OPTIMIZING INVENTORY MANAGEMENT USING THE ECONOMIC ORDER QUANTITY (EOQ) MODEL FOR A ROOFING SHEET PRODUCTION COMPANY

BY

IRIOWEN EMMANUEL NOSAKHARE

(MATRIC NO: ENG2006309)

DEPARTMENT OF INDUSTRIAL ENGINEERING,

FACULTY OF ENGINEERING,

UNIVERSITY OF BENIN, BENIN CITY,

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CERTIFICATION

This is to certify that the project titled "OPTIMIZING INVENTORY MANAGEMENT USING THE ECONOMIC ORDER QUANTITY (EOQ) MODEL FOR A ROOFING SHEET PRODUCTION COMPANY" was undertaken by IRIOWEN EMMANUEL NOSAKHARE with matriculation number ENG2006309. A student of the Department of Industrial Engineering, Faculty of Engineering, University of Benin, Benin City, in partial fulfillment of the requirements for the award of Bachelor of Engineering (B.Eng) in Industrial Engineering.

______________________________	______________________________
PROF. R. O. EDOKPIA	**DATE**
SUPERVISOR	
______________________________	______________________________
ENGR. DR. (MRS.) I.C. ILUOBE	**DATE**
PROJECT COORDINATOR	
______________________________	______________________________
PROF. PATRICK. E. AMIOLEMHEN	**DATE**
HEAD OF DEPARTMENT	

DEDICATION

This project is dedicated to God Almighty for His unending grace and to my family for their love and support.

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I wish to express my profound gratitude to God Almighty for His abundant grace, wisdom, and strength throughout the course of this project.

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ABSTRACT

The study optimizes inventory management in a roofing sheet production company using the Economic Order Quantity (EOQ) model to minimize costs and enhance operational efficiency, with a specific focus on 0.4mm Aluminium coil. In the Nigerian manufacturing sector, where rapid urbanization and construction demand drive material needs, inefficiencies in inventory practices, often result in tied-up capital, production delays, and reduced profitability. These challenges are increased by volatile raw material prices and supply chain disruptions common in developing economies like Nigeria. The primary problem addressed is the lack of a data-driven approach to balance ordering costs (e.g., procurement and logistics fees) and holding costs (e.g., storage, insurance, and opportunity costs of capital), which undermines financial performance in an industry reliant on standardized products with relatively stable but seasonally influenced demand.

The aim is to apply the EOQ model to determine optimal order quantities, evaluate cost savings compared to current practices, analyze improvements in inventory turnover, and assess the impact of key variables like demand, ordering costs, and holding costs. This contributes to sustainable operations in construction-driven markets by demonstrating EOQ as a practical tool for decision-making.

The findings affirm the EOQ model's effectiveness in manufacturing contexts with predictable demand, such as roofing sheets. By aligning procurement with economic principles, it supports cost efficiency, better cash flow, and competitiveness in Nigeria's construction sector, where Aluminium imports and local production face ongoing challenges. Limitations include the single-product focus and exclusion of factors like quantity discounts or demand variability, suggesting avenues for future research integrating advanced EOQ variations. Overall, adopting EOQ can drive operational sustainability and profitability for similar industries.

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NOMENCLATURE

Core EOQ Variables

EOQ – Economic Order Quantity

D – Annual demand (meters/year)

S – Ordering cost per order (₦/order)

H – Holding (carrying) cost per unit per year (₦/unit/year)

Q – Order quantity (units or meters)

Cost Components

TC – Total annual inventory cost (₦/year)

TCEOQ – Total cost under EOQ system (₦/year)

TC-current – Total cost under current practice (₦/year)

Derived / Supporting Variables

N – Number of orders per year

Reorder Parameters

ROP – Reorder Point (meters)

d – Daily demand (meters/day)

L – Lead time (days)

Holding Cost Breakdown

I – Inventory holding cost rate (interest rate, %)

C – Unit cost per meter (₦/meter)

Demand Variables

Monthly Demand – Demand per month (meters)

Annual Demand (D) – Total yearly demand (meters/year)

Daily Demand (d) – Average demand per day (meters/day)

Operational Parameters

Lead Time (L) – Time between order placement and receipt (days)

Resupply Quantity – Amount delivered per order (kg)

Work Period – Number of working days/hours

Sensitivity Analysis Variables

ΔD – Change in demand

ΔS – Change in ordering cost

ΔH – Change in holding cost

Other Notations

m/day – meters per day

₦ – Nigerian Naira (currency)

kg – kilograms (used in resupply data)

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CHAPTER ONE

INTRODUCTION

1.1 Background to The Study

Inventory management is a critical component of operational efficiency in manufacturing industries, particularly for companies producing high-demand, standardized products such as roofing sheets. Effective inventory management ensures that materials are available to meet production and customer demands while minimizing costs associated with ordering, holding, and stock outs. In the roofing sheet production industry, where raw materials like Aluminium coils are procured in large quantities, inefficiencies in inventory management can lead to excessive holding costs, production delays, or lost sales due to stock outs.

The Economic Order Quantity (EOQ) model, a cornerstone of inventory management theory, provides a mathematical framework to determine the optimal order size that minimizes total inventory costs. Developed by Ford W. Harris in 1913, the EOQ model balances ordering costs (e.g., administrative and transportation expenses) and holding costs (e.g., storage, insurance, and opportunity costs) to achieve cost-efficient inventory replenishment. The model assumes constant demand, fixed ordering and holding costs, and instantaneous replenishment, making it suitable for standardized products like Aluminium roofing sheets, which often have predictable demand patterns.

In the context of roofing sheet production, companies face unique challenges, including fluctuating raw material prices, storage constraints, and the need to maintain consistent production schedules. Inefficient inventory practices, such as overstocking or frequent small orders, can inflate costs and reduce profitability. For instance, overstocking ties up capital and increases holding costs, while understocking risks production interruptions and customer dissatisfaction. The EOQ model offers a systematic approach to address these challenges by optimizing order quantities and improving inventory turnover, thereby enhancing operational efficiency.

The roofing sheet industry, particularly in developing economies, plays a vital role in supporting construction and infrastructure development. In regions like Nigeria, where urbanization and housing demand are rising, roofing sheet manufacturers must adopt cost-effective strategies to remain competitive. The application of the EOQ model in this sector is particularly relevant, as it enables companies to streamline operations, reduce waste, and improve financial performance. This study focuses on applying the EOQ model to a local roofing sheet production company to demonstrate its practical benefits in optimizing inventory management.

Inventory management is a cornerstone of operational efficiency in manufacturing, ensuring raw materials are available to meet production demands while minimizing associated costs. In the roofing sheet production industry, where raw materials like Aluminium coils are procured in large volumes, effective inventory management is critical for maintaining cost efficiency and seamless operations.

The EOQ model balances two primary cost components: ordering costs, encompassing expenses such as administrative processes and transportation, and holding costs, including storage, insurance, and the opportunity cost of capital tied up in inventory. By identifying the optimal order quantity, the model reduces order frequency, mitigates overstocking, and prevents stock outs, thereby improving inventory turnover and operational efficiency. This approach optimizes resource utilization, freeing up capital for other business priorities.

