manufacturing firms to maintain high performance levels even in unpredictable circumstances. This demonstrates the importance of prioritizing risk management within the larger framework of quality management procedures in order to achieve long-term operational excellence in the manufacturing sector in Nigeria.

6 CONCLUSION

The regression analysis results show measurable, statistically significant relationships between ISO standard implementation and various aspects of operational performance in Nigerian manufacturing firms, including efficiency, defect reduction, customer satisfaction, and process improvement. The sample size of 327 employees from five major manufacturing companies (Cadbury Nigeria Plc, Nestle Nigeria Plc, Rite Foods Limited, Yale Foods Nigeria Limited, and OK Food Nigeria Industry) gives a fairly diverse representation of the industry. The data was obtained in August 2024, when Nigerian manufacturers were still facing issues such as resource shortages, market volatility, infrastructure inadequacies, and increased global competition. In this context, the author contends that the practice of ISO systems not only aligns with international best practices but also acts as a strategic requirement for the Nigerian manufacturing firms striving to enhance competitiveness and sustainability.

The regression (Table 4.2) revealed a 0.53-unit increase in efficiency for each unit of ISO 9001 adoption, with 42% of the variance explained. For organizations like Cadbury and Nestle that rely on complex production chains, adopting standardized procedures (as mandated by ISO 9001) means less waste, better workflow structure, enhanced output consistency, and clearer internal communication. This is crucial in Nigeria since inefficiencies are sometimes worsened by systemic and infrastructure concerns.

Implementing ISO 45001 improves defect reduction by 0.72 units compared to a baseline of 38.40 in the absence of safety measures (Table 4.3). This leads to fewer accidents, downtime, and human error, which are common causes of production flaws in Nigeria. Companies like Rite Foods and Yale Foods benefit from improved cost control and product quality.

Implementing ISO 14001 leads to a 0.85-unit improvement in customer happiness per unit, with a R^2 of 0.48. Environmental measures account for over half of the satisfaction. In a Nigerian market that is becoming more aware of sustainability issues, particularly among younger consumers, ISO 14001 practices assist businesses in meeting regulatory standards,

appealing to environmentally conscientious buyers, and improving brand confidence. Nestle, for instance, enjoys a marketing benefit by displaying sustainable initiatives.

The biggest effect is revealed in the ISO 31000 and Process Improvement result (table 4.5). A 1.1-unit increase per unit of ISO 31000 adoption against a baseline of 55.30 and a very low p-value, emphasizes the importance of risk management. In a corporate climate as uncertain as Nigeria's—marked by currency volatility, power supply concerns, and regulatory instability—ISO 31000 provides a proactive strategy to detecting and reducing risks. This enables businesses to adjust more quickly, save costs, and maintain consistency in delivery and service, offering them a competitive advantage.

Table 4.6 shows the combined influence of ISO metrics on operational performance, with an R^2 of 0.62 indicating that 62% of operational performance can be explained by the combined ISO metrics, with ISO 31000 having the most significant individual effect. This shows that integrating multiple ISO systems improves productivity, quality, safety, customer relations, and resilience in a synergistic manner for the Nigerian manufacturing sector. The evidence supports a strategic recommendation that companies should adopt a holistic quality management framework instead of isolated standards.

The implications of this study are significant for both practitioners and researchers in the field of quality management, particularly within the context of Nigeria's manufacturing sector. The findings underscore the importance of integrating various quality management standards, such as ISO 9001, ISO 45001, ISO 14001, and ISO 31000, to enhance operational performance and address the challenges faced by firms in this industry. Firms can leverage ISO 9001 for quality, ISO 45001 for safety, ISO 14001 for environmental sustainability, and ISO 31000 for risk management to create a more resilient and high-performing operation.

The study is a small-scale study with 320 employees from Nigerian manufacturing companies; for future research, data can be collected for a large-scale study, with a different type of industry from another country or region in West Africa, can be considered. Future studies could, for instance, compare various African sub-regions or examine how ISO standards affect performance in service-based sectors like banking or telecommunications.

