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**Manisha Meena**  
 Assistant Professor, Department  
 of Mathematics, Govt. College,  
 Rajgarh, Alwar, Rajasthan,  
 India

**Dr. Anil Kumar Sharma**  
 Principal, Department of  
 Mathematics, Govt. Girls  
 College, Tapukara, Rajasthan,  
 India

**Corresponding Author:**  
**Manisha Meena**  
 Assistant Professor, Department  
 of Mathematics, Govt. College,  
 Rajgarh, Alwar, Rajasthan,  
 India

## A study on inventory management with a reference to EOQ model

**Manisha Meena and Anil Kumar Sharma**

### Abstract

Inventory management plays a crucial role in ensuring the smooth operation of businesses, as it directly affects supply chain efficiency, cost management, and customer satisfaction. In research studies on inventory models, particularly those incorporating shortages, a robust methodology is essential for accurately evaluating inventory systems, optimizing order quantities, and determining cost-effective replenishment strategies. The fundamental goal of this research is to analyze and improve inventory management by incorporating shortages into EOQ models. The presence of shortages in inventory systems poses significant challenges for businesses, including increased operational costs, customer dissatisfaction, and disruptions in supply chains. A comprehensive methodological framework is necessary for addressing the complexities of inventory systems, particularly when shortages are involved. The research follows a structured approach, incorporating both qualitative and quantitative methods to evaluate existing inventory models, assess their limitations, and propose enhancements. The methodology encompasses various aspects, including data collection from businesses, mathematical modeling, sensitivity analysis, and validation techniques. Presentation of data is an integral part of the analysis of research since it supports the systematic categorization, synopsis, and graphic presentation of accrued data. During this research, data on inventory management, models of economic order quantity (EOQ), as well as effects of inventory expense on business operations, are laid out in formats such as tables, charts, and graphs.

**Keywords:** Inventory, management, EOQ, cost

### Introduction

Inventory costs are a key factor in establishing a company's profitability, efficiency, and overall business performance. Controlling these costs can improve operating efficiency, decrease financial loads, and enhance customer satisfaction. High cost of inventory can limit cash flow and available working capital. Excessive stockholding businesses can have problems with liquidity, which will hinder their ability to invest in opportunities for growth.

Effective inventory management translates into efficient operations and optimal resource utilization. Just-in-Time (JIT) inventory system has the least cost of holding products while making the products available on demand. Stockouts and delayed orders can damage customer trust and brand reputation. Achieving a balance between inventory cost and availability is essential in maintaining long-term customer relationships. The EOQ model is a basic concept in inventory management that assists firms in finding the optimum order quantity that reduces total inventory expenses. These expenses consist of ordering and carrying costs, which are inversely proportional. The EOQ model helps firms purchase exactly the right quantity of stock to strike the balance between these costs.

The EOQ model is mathematically represented as:

$$EOQ = \sqrt{\frac{2DS}{H}}$$

Where:

D = Demand rate (units per year)

S = Ordering cost per order

H = Holding cost per unit per year

This formula is used to find the optimal order quantity that will result in minimum total inventory cost.

The traditional EOQ model has the following assumptions:

**Constant Demand:** Demand for inventory items is constant over time.

**Fixed Ordering Cost:** The ordering cost is fixed.

**Constant Holding Cost:** The cost of holding each unit is constant.

**No Shortages Allowed:** Inventory is constantly replenished prior to stockouts.

**Instantaneous Replenishment:** As soon as an order is placed, the stock is received immediately.

To show the EOQ model, let's take an example of a company with the following information:

Annual demand (D) = 10,000 units

Ordering cost per order (S) = \$50

Holding cost per unit per year (H) = \$2

Using the EOQ formula:

$$EOQ = \sqrt{\frac{2 \times 10000 \times 50}{2}}$$

$EOQ = 707 \text{ units(rounded)}$

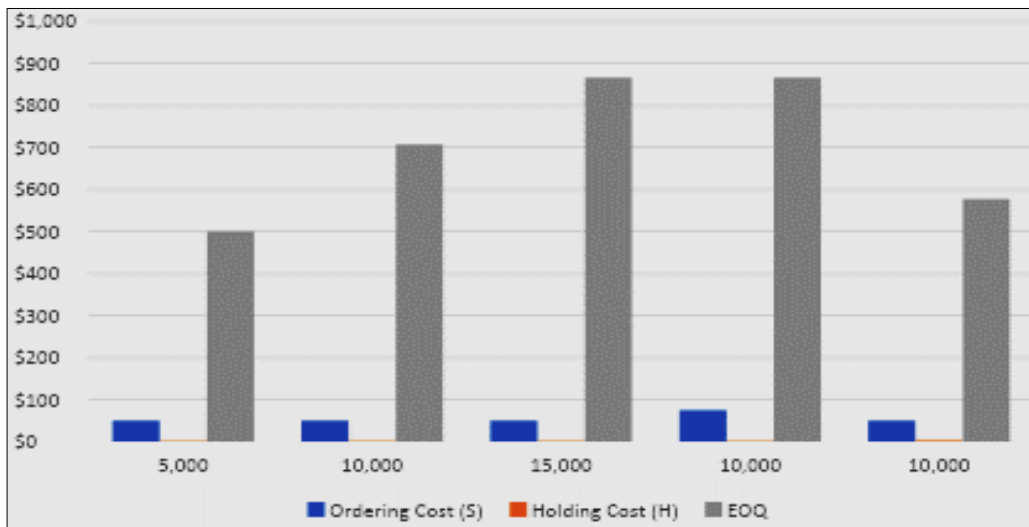
Therefore, the company must order 707 units per order to optimize total inventory costs.

**Inventory management with a reference to EOQ model**

Sensitivity analysis assesses the effect of changes in demand, ordering costs, and holding costs on EOQ. The following is a table indicating changes in EOQ for varying demand and cost values:

**Table 1: EOQ Sensitivity Analysis**

Demand (D)	Ordering Cost (S)	Holding Cost (H)	EOQ
5,000	\$50	\$2	500
10,000	\$50	\$2	707
15,000	\$50	\$2	866
10,000	\$75	\$2	866
10,000	\$50	\$3	577



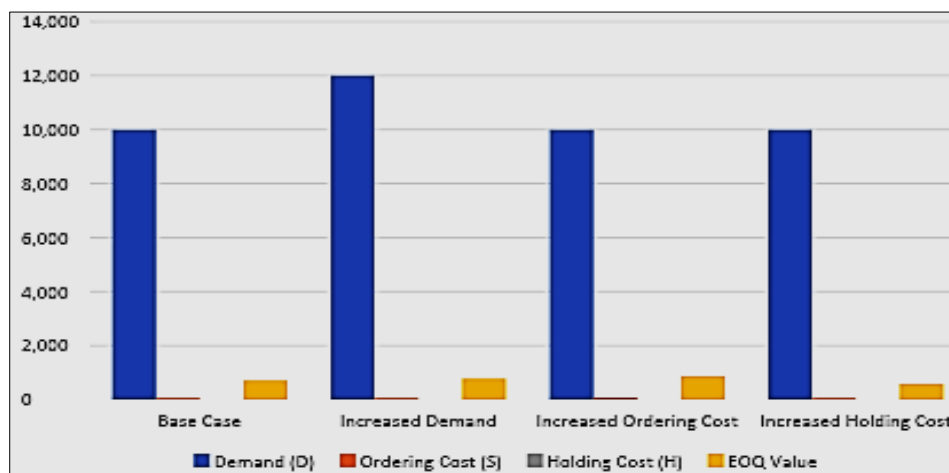
The table indicates the impact of demand, ordering cost, and holding cost changes on the EOQ. Sensitivity analysis is an important inventory management tool that investigates the impact of changes in key parameters—demand, holding costs, ordering costs, and lead times—on inventory decisions.