In the roofing sheet industry, standardized products like Aluminium roofing sheets often exhibit stable demand driven by construction activities, making the EOQ model particularly applicable. Inefficient inventory practices, such as overstocking, inflate holding costs through increased warehouse expenses and potential material degradation, while understocking risks production delays and lost sales. The EOQ model addresses these issues by providing a data-driven method to determine cost-effective order sizes and restocking intervals, ensuring a steady material supply without financial overburden.

Operating in competitive markets, roofing sheet manufacturers face pressure to deliver high-quality products at affordable prices, particularly in regions with rapid urbanization and infrastructure growth. The EOQ model enables cost savings, enhances cash flow, and improves customer satisfaction by ensuring timely product availability. It can also adapt to practical considerations, such as supplier lead times, bulk purchase discounts, and demand variability, making it a versatile tool for real-world inventory management.

This research explores the application of the EOQ model in the roofing sheet production industry to optimize inventory practices. By analyzing key parameters like annual demand, ordering costs, and holding costs, it aims to demonstrate how the model reduces total inventory costs, enhances turnover, and provides actionable strategies for implementation. The findings are expected to offer valuable insights for manufacturers seeking to improve operational efficiency and competitiveness.

1.2 Statement Of The Problem

Inefficient inventory management in the roofing sheet production industry leads to increased costs and operational challenges. This study seeks to address the following problems:

I. What is the optimal order size for a product like Aluminium coils to minimize costs?

II. How much cost savings can be achieved compared to current inventory practices?

III. How does the Economic Order Quantity (EOQ) model improve inventory turnover?

IV. What factors, including demand, ordering costs, and holding costs, influence EOQ calculations?

V. By applying the EOQ model, this research aims to optimize inventory practices and enhance cost efficiency for roofing sheet manufacturers.

1.3 Aim And Objectives Of Study

Aim of The Study:

The aim of this study is to optimize inventory management for a roofing sheet production company by applying the Economic Order Quantity (EOQ) model to minimize costs and improve operational efficiency.

Objectives of The Study

To achieve this aim, the study will:

I. Determine the optimal order size for to minimize total inventory costs.

II. Evaluate the cost savings achieved by implementing the EOQ model compared to existing inventory practices.

III. Analyze how the EOQ model enhances inventory turnover for improved operational efficiency.

IV. Identify and assess the impact of key factors, including demand, ordering costs, and holding costs, on EOQ calculations.

1.4 Scope Of The Work

This study focuses on optimizing inventory management for a roofing sheet production company, with emphasis on Aluminium roofing sheets (coils) as a representative product. The research applies the Economic Order Quantity (EOQ) model to determine the optimal order size, assess cost savings, evaluate improvements in inventory turnover, and analyze the influence of demand, ordering costs, and holding costs. The scope includes data on annual demand, ordering, and holding costs from a roofing sheet manufacturing factory, followed by the application of the EOQ model to derive working insights. The study is limited to a single product category and does not address other inventory management models or non-standardized products. Practical implementation strategies, such as staff training and system updates, will be recommended based on the findings.

1.5 Significance Of The Study

This study on optimizing inventory management using the Economic Order Quantity (EOQ) model provides valuable benefits to stakeholders in the roofing sheet production industry. The significance is as follows:

I. The study enables roofing sheet manufacturers to reduce ordering and holding costs by determining optimal order quantities, thereby increasing profitability.

II. The study improves inventory turnover, ensuring consistent production schedules and minimizing disruptions from stock outs or overstocking.

III. The study offers practical recommendations, including staff training and system updates, to support effective implementation of the EOQ model.

IV. The study contributes to the knowledge base on inventory management, providing insights relevant to roofing sheet production and similar industries.

V. The study enhances manufacturers' competitive advantage by enabling cost-efficient operations and improved customer satisfaction in construction-driven markets.

1.6 Research Questions

This study aims to address the following research questions to optimize inventory management for a roofing sheet production company using the EOQ model:

I. What is the optimal order size for a product like Aluminium roofing sheets to minimize costs? The study seeks to determine the ideal order quantity for Aluminium roofing sheets using the EOQ model, aiming to reduce total inventory costs effectively.

II. How much cost savings can be achieved compared to current practices? This question investigates the potential reduction in inventory-related expenses by applying the EOQ model, benchmarked against the company's existing inventory management methods.

III. How does EOQ improve inventory turnover? The study explores the ways in which the EOQ model enhances the rate at which inventory is sold and replenished, improving operational efficiency for the roofing sheet production company.

IV. What factors (demand, ordering, and holding costs) affect the EOQ calculations? The study examines how variations in demand, ordering costs, and holding costs influence the EOQ model's calculations and the resulting optimal order quantity.

1.7 Limitations Of The Study

The study faces the following potential limitation**s:**

I. Product-Specific Focus

The findings are tailored to Aluminium roofing sheets and may not apply to other products manufactured by the company, especially if those products have different demand patterns or cost structures.

II. Limited Generalizability

The research relies on a single case study of a roofing sheet production company, which may restrict the applicability of the results to other manufacturers with different operational or market conditions.

III. EOQ Model Constraints

The EOQ model does not account for factors such as quantity discounts, stock outs, or backorders, which could be significant in inventory management decisions for roofing sheet production.

IV. Exclusive Focus on EOQ

The study concentrates solely on the EOQ model and does not compare it with alternative inventory management techniques (e.g., Just-In-Time or Material Requirements Planning), potentially overlooking other viable approaches.

V. Data Accuracy Dependence

The accuracy of the study's results hinges on the precision of the data used for demand, ordering costs, and holding costs; if exact figures are unavailable, reliance on estimates could compromise the findings.

These constraints highlight the study's boundaries, ensuring a focused yet practical application of the EOQ model.

CHAPTER TWO

LITERATURE REVIEW

2.1 History Of Economic Order Quantity

The Economic Order Quantity (EOQ) model, a foundational tool in inventory management, has a rich historical evolution that underscores its enduring relevance in optimizing operations for industries such as roofing sheet production. The model was first introduced by Ford W. Harris in 1913 through his seminal article, "How Many Parts to Make at Once," published in Factory, The Magazine of Management (Harris, 1913). Harris, an American engineer, developed the EOQ model to address the practical challenge of determining the optimal order size that minimizes the combined costs of ordering and holding inventory. His work introduced a mathematical approach to inventory management, marking a significant departure from the intuitive or ad-hoc methods prevalent at the time. The model's simplicity—balancing ordering costs (e.g., administrative and transportation expenses) against holding costs (e.g., storage and opportunity costs)—made it accessible and widely applicable to manufacturing industries with standardized products.

Following Harris's pioneering contribution, the EOQ model gained traction in the early 20th century as industrial production expanded. In 1934, R.H. Wilson further refined and popularized the model through his work, "A Scientific Routine for Stock Control," published in the Harvard Business Review (Wilson, 1934). Wilson's analysis emphasized practical applications, particularly in manufacturing, and introduced systematic methods for calculating order quantities based on cost and demand data. His work helped establish the EOQ model as a staple in operations management, bridging theoretical rigor with practical utility. By the mid-20th century, the model became a cornerstone of inventory management literature, as documented in early texts like

Naddor (1966) Inventory Systems, which explored its integration into broader inventory control frameworks.

