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A Short Review of EOQ Models and Fuzzy Theory in Inventory Management

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Abstract


In our manuscript, we investigate diverse approaches and methodologies proposed by researchers and scientists. Our analysis encompasses supply chain management, vendor management, and healthcare systems. Specifically, we delve into Economic Order Quantity (EOQ) within IM, exploring its implications. Additionally, we aim to present literature on fuzzy theory, including discussions about triangular and trapezoidal fuzzy sets. Recognizing that classical theory grapples with uncertainty, we underscore the significance of comprehending fuzzy theory through relevant scholarly works.

Keywords: EOQ, SCM, IM.

1 | Introduction

During WW-II from 1939 to 1945, the Operational Research (OR) emanated as a response to the urgent need for managing scarce resources. Analytical methods are used by OR to design, analyze, and enhance systems and processes across various areas, such as transportation, logistics, manufacturing [1], and finance [2].

The goal is to optimize effectiveness, reduce costs, and enhance comprehensive effectiveness by employing mathematical models and algorithms. In the words of Stafford Beer [3], OR applies scientific methods to address challenges in managing large systems involving people, machines, materials, and finances in industry, defense, business, and government. In recent years, several studies have explored various aspects of inventory control, linear programming, and project management under uncertain conditions. Dubey and Kumar [4] reviewed the extended uncertainty principle for inventory control, while Tripathi and Kumar [5] focused on Neutrosophic Linear Programming Problems (LPP). Miriyala and Kumar [6] conducted a state-of-the-art review of critical path methods and project evaluation techniques. Additionally, Navya and Kumar [7]

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discussed trends in inventory management and Tripathi and Kumar [8] introduced a short literature on LPP. Looking ahead, Tripathi et al. [9] investigated Neutrosophic LP in advanced fuzzy contexts, and Miriyala et al. [10] explored Neutrosophic critical path problems. Furthermore, Miriyala and Kumar [11] enhanced critical path analysis using Python in Neutrosophic environments, while Dubey and Kumar [12] examined inventory models with sensitivity analysis. Moreover, Miriyala and Kumar [13] discussed enhancing critical path problem in Neutrosophic Environment Using Python. Lastly, Tripathi and Kumar [14] addressed Neutrosophic minimal cost flow problems through multi-objective linear programming.

Moreover, we have investigated various substantial contributions to OR, briefly summarized in *Table 1*.

Table 1. According to different researchers, the effect of OR in real-life.

Ref.	Years	Application	Contribution
[15]	2018	Data modeling	Data Envelopment Analysis (DEA) from a neutrosophic perspective.
[16]	2019	Linear programming	Developing a nonlinear approach for neutrosophic linear programming.
[17]	2020	Supplier problem	Selecting suppliers using the fuzzy Analytic Hierarchy Process (AHP) technique and D-Numbers.
[18]	2023	LPP	Solving fuzzy LPP in multiple dimensions.
[19]	2023	SCM	Internet of Things (IoT) in SCM: addressing challenges, exploring opportunities, and implementing best practices.
[20]	2024	Goal programming	Applying the min-max goal programming approach to solve piecewise quadratic fuzzy multi-objective de novo programming problems.
[21]	2024	SCM	A review of multi-criteria analysis techniques for decision-making in renewable energy supply chains.
[22]	2024	Automotive industry	Developing a structural model for a lean and sustainable supply chain using a total quality management approach in the automotive industry.
[23]	2024	Production management	Optimizing decision-making in production, maintenance, repair, and quality planning through agent-based simulation.
[24]	2024	Vendor problem	An interactive compromise programming approach for solving vendor selection problems under fuzziness.

The overall goal of OR is to equip stakeholders with the necessary instruments and particulars for making informed decisions that enhance organizational performance and efficiency. IM constitutes a frequently discussed topic within OR.