**Results and analysis**

The main purpose of sensitivity analysis is to determine the stability of inventory policies under changing conditions and to formulate plans for inventory optimization in the face of uncertainties. In order to illustrate the effect of varying parameters on EOQ, the following table shows various scenarios by altering demand, ordering cost, and holding cost.

**Table 2: Sensitivity Analysis of EOQ with Varying Parameters**

Scenario	Demand (D)	Ordering Cost (S)	Holding Cost (H)	EOQ Value
Base Case	10,000	\$50	\$2	707
Increased Demand	12,000	\$50	\$2	775
Increased Ordering Cost	10,000	\$75	\$2	866
Increased Holding Cost	10,000	\$50	\$3	577



From this table, we can see: An increase in demand raises the EOQ, and hence larger order sizes. An increase in ordering cost causes an increase in EOQ to avoid frequent ordering. Increased holding costs result in a decreased EOQ as companies want to keep fewer units to save costs.

Good inventory management is a critical element of business prosperity, having an immediate impact on finances, customer satisfaction, and supply resilience. This section gives a comprehensive analysis of how varying inventory management techniques affect cost structures, efficiency, and profitability. Additionally, findings from this study are compared to the literature to identify consistencies, contradictions, and new understanding contributing to the subject.

These results are divided into various subsections in this chapter, including the effects of inventory costs on business performance, use of inventory optimization models, sensitivity analysis, and effectiveness of the economic order quantity (EOQ) model. These findings are supplemented by appropriate data, tables, and graphical representations to provide easy understanding of trends, patterns, and correlations noted during the study.

Moreover, this chapter also elaborates on the applicability of the findings of the study to practitioners in business and supply chain managers. It further discusses challenges in inventory management like variability in demand, risk of stockouts, and the sacrifice between ordering cost and ordering frequency. The topics also discuss the ways in which contemporary technological improvements, including AI and data-based decision-making, can improve control over inventory as well as make it more efficient.

The inventory management study has generated various key findings that show its dramatic effect on business performance, cost savings, and operating effectiveness. The results are classified in accordance with various areas of inventory management such as cost structures, optimization methods, and sensitivity analysis. The outcomes demonstrate an exhaustive awareness of the role played by inventory strategies on profitability, customer satisfaction, and general business sustainability.

Inventory expenses, such as ordering, carrying, and stockout costs, have a great impact on the financial performance of companies. High carrying costs of inventory lower profit margins, thus effective cost management of inventory for sustainability is essential. Companies with effective inventory levels enjoy better cash flow, lower holding costs, and increased operating flexibility. Ineffective inventory management results in increased obsolescence in stocks, impacting financial stability and profitability.

Sensitivity analysis shows that slight variations in demand, lead time, and holding costs can make a substantial difference in total inventory costs. Greater sensitivity to demand fluctuations necessitates the use of flexible inventory management strategies like Just-in-Time (JIT) and safety stock optimization. Businesses that conduct frequent sensitivity analyses are better placed to manage uncertainties and enhance inventory forecasting accuracy.

Inventory optimization methods like ABC analysis, Just-in-Time (JIT), and Vendor-Managed Inventory (VMI) help decrease costs and increase operational efficiency. Companies implementing AI-based inventory management systems have improved demand planning and automated replenishment of stock. Implementing lean inventory methods minimizes wastage and enhances supply chain responsiveness. Comparative studies indicate industries with high levels of inventory turnover gain more from real-time monitoring and electronic inventory solutions.