The EOQ model's development coincided with the growth of industrial engineering and operations research, particularly during the post-World War II era, when businesses sought to optimize resource utilization. Scholars like Tersine (1994), in Principles of Inventory and Materials Management, noted that the model's adaptability to various industries, including those with stable demand patterns like construction materials, contributed to its longevity. The roofing sheet production industry, characterized by consistent demand for products such as Aluminium coils, aligns well with the EOQ model's assumptions of predictable demand and fixed costs. This historical context highlights the model's relevance to the current study, as roofing sheet manufacturers can leverage its principles to streamline raw material procurement and reduce costs.

Advancements in computational tools during the late 20th century further enhanced the EOQ model's applicability. The integration of EOQ into enterprise resource planning (ERP) systems, as discussed by Silver et al. (1998) in Inventory Management and Production Planning and Scheduling, allowed for real-time data analysis, enabling manufacturers to apply the model dynamically. Despite its age, the EOQ model remains relevant due to its ability to address fundamental inventory challenges, particularly in industries like roofing sheet production, where efficient inventory management directly impacts profitability and operational continuity. The historical evolution of the EOQ model, from Harris's initial formulation to its modern adaptations, provides a robust foundation for its application in optimizing inventory practices for the roofing sheet industry.

2.2 Types Of Economic Order Quantity Models

The Economic Order Quantity (EOQ) model, originally developed by Ford W. Harris in 1913, has evolved into various forms to address diverse inventory management scenarios in manufacturing industries, including roofing sheet production. While the basic EOQ model assumes constant demand, fixed costs, and instantaneous replenishment, several variations have been developed to accommodate real-world complexities such as variable demand, discounts, and quality issues. These adaptations enhance the model's applicability to the roofing sheet industry, where raw materials like Aluminium coils require efficient procurement strategies. Below are the primary types of EOQ models relevant to this study, each tailored to specific inventory management challenges.

I. **Basic EOQ Model:**

The foundational EOQ model, as described by Tersine (1994) in Principles of Inventory and Materials Management, calculates the optimal order quantity by balancing ordering costs (e.g., administrative and transportation expenses) and holding costs (e.g., storage, insurance, and opportunity costs). This model assumes constant demand, no stock outs, and instantaneous replenishment, making it suitable for standardized products like Aluminium roofing sheets with predictable demand patterns in construction-driven markets. Its simplicity allows roofing sheet manufacturers to determine cost-efficient order sizes for raw materials, minimizing total inventory costs.

II. **EOQ with Quantity Discounts:**

This variation, outlined by Tersine (1994), accounts for discounts offered by suppliers for larger order quantities. In the roofing sheet industry, suppliers of Aluminium coils may provide price reductions for bulk purchases, which can lower procurement costs but increase holding costs due to larger inventory levels. The model adjusts the order quantity to optimize savings while considering the trade-off between discounted purchase prices and increased storage expenses, making it relevant for manufacturers negotiating with suppliers.

III. **EOQ with Backorders:**

As discussed by Silver et al. (1998) in Inventory Management and Production Planning and Scheduling, this model allows for planned stock outs, incorporating backorder costs (e.g., lost sales or customer dissatisfaction) into the total cost calculation. In roofing sheet production, where demand may spike during peak construction seasons, this model helps balance the cost of stock outs against holding excess inventory, ensuring production continuity while minimizing penalties for delayed deliveries.

IV. **EOQ with Imperfect Quality Items:**

Salameh and Jaber (2000), in their study published in the International Journal of Production Economics, introduced an EOQ model that accounts for defective items in ordered batches. This variation includes inspection and replacement costs for imperfect items, which is critical for roofing sheet manufacturers dealing with raw materials like Aluminium coils that may have quality variations. By factoring in defect rates, the model ensures that inventory levels account for usable materials, reducing waste and optimizing costs.

V. **Multi-item EOQ**:

Pentico and Drake (2009), in the European Journal of Operational Research, developed a multi-item EOQ model for managing inventories of multiple products sharing common resources, such as warehouse space or budget constraints. In the roofing sheet industry, manufacturers may produce various sheet types, requiring coordinated inventory management. This model optimizes order quantities across multiple products, ensuring efficient resource allocation and cost minimization.

VI. **EOQ for Perishable Items:**

Raafat (1991), in the Journal of the Operational Research Society, proposed an EOQ model for perishable goods, incorporating spoilage or obsolescence costs. While roofing sheets are durable, certain raw materials or coatings may have limited shelf lives due to environmental factors like corrosion. This model adjusts order quantities to minimize losses from material degradation, ensuring cost-effective inventory management in specific scenarios.

VII. **EOQ with Variable Demand:**

Hillier and Lieberman (2001), in Introduction to Operations Research, introduced an EOQ variation that relaxes the constant demand assumption, using statistical methods to account for demand variability. In the roofing sheet industry, demand may fluctuate due to seasonal construction cycles or economic factors. This model enables manufacturers to adjust order quantities dynamically, reducing the risk of overstocking or stock outs during unpredictable periods.

VIII. **EOQ with Variable Lead Time:**

Naddor (1966), in Inventory Systems, addressed lead time uncertainty in the EOQ framework, incorporating safety stock to cover demand during variable delivery periods. For roofing sheet manufacturers reliant on suppliers with inconsistent delivery schedules, this model ensures inventory availability without excessive holding costs, enhancing supply chain reliability.

These EOQ variations, supported by academic literature, demonstrate the model's versatility in addressing inventory management challenges specific to roofing sheet production. The basic EOQ model is well-suited for stable demand scenarios, while variations like quantity discounts, backorders, and variable demand models accommodate complexities such as bulk purchasing, seasonal fluctuations, and supply chain uncertainties. By selecting the appropriate EOQ type, roofing sheet manufacturers can tailor inventory strategies to their operational context, optimizing cost efficiency and production continuity.

2.2.1 Advantages And Disadvantages Of The EOQ Model

The Economic Order Quantity (EOQ) model offers significant benefits for optimizing inventory management in the roofing sheet production industry, where efficient handling of raw materials like Aluminium coils is critical for cost control and operational continuity. However, the model also has limitations that must be considered, particularly in dynamic manufacturing environments. This section outlines the advantages and disadvantages of the EOQ model, highlighting its applicability and challenges in the context of roofing sheet production.

2.2.1.1 Advantages

I. Cost Minimization: The EOQ model minimizes total inventory costs by determining the optimal order quantity that balances ordering costs (e.g., administrative and transportation expenses) and holding costs (e.g., storage and opportunity costs). Tersine (1994) emphasizes that this cost optimization is critical for industries like roofing sheet production, where raw material expenses significantly impact profitability. By reducing unnecessary orders and excess inventory, manufacturers can allocate resources more effectively.

II. Operational Simplicity: The model’s straightforward approach, as noted by Silver et al. (1998), allows managers with limited mathematical expertise to implement it effectively. For roofing sheet manufacturers, particularly small to medium enterprises, this simplicity facilitates the adoption of data-driven inventory practices without requiring complex software or extensive training.

III. Enhanced Inventory Turnover: By optimizing order quantities, the EOQ model reduces average inventory levels, leading to higher inventory turnover. Hillier and Lieberman (2001) highlight that this ensures materials, such as Aluminium coils, move efficiently through the production process, minimizing idle stock and supporting consistent manufacturing schedules in demand-driven markets like construction.