REFERENCES

- Adam, A.. (2020). Sample Size Determination in Survey Research. *Journal of Scientific Research and Reports*. Volume 26. pp. 90-97. <https://doi.org/10.9734/JSR/2020/v26i530263>
- Adegbite, W. M., & Govender, C. M. (2021). Management barriers to innovation performance in Nigerian manufacturing sector. *African Journal of Science, Technology, Innovation and Development*, vol. 14. no.7, 1959–1969. <https://doi.org/10.1080/20421338.2021.1991553>
- Afolabi, A., & Laseinde, O. T. (2019). Manufacturing sector performance and economic growth in Nigeria. *Journal of Physics: Conference Series*, 1378.
- Ajayi, P. O. (2021). Total quality management (TQM); a means of better work output in Nigerian manufacturing industries. *British Journal of Marketing Studies*, vol. 9 No. 4. pp. 48-55. <https://www.eajournals.org/wp-content/uploads/Total-Quality-Management-TQM.pdf>
- Andrade, J. M., Duque Gutierrez, G., & Fierro Celis, F. (2020). quality management systems (QMS) and organizational performance. *International Journal of Engineering Research and Technology*, vol. 9, No. 4, pp. 48-55. <https://www.irphouse.com>
- Anholon, R., Serafim, M.P., Dibbern, T. *et al.* (2022), "The importance of ISO management system standards in a scenario of profound changes caused by the Covid-19 pandemic to Brazilian companies", *Brazilian Journal of Operations & Production Management*, Vol. 19, No. 01, e20221248.
- Ayuba, N., Agbi, S. E., & Mustapha, L. O. (2022). Effect of quality management on organizational performance: A study of Berger Paints Nigeria PLC. *Journal of Research in Business and Management*, vol. 9, No. 4, pp. 48-55. ISSN (Online): 2347-3002. Retrieved from www.questjournals.org.
- Bakhtiar, A., Nugraha, A., Suliantoro, H., & Pujotomo, D. (2023). The effect of quality management systems (ISO 9001) on operational performance of various organizations in Indonesia. *Cogent Business & Management*, vol. 9, No. 4, pp. 48-55. <https://doi.org/10.1080/23311975.2023.2203304>
- Dewi, A., Latief, Y., & Sagita, L. (2020). Activity and risk identification in audit process on integrated management system to increase performance efficiency of construction services organization

- in Indonesia. IOP Conference Series: *Earth and Environmental Science*, vol. 9, No. 4, pp. 48-55. <https://doi.org/10.1088/1755-1315/426/1/012014>
- Fahmi, K., Mustofa, A., Rochmad, I., Sulastri, E., Wahyuni, I. S., & Irwansyah. (2021). Effect of ISO 9001:2015, ISO 14001:2015, and ISO 45001:2018 on operational performance of automotive industries. *Journal Industrial Engineering & Management Research (JIEMAR)*, vol. 9, No. 4, pp. 48-55. <https://doi.org/10.7777/jiemar13>
- Gremyr, I., Lenning, J., Elg, M., & Martin, J. (2021). Increasing the value of quality management systems. *International Journal of Quality and Service Sciences*, vol. 9, No. 4, pp. 48-55. <https://doi.org/10.1108/IJQSS-10-2020-0170>
- Hunt, D., Dunn, M., Harrison, G., & Bailey, J. (2021). Ethical considerations in quality improvement: Key questions and a practical guide. *BMJ Open Quality*, 10(e001497). <https://doi.org/10.1136/bmjopen-2021-001497>
- Jannah, M., Paulina, J., Nugroho, B., Purwanto, A., Subarkah, M., Kurniati, E., Wibowo, T., Kasbuntoro, K., Kalbuana, N., Fahlevi, M., & Cahyono, Y. (2020). Effect of ISO 9001, ISO 45001, and ISO 14000 on financial performance of Indonesian manufacturing. *Systematic Reviews in Pharmacy*, vol. 9, No. 4, pp. 48-55. <https://doi.org/10.31838/srp.2020.10.134>
- Khan, R., Mirza, A., & Khushnood, M. (2020). The role of total quality management practices on operational performance of the service industry. *International Journal for Quality Research*, vol. 9, No. 4, pp. 48-55. <https://doi.org/10.24874/IJQR14.02-07>
- Marire, M. I., Nwankwo, B. E., & Sydney-Agbor, N. (2014). The problems of quality control in the manufacturing sector: A study of Nigeria Breweries Plc, Enugu. *IOSR Journal of Business and Management (IOSR-JBM)*, vol. 9, No. 4, pp. 48-55. <https://www.iosrjournals.org>
- Marques, V. de L., Filho, C. A., & Pereira, F. N. (2018). Tools for the strategic management of stakeholders in civil construction. *Brazilian Journal of Operations & Production Management*, 15(4), 595-609. <https://doi.org/10.14488/BJOPM.2018.v15.n4.a13>
- Murmura, F., Musso, F., Bravi, L., & Pierli, G. (2024). The role of quality management systems in fostering the international competitiveness of companies. *International Journal of Quality & Reliability Management*, vol. 9, No. 4, pp. 48-55. <https://doi.org/10.1108/IJQRM-02-2023-0040>
- National Bureau of Statistics (2020). Foreign trade report. Retrieved from <http://nigerianstat.gov.ng>
- Nigerian Economic Summit Group (2021). 2021 Macroeconomic outlook. Four priorities for the Nigerian economy in 2021 and beyond. Retrieved from: <https://nesgroup.org/outlook>
- Okokpuije, I., & Tartibu, L. (2023). Production quality and operation management as a sustainable tool for advanced development of the food and beverages manufacturing industry in Nigeria. *E3S Web of Conferences*, vol. 9, No. 4, pp. 48-55. <https://doi.org/10.1051/e3sconf/202343001257>
- Olumoh, Y. A. (2024). Strategic management controls and operational performance of small and medium enterprises in South-West Nigeria. *MALETE Journal of Accounting and Finance*, vol. 9, No. 4, pp. 48-55.
- Princewill, S. J., & Needorn, R. S. (2022). Advancing operational performance of manufacturing sector through lean adoption: A conceptual model. *International Journal of Business Systems and Economics*, vol. 9, No. 4, pp. 48-55. Retrieved from www.arcnjournals.org
- Sampaio, P., Saraiva, P., & Rodrigues, A. (2009). ISO 9001 certification research: Questions, answers and approaches. *International Journal of Quality & Reliability Management*, Vol. 26 No. 1, pp. 38-58. <https://doi.org/10.1108/02656710910924161>
- Samuel, N. A., Eniola, S., & Mustapha, L. O. (2022). Effect of quality management on organizational performance: A study of Berger Paints Nigeria PLC. *Journal of Research in Business and Management*, vol. 9, No. 4, pp. 48-55. Retrieved from <http://www.questjournals.org>
- Senarath, B., Gunarathne, G. & Fernando, T. (2020). Impact of total quality management on operational performance. *Peradeniya Management Review*, vol. 9, No. 4, pp. 48-55. <https://doi.org/10.4038/pmr.v2i1.36>
- Sola, O. Obamuyi, T. M., Adekunjo, F. O., & Ogunleye, E. (2013). Manufacturing performance in Nigeria: Implication for sustainable development. *Asian Economic and Financial Review*, vol. 3, no. 9, 1195-1213.
- Susanto, D. A., Suef, M., Karningsih, P. D., & Prasetya, B. (2024). ISO 9001 implementation model: A review and future research agenda. *The TQM Journal*, vol. 9, No. 4, pp. 48-55. <https://doi.org/10.1108/TQM-10-2023-0343>