Our primary goal in this paper is to understand inventory management. Nowadays, inventory plays a crucial role in our lives, whether it's in our home kitchens or large factories. Whoever manages inventory can achieve profits. But how do we maximize those profits? To answer this, we need to determine the optimal quantity to purchase and when to place orders. Back in 1913, F. W. Harris [25] introduced a model called Economic Order Quantity (EOQ). This model provides a formula for handling order quantities. R. H. Wilson later modified it in 1940 to address costs associated with inventory, such as carrying costs and set-up costs. Inventory control has various applications, including vendor problems [26], healthcare systems [27], service levels [28], blood banks [29], and methods like ABC [30], FIFO [31], and LIFO [32]. We'll explore some of these inventory control challenges in *Table 2*.

In the table above, we observed the contributions made by various authors to inventory models. This highlights the significant role inventory models play in OR. Researchers and authors explore how to maximize profits while minimizing costs and losses within the inventory model. Consequently, we can assert that inventory models have a substantial impact on real-life scenarios. Now, let's delve into the concept of EOQ within the context of inventory management. We'll explore different authors' contributions to EOQ and examine its practical applications.

Table 2. Some authors-contribution to the inventory model in different areas.

Authors	Contribution
[33]	Optimizing spare parts inventory control Using maintenance planning.
[34]	In this study, authors explore the dimensions related to disruptive factors and inventory control using exploratory factor analysis.
[35]	Identifying weaknesses in the inventory control system: insights from accounting postgraduate students
[36]	In this study, author's authors explore the mediation effect of inventory control practices on organizational performance within the context of state-funded hospitals.
[37]	Recent advances in spare parts classification and forecasting for inventory control: a comprehensive literature review.
[30]	Creating a fresh mathematical model using ABC analysis for an inventory control problem: A real-world case study.
[38]	Managing demand and controlling inventory for substitutable products.
[39]	A roadmap for deep reinforcement learning in inventory control.
[40]	The comprehensive approach for intelligent order management application provides a framework for optimized sales and inventory control.

2 | Recent Trends in IM

In this section, we are discussing recent trends in inventory control models. There are many models in inventory control, such as the supply chain, Economic Production Quantity (EPQ), EOQ, and others. However, we will focus only on the EOQ model. As we know, Harris first introduced the EOQ model. In this section, we will discuss the work done by different researchers related to EOQ. Further details are explained below.

Mandal [41] developed an EOQ model specifically for items that deteriorate over time. The demand for these items follows a cubic pattern, and the model takes into account salvage value and shortages. Samal et al. [42] proposed an EOQ model for inventory systems where inventory levels depend on the current stock, and in this system, no shortages are allowed. Caliskan [43] derived the optimal solution for the EPQ model with planned shortages without using derivatives. Patriarca et al. [44] studied an EOQ inventory model specifically for perishable products, considering uncertainty. Sundararajan et al. [45] explored how delays in payment, shortages, and inflation impact an EOQ model with bivariate demand. Ghai et al. [46] optimized the EOQ model by accounting for reliability-affected demand rates and uncertainty. Sundararajan [47] investigated amount determination in a non-instantaneous decay EOQ model with shortages, inflation, and delayed payments.

Conclusion

In our manuscript, we explore various approaches and methodologies proposed by researchers and scientists. Our analysis spans supply chain management, vendor management, and healthcare systems. Specifically, we delve into EOQ within IM and discuss its impact. Additionally, we aim to share literature on fuzzy theory, including discussions about triangular and trapezoidal fuzzy sets. Recognizing that classical theory struggles with uncertainty, we emphasize the importance of understanding fuzzy theory through relevant literature.

Authors' Contribution

The study's conception and design were contributed to by the authors. Material preparation, analysis and discussion of results were done by the authors. All authors have read and approved the manuscript.

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Conflict of Interests

The authors whose names are written on this manuscript certify that they have NO affiliations with or involvement in any organization or entity with any financial interest in the subject matter or materials discussed in this manuscript.

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