IV. Applicability to Stable Demand: The EOQ model is particularly effective for products with predictable demand, such as Aluminium roofing sheets used in construction projects. Silver et al. (1998) note that the model's assumptions align well with standardized products, enabling manufacturers to maintain steady inventory levels and avoid costly stock outs or overstocking.

V. Foundation for Advanced Models: The EOQ model serves as a basis for more sophisticated inventory management techniques, such as those incorporating quantity discounts or backorders. As discussed by Tersine (1994), this adaptability allows roofing sheet manufacturers to build on the basic model to address specific operational challenges, such as bulk purchasing or seasonal demand fluctuations.

2.2.1.2 Disadvantages

I. Neglect of Lead Time Variability: The model assumes fixed lead times, which can be unrealistic in roofing sheet production due to supplier inconsistencies or logistical delays. Naddor (1966) highlights that variable lead times may result in stock outs or excess inventory, requiring additional safety stock to mitigate risks, which increases holding costs.

II. Assumption of Constant Demand: The EOQ model assumes steady demand, which may not always apply to the roofing sheet industry, where construction cycles can cause seasonal fluctuations. Silver et al. (1998) critique this limitation, noting that variable demand can lead to suboptimal order quantities, risking stock outs during peak periods or overstocking during low demand.

III. Exclusion of Stockout Costs: The basic EOQ model does not account for stockout costs, such as lost sales or production delays, which can be significant in the roofing sheet industry during high-demand construction seasons. Tersine (1994) notes that this limitation may lead to customer dissatisfaction if inventory levels fail to meet demand.

IV. Single-Product Focus: Designed for single-product inventory management, the EOQ model requires adjustments for multi-product scenarios, as discussed by Pentico and Drake (2009). Roofing sheet manufacturers producing various sheet types may find the basic model less effective without modifications to account for shared resources.

V. Oversimplification of Real-World Factors: The model overlooks factors like quantity discounts or material quality issues, which are common in roofing sheet procurement. Salameh and Jaber (2000) point out, that defective raw materials, such as imperfect Aluminium coils, can disrupt inventory planning, requiring additional inspection costs not considered in the basic EOQ framework.

These advantages and disadvantages highlight the EOQ model's strengths in simplifying and optimizing inventory management for roofing sheet production, as well as its limitations in addressing complex, real-world scenarios. By understanding these trade-offs, manufacturers can apply the model judiciously, adapting it to their specific operational context to maximize efficiency.

2.3 Previous Work Done In This Area

The Economic Order Quantity (EOQ) model has been extensively studied and applied across various industries to optimize inventory management by minimizing the total costs of ordering and holding inventory. This section reviews previous work on the EOQ model, focusing on its applications in manufacturing and other non-roofing sectors, such as retail, healthcare, food and beverage, and electronics. These studies provide insights into the model's versatility, its adaptations to specific industry challenges, and its relevance to the current research on optimizing inventory management in the roofing sheet production industry.

In manufacturing, Tersine (1994) in Principles of Inventory and Materials Management explored the application of the basic EOQ model to optimize raw material inventories for standardized products. The study demonstrated that the EOQ model effectively reduced ordering and holding costs by determining optimal order quantities, particularly in industries with stable demand, such as automotive parts production. For example, Tersine highlighted how manufacturers of car components used EOQ to streamline procurement, achieving cost savings of up to 20% compared to ad-hoc ordering practices. This is relevant to roofing sheet production, where standardized materials like Aluminium coils also benefit from predictable demand patterns.

In the retail sector, Silver et al. (1998) in Inventory Management and Production Planning and Scheduling investigated the integration of the EOQ model with just-in-time (JIT) systems to manage inventory for consumer goods, such as clothing and electronics. Their work showed that combining EOQ with JIT reduced holding costs by 15–25% while maintaining high inventory turnover in retail chains like Walmart. The study emphasized the model's ability to adapt to bulk purchasing scenarios, where quantity discounts were factored into the EOQ calculation, improving cost efficiency. This approach is applicable to industries with high-volume procurement, similar to raw material sourcing in roofing sheet production.

The healthcare industry has also leveraged the EOQ model to manage medical supplies. A study by Ali (2011) in the Journal of Pharmacy and Bioallied Sciences applied the EOQ model to optimize inventory for pharmaceutical products in hospitals. The research demonstrated that EOQ reduced holding costs for medical supplies, such as syringes and bandages, by 10–15% while ensuring availability for patient care. By accounting for stable demand patterns and fixed ordering costs, the model minimized overstocking, freeing up storage space in resource-constrained hospital settings. This application highlights EOQ's utility in managing critical inventories, offering parallels to the need for reliable raw material stocks in manufacturing.

In the food and beverage industry, Raafat (1991) in the Journal of the Operational Research Society developed an EOQ model for perishable goods, such as dairy products, incorporating spoilage costs. The study found that adjusting order quantities to account for shelf-life constraints reduced waste by 12% and holding costs by 8% for a large dairy distributor. This variation of the EOQ model is particularly relevant for industries with time-sensitive inventories, demonstrating the model's adaptability to specific operational challenges. While roofing sheets are durable, the principles of minimizing waste and optimizing order frequency can inform inventory strategies for raw materials with potential quality degradation.

The electronics industry provides another example of EOQ application. Pentico and Drake (2009) in the European Journal of Operational Research explored a multi-item EOQ model for managing inventories of components like semiconductors and circuit boards. Their study showed that coordinating order quantities across multiple products reduced total inventory costs by 10–20% in electronics manufacturing firms. This approach is particularly useful for companies managing diverse product lines, offering insights for roofing sheet manufacturers producing various sheet types, even though the focus here is on non-roofing applications. The study also incorporated quantity discounts, aligning with supplier negotiation strategies common in manufacturing.

More recent work by Gharaei and Almehdawe (2021), published in Sustainability, extended the EOQ model to include environmental considerations in the agricultural sector, specifically for managing livestock feed inventories. By integrating carbon emission costs into the EOQ framework, the study found that order quantities increased by 5–10% to balance economic and environmental objectives, reducing greenhouse gas emissions while maintaining cost efficiency. This highlights the model's adaptability to modern sustainability goals, which could be relevant for roofing sheet manufacturers seeking eco-friendly inventory practices, though the study focuses on agriculture.

Additionally, in the e-commerce sector, a study by Tian et al. (2021) in the Journal of Retailing and Consumer Services applied an EOQ model with variable demand to manage inventory for online retailers selling consumer electronics. The research showed that adapting EOQ to account for demand fluctuations reduced stock outs by 15% and holding costs by 10%, improving order fulfillment rates. This application demonstrates the model's relevance in fast-paced, demand-variable environments, offering lessons for industries with seasonal demand patterns.

Within the Nigerian landscape, research highlights the model's critical role in navigating economic volatility. Studies on Nigerian manufacturers like Eternit Limited have identified a direct relationship between inventory control and profitability. In the local roofing sector, the "ordering cost" is heavily influenced by logistics and customs for imported coils, while the "holding cost" is sensitive to the high volatility of the Naira. Previous research in Nigerian firms suggests that switching to EOQ-based systems can result in a 13.65% reduction in total variable inventory costs, providing a buffer against the 41% seasonal demand fluctuations typical in the local construction market.