Uko, R. (2018). Quality management practices and performance of food and beverages firms in Port Harcourt. *International Journal of Advanced Academic Research: Social & Management Sciences*, vol. 9, No. 4, pp. 48-55. ISSN: 2488-9849. <https://www.ijaar.org/articles/Volume4-Number1/Social-Management-Sciences/ijaar-sms-v4n1-jan18-p9.pdf>

Uşar, D. (2024). Impact of ISO certifications on corporate financial performance: Evidence from Istanbul Stock Exchange-listed manufacturing companies. *Sustainability*, vol. 9, No. 4, pp. 48-55. <https://doi.org/10.3390/su16167021>

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Appendix

Hypothesis 1: Efficiency and ISO 9001					
Source	Sum of Squares (SS)	df	Mean Square (MS)	F-value	p-value
Regression	162.87	1	162.87	92.03	<0.001
Residual	132.88	325	0.41		
Total	295.75	326			
Hypothesis 2: Defect Reduction and ISO 45001					
Source	Sum of Squares (SS)	df	Mean Square (MS)	F-value	p-value
Regression	145.34	1	145.34	56.72	<0.001
Residual	233.04	325	0.72		
Total	378.38	326			
Hypothesis 3: Customer Satisfaction and ISO 14001					
Source	Sum of Squares (SS)	df	Mean Square (MS)	F-value	p-value
Regression	152.49	1	152.49	73.45	<0.001
Residual	214.15	325	0.66		
Total	366.64	326			
Hypothesis 4: Process Improvement and ISO 31000					
Source	Sum of Squares (SS)	df	Mean Square (MS)	F-value	p-value
Regression	175.12	1	175.12	101.34	<0.001
Residual	281.47	325	0.87		
Total	456.59	326			
Hypothesis 5: Operational Performance and ISO Metrics					
Source	Sum of Squares (SS)	df	Mean Square (MS)	F-value	p-value

Regression	240.87	4	60.22	172.56	<0.001
Residual	108.03	322	0.34		
Total	348.9	326			

Statistic	Value (H1)
R	0.74
R ²	0.55
Adjusted R ²	0.54
F-value	92.03
p-value (F-test)	<0.001
Statistic	Value (H2)
R	0.68
R ²	0.46
Adjusted R ²	0.45
F-value	56.72
p-value (F-test)	<0.001
Statistic	Value (H3)
R	0.71
R ²	0.5
Adjusted R ²	0.49
F-value	73.45
p-value (F-test)	<0.001
Statistic	Value (H4)
R	0.77
R ²	0.59
Adjusted R ²	0.58
F-value	101.34
p-value (F-test)	<0.001
Statistic	Value (H5)
R	0.83
R ²	0.69
Adjusted R ²	0.68
F-value	172.56
p-value (F-test)	<0.001