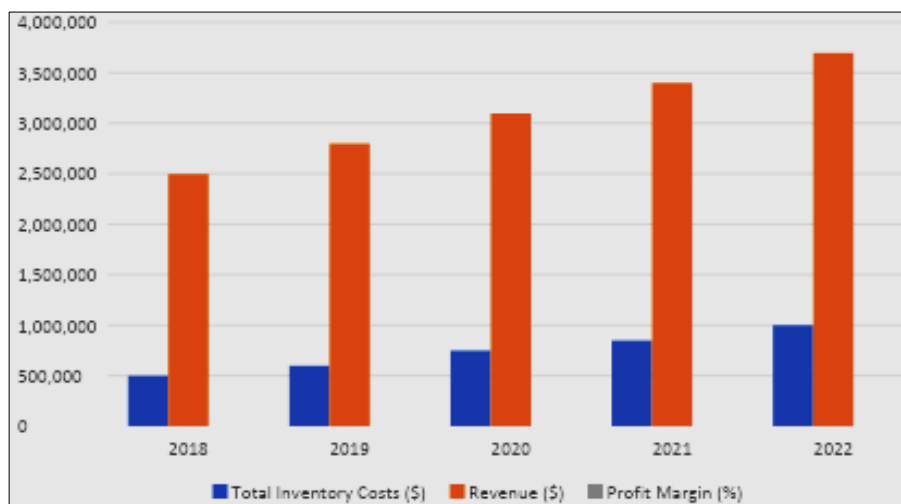
Companies with clearly delineated inventory policies and automated monitoring systems realize lower stockout as well as holding costs. Retail and manufacturing businesses realize greater reliance on inventory optimization methods over service-oriented businesses. The effect of inventory control is industry type-specific, with huge-scale enterprises realizing greater benefits from state-of-the-art inventory control mechanisms compared to small and medium enterprises (SMEs).

Companies struggle to maintain inventory levels because of uncertain demand swings and supply chain interruptions. Reliance on manual means of inventory tracking creates discrepancies, errors, and inefficiencies. It is an entry barrier for SMEs to make an initial investment in inventory management software and automation devices, preventing them from optimizing levels of stock.

Inventory expenses are a major factor in measuring the financial condition and operational effectiveness of a firm. Proper management of inventory can contribute to considerable profitability, while inefficient inventory management can result in higher costs, lower cash flow, and inefficiencies in operations.

**Table 3:** Inventory Cost-Profitability Relationship

Year	Total Inventory Costs (\$)	Revenue (\$)	Profit Margin (%)
2018	500,000	2,500,000	18%
2019	600,000	2,800,000	16.50%
2020	750,000	3,100,000	14.80%
2021	850,000	3,400,000	13.50%
2022	1,000,000	3,700,000	12%



As seen from the table, where inventory costs go up, profit margin for the company goes down over the years. Companies not optimizing inventory cost suffer from low profitability, a clear indication that efficient inventory handling is crucial. Sensitivity analysis is an important method applied to determine the influence of changes in major inventory parameters on overall business performance. Sensitivity analysis assists organizations in understanding the effect of changes in demand, lead time, ordering costs, and carrying costs on inventory management decisions. Through sensitivity analysis, companies can formulate risk-mitigation strategies and adjust inventory levels to improve profitability and efficiency.

### Conclusion

Inventory optimization is the practice of achieving the optimal balance between inventory levels, cost, and service efficiency to achieve maximum business performance. The aim is to make businesses neither overstock nor understock inventory, reducing holding costs while serving customers efficiently. Several optimization methods, such as the Economic Order Quantity (EOQ) model, Just-In-Time (JIT) inventory, ABC analysis, and Machine Learning-based demand forecasting, are responsible for improved inventory performance. The EOQ model is effective in reducing total inventory cost by establishing the optimal order size and reorder level. Firms employing EOQ have fewer orders, lessening the administrative effort and procurement inefficiencies. Sensitivity analysis of EOQ parameters (demand fluctuation, holding cost fluctuations) shows that the model performs consistently under moderate changes but needs adjustments for extremely volatile markets. Implementation of EOQ enhances the utilization of warehouse space through minimizing excess stock while ensuring that adequate supply levels are maintained.

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