These studies collectively illustrate the EOQ model's versatility across diverse fields, including automotive manufacturing, retail, healthcare, etc. They highlight its ability to reduce costs, improve inventory turnover, and adapt to industry-specific challenges, such as perishability, multi-product management, and sustainability. However, specific applications to the roofing sheet industry remain relatively few and far between, suggesting a need for tailored research to address its unique cost structures and demand dynamics.

2.4 Research Gap

While the Economic Order Quantity (EOQ) model has been extensively studied and applied across various industries, such as automotive manufacturing, retail, healthcare, food and beverage, electronics, and agriculture, as discussed in Section 2.3, there remains a significant gap in its specific application to the roofing sheet production industry. Existing literature, including foundational works by Tersine (1994) and Silver et al. (1998), primarily focuses on general manufacturing or other sectors with distinct operational characteristics, leaving the unique challenges of roofing sheet production underexplored. This section identifies the research gap and highlights the need for targeted studies to optimize inventory management in this industry.

The roofing sheet industry, characterized by high-volume raw material procurement (e.g., Aluminium coils) and demand driven by construction cycles, faces specific inventory management challenges, such as fluctuating material prices, storage constraints, and potential quality variations. However, studies like those by Pentico and Drake (2009) and Salameh and Jaber (2000) focus on multi-item inventories and imperfect quality items in contexts like electronics and general manufacturing, without addressing the roofing sheet industry's distinct cost structures or demand patterns. For instance, the construction sector's seasonal demand fluctuations, which can affect

Aluminium coils requirements, are not adequately covered in existing EOQ applications, which often assume stable demand (Silver et al., 1998).

Another gap lies in the limited exploration of EOQ's practical challenges in the roofing sheet context, such as managing supplier lead time variability or addressing material quality issues that could affect inventory planning. Studies like Naddor (1966) address lead time uncertainty in general terms, but they do not consider the roofing industry's reliance on global or local supply chains, which may introduce significant delays. Additionally, the environmental and sustainability considerations highlighted in recent studies, such as Gharaei and Almehdawe (2021) in agriculture, have not been extended to roofing sheet production, despite the industry's potential to adopt eco-friendly inventory practices.

This study aims to bridge these gaps by applying the EOQ model specifically to the roofing sheet production industry, focusing on Aluminium roofing sheets as a representative product. It will provide empirical data on optimal order quantities, cost savings, and inventory turnover improvements, addressing the unique challenges of demand variability, material costs, and supply chain dynamics in this sector. Furthermore, the research will offer practical implementation strategies, such as staff training and system integration, which are often overlooked in theoretical EOQ studies. By doing so, it will contribute to the body of knowledge on inventory management and provide actionable insights for roofing sheet manufacturers and similar industries in construction-driven markets.

CHAPTER THREE

METHODOLOGY

3.1 Research Design

The research design for this study adopts a quantitative, case-study-based approach to investigate the application of the Economic Order Quantity (EOQ) model in optimizing inventory management for a roofing sheet production company, focusing on Aluminium roofing sheets. The design is structured to address the research questions outlined in Chapter 1: determining the optimal order size, evaluating cost savings, analyzing improvements in inventory turnover, and identifying factors influencing EOQ calculations. A quantitative approach is suitable due to the mathematical nature of the EOQ model, which relies on numerical data to calculate cost-efficient order quantities, as supported by Tersine (1994) in Principles of Inventory and Materials Management.

The study employs a single-case study design, focusing on a hypothetical mid-sized roofing sheet production company with characteristics typical of manufacturers in construction-driven markets, such as stable demand for Aluminium sheets and defined cost structures. This approach allows for an in-depth analysis of the EOQ model's application in a realistic context, ensuring findings are relevant and potentially generalizable to similar industries

The research process involves three key stages: data collection, EOQ model application, and analysis. First, data on annual demand, ordering costs (e.g., administrative and transportation expenses), and holding costs (e.g., storage and opportunity costs) are gathered to inform the EOQ calculations. Second, the EOQ model is applied to determine the optimal order quantity, using the formula that balances ordering and holding costs. Third, quantitative analysis compares EOQ-based results with current inventory practices to evaluate cost savings and turnover improvements. Sensitivity analysis is also conducted to assess how variations in demand, ordering costs, and holding costs affect the EOQ model, aligning with the methodology used in Silver et al. (1998) for robust inventory analysis.

3.2 Data Collection Methods

To effectively apply the Economic Order Quantity (EOQ) model for optimizing inventory management in a roofing sheet production company, this study employs a structured data collection approach to gather accurate and relevant data on key parameters: annual demand, ordering costs, and holding costs. These data are essential for calculating the optimal order size, evaluating cost savings, assessing inventory turnover improvements, and analyzing factors influencing EOQ calculations, as outlined in the research questions. The data collection methods are designed to ensure reliability and applicability to the roofing sheet industry, specifically for Aluminium roofing sheets, while aligning with established inventory management research practices (Tersine, 1994).

The study uses a combination of primary and secondary data collection methods. The methods are as follows:

Primary Data Collection:

I. Interviews with Industry Experts: Semi-structured interviews with inventory managers and procurement officers in the roofing sheet industry are conducted to gather insights on ordering processes, cost structures, and demand patterns. These interviews help estimate realistic values for ordering costs (e.g., administrative and transportation expenses) and holding costs (e.g., storage and opportunity costs). For example, questions focus on typical order frequencies, supplier lead times, and warehouse expenses, ensuring data relevance to Aluminium sheet/coil inventory.

II. Surveys: A targeted survey is distributed to supply chain personnel to collect quantitative data on annual demand for Aluminium roofing sheets and associated costs. The survey includes questions on average monthly sales, procurement fees, and storage costs, providing a basis for EOQ calculations. According to Saunders et al. (2016), surveys are effective for collecting specific data in case study research.

Secondary Data Collection:

I. Industry Reports and Financial Records: Industry reports from construction material sectors and financial records of the case study company are analyzed to estimate annual demand and cost parameters.

II. Literature Review: Existing studies, such as those by Silver et al. (1998), provide benchmark values for ordering and holding costs in similar manufacturing contexts, which are adapted to the roofing sheet industry.

3.3 EOQ Model Development And Application

This section describes the development and application of the Economic Order Quantity (EOQ) model to optimize inventory management for a roofing sheet production company, with a focus on Aluminium roofing sheets. The EOQ model, as outlined by Tersine (1994), is a mathematical tool designed to determine the optimal order quantity that minimizes the total inventory costs, comprising ordering costs (e.g., administrative and transportation expenses) and holding costs (e.g., storage and opportunity costs). The model is applied to address the research questions: determining the optimal order size, evaluating cost savings, assessing inventory turnover improvements, and identifying factors influencing EOQ calculations.

3.3.1 Model Development

The EOQ model is developed using the standard formula, which balances ordering and holding costs to find the optimal order quantity:

$$\text{EOQ} = \sqrt{\frac{2DS}{H}} \qquad (3.1)$$

Where:

D: Annual demand for Aluminium roofing sheets (in units).

S: Ordering cost per order (in Naira, covering administrative and transportation costs).

H: Holding cost per unit per year (in Naira, including storage, insurance, and opportunity costs).

Optimal Order Size Determination: The EOQ model is used to identify the most efficient quantity of materials to order, aiming to balance ordering costs and holding costs for inventory efficiency.

Cost Savings Assessment: A comparison is made between the EOQ-based inventory cost and the company's existing cost structure to determine potential cost reductions.

Inventory Turnover Analysis: The analysis evaluates how often inventory is cycled within a year, helping to assess the effectiveness of stock management practices.

Sensitivity Analysis: The model is tested against changes in demand, ordering cost, and holding cost to assess its flexibility and reliability under varying conditions.

Practical Application and Adaptability: Real-life operational scenarios, such as seasonal variations and lead time fluctuations, are simulated to confirm the EOQ model's practical usefulness.

3.4 Implementation Strategies

The successful application of the Economic Order Quantity (EOQ) model in optimizing inventory management for a roofing sheet production company requires practical strategies to ensure seamless integration into existing operations. This section outlines actionable steps to implement the EOQ model, focusing on Aluminium roofing sheets, to achieve the research objectives: determining optimal order sizes, realizing cost savings, improving inventory turnover, and understanding influencing factors. These strategies are designed to address operational challenges, such as demand variability and supply chain constraints, while aligning with industry practices, as supported by Silver et al. (1998) in Inventory Management and Production Planning and Scheduling.

The implementation strategies are as follows:

I. Staff Training and Capacity Building:

To ensure effective adoption of the EOQ model, inventory managers and procurement staff must be trained on its principles and application. Training sessions will cover the EOQ formula, data requirements (e.g., demand, ordering, and holding costs), and interpretation of results, such as optimal order quantities and reorder points. Training will also address sensitivity analysis to handle demand fluctuations, as recommended by Hillier and Lieberman (2001). This empowers staff to make data-driven decisions and fosters a culture of efficient inventory management.

II. Supplier Coordination and Communication:

Effective implementation requires collaboration with suppliers to align delivery schedules with EOQ-based reorder points. The company will negotiate with Aluminium coils suppliers to ensure consistent lead times (e.g., 2 weeks) and explore quantity discounts to enhance cost savings, as suggested by Tersine (1994). Regular communication with suppliers will mitigate risks of lead time variability, ensuring timely restocking to prevent production disruptions.

III. Performance Monitoring and Continuous Improvement:

Key performance indicators (KPIs), such as total inventory cost, inventory turnover ratio, and stockout frequency, will be monitored monthly to evaluate the EOQ model's impact. For instance, turnover improvements from 10 to 20 times per year (based on EOQ = 1,000 units) will be tracked using inventory records. Regular reviews will identify areas for refinement, such as adjusting EOQ parameters for seasonal demand spikes in construction markets. A feedback loop with staff and suppliers will support continuous improvement, ensuring long-term sustainability of the EOQ strategy.

These strategies ensure that the EOQ model is not only theoretically applied but also practically embedded in the company's operations. By addressing training, technology, supplier relationships, testing, and monitoring, the implementation plan maximizes the model's benefits, including cost reduction and improved inventory turnover, while mitigating challenges like demand variability and system integration.

3.5 Ethical Considerations

This study adheres to ethical principles to ensure integrity and reliability in applying the Economic Order Quantity (EOQ) model to optimize inventory management. Key considerations include:

I. Data Accuracy and Transparency: All data, including values for demand, ordering, and holding costs, are derived from credible sources (e.g., industry averages, expert inputs) and clearly documented to avoid misrepresentation, as emphasized by Saunders et al. (2016).

II. Confidentiality: Information gathered from interviews or surveys with industry professionals is anonymized to protect participant privacy.

III. Objectivity: The analysis remains unbiased, presenting EOQ results without exaggeration to ensure practical and realistic recommendations for roofing sheet manufacturers.

IV. Responsible Implementation: Recommendations prioritize operational efficiency without compromising employee or supplier welfare, ensuring fair application of the EOQ model.

These measures uphold ethical standards, ensuring the study's findings are trustworthy and beneficial to stakeholders.

3.6 Limitations Of The Methodology

The methodology employed in this study, while robust, has certain limitations that may affect the application of the Economic Order Quantity (EOQ) model for optimizing inventory management in a roofing sheet production company. These limitations are outlined below to provide context for the study's findings and recommendations:

I. Focus on a Single Product: The study concentrates on Aluminium materials, limiting the generalizability of findings to other products with different demand or cost profiles.

II. Exclusion of Advanced EOQ Variations: The methodology employs the basic EOQ model, excluding factors like quantity discounts or stockout costs, which could enhance applicability, as discussed by Tersine (1994).

III. Limited Comparison with Other Models: The study does not compare EOQ with alternative inventory models (e.g., Just-In-Time), potentially overlooking more effective approaches for certain scenarios.

IV. Dependence on Data Accuracy: The accuracy of EOQ calculations relies on precise data inputs, and inaccuracies in demand or cost estimates could affect the reliability of results.

These limitations highlight the need for cautious interpretation of findings and potential adjustments when applying the EOQ model in real-world roofing sheet production settings.

CHAPTER FOUR

DATA ANALYSIS AND RESULTS

The objectives are to determine the optimal order size that minimizes total inventory cost, evaluate potential cost savings compared with current practices, analyse inventory turnover implications, and examine how demand, ordering cost and holding cost influence EOQ results. The calculations that follow use the combined annual demand from the two years, an ordering cost of ₦3,000,000 per order, and an estimated holding cost of ₦200 per meter per year.

Table 4.1: Customer Demand Data For JetBlack 0.4mm (Thickness) Aluminium Roofing Sheet 2023

Year(s)	Month	Monthly Demand (meters)	Work Period (days/hrs)	Daily Demand (m/day)
2023	Jan	3,660	25 (255)	146.40
2023	Feb	5,750	24 (244)	239.58
2023	Mar	3,660	27 (277)	135.56
2023	Apr	8,480	21 (206)	403.81
2023	May	5,170	25 (255)	206.80
2023	Jun	4,240	23 (233)	184.35
2023	Jul	8,930	26 (261)	343.46
2023	Aug	7,870	27 (277)	291.48
2023	Sep	10,910	25 (250)	436.40
2023	Oct	7,360	25 (255)	294.40
2023	Nov	7,360	26 (266)	283.08
2023	Dec	970	20 (200)	48.50
Annual Total	—	**74,360 m**	**294 (2979)**	**253.94 (avg/day)**

Table 4.2: Customer Demand Data For JetBlack 0.4mm (Thickness) Aluminium Roofing Sheet 2024

Year(s)	Month	Monthly Demand (meters)	Work Period (days/hrs)	Daily Demand (m/day)
2024	Jan	1,430	24 (244)	59.58
2024	Feb	8,730	25 (255)	349.20
2024	Mar	1,290	25 (250)	51.60
2024	Apr	5,980	23 (233)	260.00
2024	May	8,430	26 (266)	324.23
2024	Jun	9,150	23 (228)	397.83
2024	Jul	9,870	27 (277)	365.56
2024	Aug	6,970	27 (272)	258.15
2024	Sep	9,000	24 (244)	375.00
2024	Oct	15,950	26 (266)	613.46
2024	Nov	7,490	26 (261)	288.08
2024	Dec	4,130	19 (194)	217.37
Annual Total	—	**88,420 m**	**295 (2990)**	**299.73 (avg/day)**

Table 4.3: Company Resupply Data For JetBlack 0.4mm (Thickness) Aluminium Coils 2023

Year(s)	**Month**	**Lead time (days)**	**Resupply (kg)**
2023	Jan	3	6280
2023	Feb	2	4300
2023	Mar	3	6280
2023	Apr	2	4180
2023	May	4	8140
2023	Jun	1	2060
2023	Jul	4	8450
2023	Aug	4	8360
2023	Sep	3	6380
2023	Oct	3	6340
2023	Nov	1	2120
2023	Dec	0	0
Total	—	**30**	**63888 kg**

Table 4.4: Company Resupply Data For JetBlack 0.4mm (Thickness) Aluminium Coils 2024

Year	Month	Lead time (days)	Resupply (kg)
2024	Jan	2	5200
2024	Feb	3	4100
2024	Mar	3	5600
2024	Apr	2	4300
2024	May	4	7500
2024	Jun	1	2400
2024	Jul	4	8200
2024	Aug	4	8100
2024	Sep	3	6000
2024	Oct	3	6800
2024	Nov	1	2600
2024	Dec	0	0
Total	—	**30**	**55400 kg**

Calculation of annual demand (D)

Based on the monthly demand figures provided in the tables:

1. Total demand for 2023: 74,360 meters

2. Total demand for 2024: 88,420 meters

3. Combined demand (2 years): 74,360 + 88,420 = 162,780 meters

4. Average annual demand (D): $\frac{162,780}{2} = 81,390$ meters per year

From the company records the average working days per year used here is 295 days (the mean of work-period summaries). Therefore average daily demand used in reorder point calculation is:

$$\text{Daily demand} = \frac{D}{WORK\ DAYS} \qquad (4.1)$$

$$= \frac{81390}{295}$$

= 275.89830508474574

≈275.90 m/day

4.1 EOQ computation

Using the classical EOQ formula:

$$\text{EOQ} = \sqrt{\frac{2DS}{H}} \qquad (4.2)$$

Substitute the known values:

D = 81,390 meters

S = ₦3,000,000

H = IC: where I (derived from bank lending rates) = 22%, and C (unit cost per meter) = ₦8000

H = 22% × ₦8000 = ₦1760 per meter per year

$$\sqrt{\frac{2 \times 81390 \times 3000000}{1760}}$$

= 16,657.3 meters per order.

Interpretation: ordering about 16,657.3 meters in each replenishment minimizes the total inventory cost

Number of orders per year:

$$N = \frac{D}{EOQ} \qquad (4.3)$$

$$= \frac{81390}{16657}$$

$$= 4.89$$

≈ 5 orders per year.

Thus the firm will place approximately 5 large orders per year under EOQ.

4.2 Total annual inventory cost (showing both terms)

Total annual inventory cost is:

$$TC = \left(\frac{D}{Q}\right)S + \left(\frac{Q}{2}\right)H \qquad (4.4)$$

$$TC = \left(\frac{81390}{16657}\right) \times 3000000 + \left(\frac{16657}{2}\right) \times 1760$$

TC = ₦29,316,861 per year (minimum total inventory cost).

4.3 Reorder point (ROP)

Reorder point = daily demand × lead time. Using the daily demand computed in section 4.2 (275.898305... m/day) and the average lead time of 2.5 days:

ROP = 275.89830508474574 ×2.5 = 689.7457627118644

Rounded: ≈ 690 meters. When stock falls to 690 meters the firm would place an order approximately 5 times per year

4.4 Comparison with current practice

Assume the current practice is to place ten orders per year (as used in earlier comparisons). Compute the implied current order quantity and total cost.

Current order quantity

$$\text{Q-comparison} = \frac{D}{10} \qquad (4.5)$$

$$= \frac{81390}{10}$$

$$= 8139 \text{ meters per order.}$$

Average inventory under current practice =

$$\text{Q-comparison}/2 =$$

$$= \frac{8139}{2}$$

$$= 4069.5 \text{ meters.}$$

Ordering cost under current practice = number of orders × S = 10 × 3,000,000 = 30,000,000

Holding cost under current practice = average inventory × H = 4069.5 × 1760 = 7,162,320

Total current cost:

TC-current = 30,000,000 + 7,162,320 = ₦37,162,320.

Savings by switching to EOQ:

Annual ordering cost = (81390/16,657) x 3,000,000 = ₦14,658,430

Annual holding cost = (16,657/2) x 1760 = ₦14,658,424

Savings = TC-current - TCEOQ = 14,658,430 – 14,658,424 = ₦29,316,861

Percentage reduction:

$$\frac{7{,}845{,}466}{37{,}162{,}320} \times 100\% = 21.11\% \approx 21\%$$

$$annual\ savings = 7.845\ million \approx 21\%$$

4.5 Inventory turnover

$$\text{Inventory turnover} = \frac{D}{AVERAGE\ INVENTORY} \qquad (4.6)$$

Under EOQ:

Average inventory = EOQ/2 = 8328.65 meters.

Turnover = 81,390/8328.65 = 9.77 times per year.

Under current practice (10 orders/year):

Average inventory = 4,069.5 m.

Turnover = 81,390/4069.5 = 20 times per year.

Interpretation: while the numerical turnover ratio is lower under EOQ, (9.77 vs 20), the EOQ model achieves cost efficient turnover. The current system's higher turnover frequency incurs excessive ordering costs (30M vs 14.6M), making the EOQ approach more economically sustainable.

4.6 Sensitivity analysis

Sensitivity tests confirm the relationships:

1. Increase in ordering cost (S) — suppose increases from ₦3,000,000 to ₦4,000,000.

$$\text{Compute EOQ} = \sqrt{\frac{2DS}{H}} \qquad (4.7)$$

$$= \sqrt{\frac{2 \times 81390 \times 4{,}000{,}000}{1760}} = 19{,}234m$$

Conclusion: as ordering costs increase, optimal order size increases to minimize the impact of frequent replenishment fees.

2. Increase in holding cost (H) — suppose I rises to 30%, thus H = 2400

$$\text{Compute EOQ: } = \sqrt{\frac{2DS}{H}} \tag{4.8}$$

$$= \sqrt{\frac{2 \times 81390 \times 3{,}000{,}000}{2400}} = 14{,}264m$$

Conclusion: higher holding costs due to increased capital costs necessitate smaller, more frequent orders to reduce tied up capital.

3. Increase in demand (D) — suppose increases to 100,000 m/year.

$$\text{Compute EOQ: } = \sqrt{\frac{2DS}{H}}$$

$$= \sqrt{\frac{2 \times 100000 \times 3{,}000{,}000}{1760}} = 18{,}463m \tag{4.9}$$

Conclusion: EOQ increases proportionally with demand.

These tests confirm the theoretical relationships:

$$EOQ \propto \sqrt{D}$$

And

$$EOQ \propto \sqrt{S}$$

While

$$EOQ \propto \frac{1}{\sqrt{H}}$$

4.7 Answers to the research questions

1. Optimal order size — The EOQ calculation yields an optimal order quantity of approximately 16,657 meters per order for the roofing sheet coils, which minimizes total annual inventory cost given the data used.

2. Cost savings compared to current practice — Switching from the current practice of 10 orders/year to the EOQ policy reduces total annual inventory cost from approximately ₦37,162,320 to ₦29,316,854, yielding savings of about ₦7,845,466 (≈21.1%).

3. How EOQ improves inventory turnover — Although EOQ reduces replenishment frequency (from ~20 cycles/year to ~9.77 cycles/year), it improves turnover efficiency by lowering combined ordering and holding costs and by reducing the administrative/operational burden of frequent large number of orders. Thus EOQ produces more cost-efficient turnover supporting continuous production with fewer, better-sized orders.

4. Factors affecting EOQ calculations — The sensitivity analysis shows EOQ increases with higher demand and higher ordering cost, and decreases with higher holding cost. This confirms that periodic recalculation is necessary when these parameters change.

4.8 Discussion and practical implications

The application of the EOQ model using a formal holding cost of **₦1,760** (based on a 22% interest rate and ₦8,000 unit cost) demonstrates that the most cost-effective strategy for the company is to order approximately **16,657 meters** per replenishment.

The practical benefits of this data-driven approach include:

Significant Cost Reduction: By shifting from the current 10-order-per-year cycle to approximately 5 orders per year, the firm reduces its total annual inventory cost from ₦37.16 million to ₦29.32 million.

Liquidity Management: The transition yields an annual saving of ₦7.85 million (a 21.1% reduction), providing a vital financial buffer in the volatile Nigerian manufacturing sector.

Operational Precision: The reorder point of 690 meters ensures that replenishment is triggered scientifically, accounting for the average 2.5-day lead time identified in the resupply records to prevent production interruptions.

Informed Supplier Negotiations: These results empower management to negotiate favorable long-term contracts that align with the five-cycle-per-year replenishment rhythm, potentially reducing administrative workload.

4.9 Limitations

While the recomputed EOQ offers a path to optimization, its effectiveness is bound by the following constraints:

Static Variable Assumptions: The model assumes that annual demand (81,390 meters), ordering costs, and holding costs remain constant, which may not reflect real-world seasonal fluctuations or sudden inflation.

Lead Time Consistency: The 2.5-day average lead time used for calculations does not fully account for the maximum 4-day delays recorded in Table 2, which could lead to stockouts without a safety stock buffer.

Economic and Price Sensitivity: The high unit cost of ₦8,000 makes the EOQ extremely sensitive to interest rate shifts; any change in the 22% interest rate or the exchange rate for imported coils would require immediate recalculation.

Exclusion of Complex Factors: This basic model does not incorporate quantity discounts, backorder allowances, or the potential degradation of materials, which are often critical factors in large-scale roofing sheet procurement.

CHAPTER FIVE

CONCLUSION

5.1 Summary of Findings

This study applied the Economic Order Quantity (EOQ) model to optimize inventory management for a roofing sheet production company focusing on 0.4mm Aluminium roofing sheets. The research utilized a formal holding cost calculation ($H=I\times C$) based on a 22% interest rate and a unit cost of ₦8,000 per meter, resulting in a carrying cost of ₦1,760 per meter per year.

Through detailed analysis of demand data from 2023 and 2024, which yielded an average annual demand of 81,390 meters, the optimal order quantity was determined to be 16,657.3 meters per order . This result indicates that the company should transition to approximately five restock cycles per year to minimize total annual inventory costs to ₦29.32 million. The calculated reorder point was established at 690 meters, ensuring replenishment orders are triggered in time to account for the average 2.5-day lead time .

A comparison between the EOQ-based strategy and the current practice of ten orders per year revealed a total cost reduction from ₦37.16 million to ₦29.32 million. This demonstrates an annual saving of ₦7.85 million, representing a 21.1% improvement in financial and operational efficiency. Sensitivity analysis further confirmed that while the EOQ increases with demand and ordering costs, it is highly sensitive to the 22% interest rate, requiring precise data management for continued optimality.

5.2 Conclusion

The results of this study confirm that the EOQ model is a powerful tool for improving inventory management in the Nigerian roofing sheet production industry. By determining the optimal order quantity of 16,657.3 meters, the company can effectively balance high procurement costs against the steep 22% cost of capital.

The model's application offers significant financial benefits, including ₦7.85 million in annual cost savings, which enhances cash flow and strengthens the firm's competitive position in a volatile market. Despite the assumptions of constant demand and fixed costs, the study demonstrates that adopting a systematic, data-driven approach replaces the uncertainty of intuitive ordering methods with a scientifically justified foundation for decision-making.

5.3 Recommendations

Based on the findings, the following recommendations are made to improve inventory practices:

1. Formally Adopt the 16,657-Meter Order Size: The company should integrate this optimal quantity into its inventory control system to reduce total annual costs.
2. Integrate H=I×C into Digital Systems: Enterprise Resource Planning (ERP) software should be updated to compute holding costs dynamically using current bank interest rates and material prices .
3. Quarterly Review of Parameters: Due to Nigerian economic volatility, demand, ordering costs, and the 22% interest rate should be reviewed quarterly to maintain accurate EOQ levels.
4. Establish a 690-Meter Reorder Trigger: Procurement staff must be trained to place orders immediately when stock hits this level to account for supplier lead times.

5. Incorporate Safety Stock Buffers: To mitigate the maximum 4-day lead times found in the resupply data, management should maintain a small safety stock above the 690-meter reorder point.

5.4 Limitations of the Study

While the EOQ model proved effective in this research, several limitations should be acknowledged. The model assumes constant demand, fixed ordering and holding costs, and instantaneous replenishment—conditions that may not always hold true in real-world manufacturing environments. The data used were limited to two years (2023–2024) and averaged for analysis; thus, seasonal variations and external economic factors were not explicitly modeled. Additionally, the study did not incorporate other inventory control techniques such as Just-In-Time (JIT) or Material Requirements Planning (MRP), which might provide complementary insights. Future studies should explore these alternative models or hybrid approaches that combine EOQ with real-time data analytics.

5.5 Suggestions for Further Research

To build upon the insights of this study, future research should focus on several key areas. First, further investigation could incorporate EOQ models with quantity discounts or backorder allowances, which would make the model more reflective of actual supplier contracts. Second, researchers could apply the EOQ framework to multi-item inventories, optimizing order quantities across several product types that share storage or budget constraints. Third, integrating EOQ with modern predictive analytics and demand forecasting tools could improve accuracy, particularly in industries with seasonal or fluctuating demand patterns. Finally, future studies may evaluate EOQ performance over a longer timeframe using actual operational data from multiple companies to generalize findings within the roofing sheet manufacturing sector.

5.6 Final Remarks

The implementation of the EOQ model offers roofing sheet manufacturers a clear pathway toward cost-effective and efficient inventory management. The study demonstrated that by adopting a systematic, data-driven approach, companies can achieve substantial financial savings, ensure smooth production processes, and strengthen their competitive position in the market. As the demand for roofing materials continues to grow in construction-driven economies, the ability to manage inventory scientifically through models such as EOQ will remain a critical factor for long-term sustainability and profitability.

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