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Strategic Inventory Control for Deteriorating Products under Time-Sensitive Demand

Trilok Chand Bagh[1]

[1]*Associate Professor, Faculty of Commerce, ISBM University, Chhattisgarh, India*

trilokbagh.isbm@protonmail.com

Abstract— Efficient management of inventory is essential for businesses handling perishable or time-sensitive products. This study delves into advanced inventory models incorporating time-varying demand, pricing dynamics, and product deterioration. Drawing on a comprehensive review of research conducted by A. Sharma and collaborators between 2016 and 2024, the article presents strategic approaches to optimize inventory levels, reduce operational costs, and enhance overall supply chain performance. It emphasizes the role of dynamic pricing mechanisms, partial backordering, and accurate demand forecasting in developing responsive inventory control systems. The findings offer valuable insights for retailers, manufacturers, and logistics professionals while outlining promising avenues for future research in this evolving domain.

Keywords— Inventory control, deteriorating items, time-dependent demand, pricing, partial backlogging.

Introduction

Inventory management is critical to supply chain success, especially for industries dealing with perishable items like food, pharmaceuticals, and seasonal goods. While conventional inventory models often rely on the assumption of constant demand, real-world applications demand more adaptive frameworks that consider time-sensitive demand fluctuations and the natural deterioration of products (Sharma, 2022).

Building on recent insights, Sharma (2024) underscores the importance of incorporating dynamic pricing and time-dependent demand into inventory decision-making processes. This article synthesizes key findings from prior research (Sharma & Bansal, 2016; Sharma et al., 2023) to thoroughly evaluate inventory models designed explicitly for perishable goods. Key focus areas include:

- The effect of product deterioration rates on replenishment and holding policies.
- The relationship between price sensitivity and shifting consumer demand.
- Using techniques like fractional backlogging to manage shortages and improve service levels effectively.

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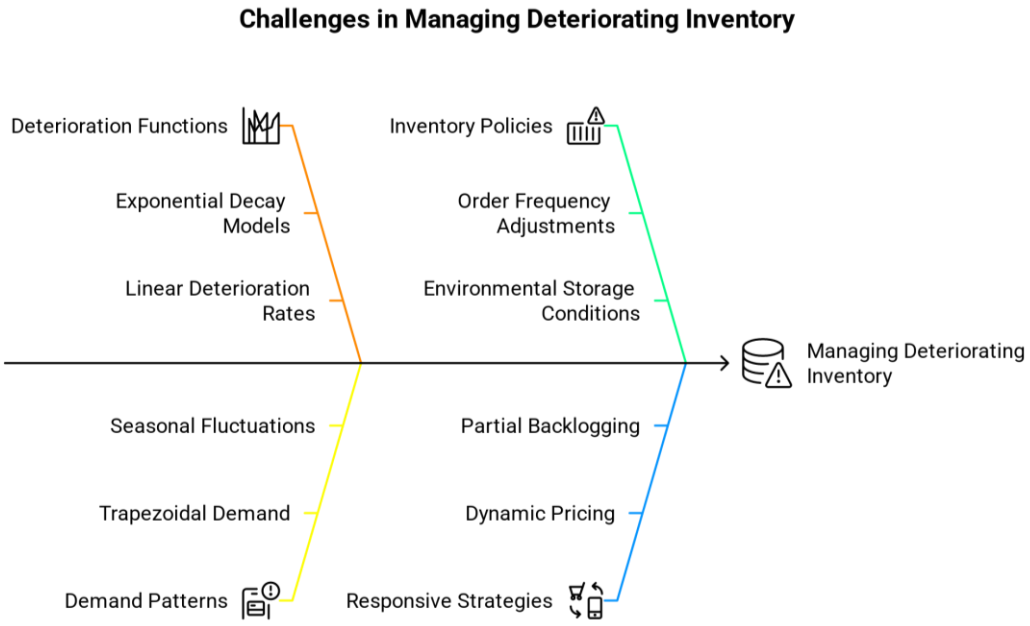
Literature Review

Deteriorating inventory models have gained significant attention in recent years due to their relevance in managing perishable goods that lose value over time through spoilage, obsolescence, or expiration (Sharma, 2019a). Various deterioration functions have been explored to reflect real-world decay patterns, including exponential decay models (Sharma, 2020) and linear deterioration rates (Sharma & Bansal, 2016). Empirical studies suggest that inventory policies must adapt order frequencies based on product shelf life and environmental storage conditions to mitigate loss (Sharma, 2019b). In parallel, demand for such goods frequently exhibits time-dependent and non-linear behavior, with models accounting for trapezoidal demand patterns (Sharma, 2015) and seasonal fluctuations (Sharma, 2022). These variations necessitate responsive strategies such as dynamic pricing, which has been shown to align stock levels with demand shifts, thereby minimizing spoilage and improving profitability (Sharma et al., 2023). Moreover, partial backlogging has emerged as a viable approach in scenarios where supply cannot immediately meet demand. Although it entails fulfilling delayed orders at the cost of reduced customer satisfaction, it remains effective for high-demand perishables such as fresh produce and vaccines (Sharma & Bansal, 2016).



Methodology

This study employs a qualitative, literature-based methodology to explore evolving trends in inventory modelling for deteriorating items, drawing insights from 13 peer-reviewed articles authored by Sharma and collaborators between 2016 and 2024. A systematic review process was adopted, beginning with the

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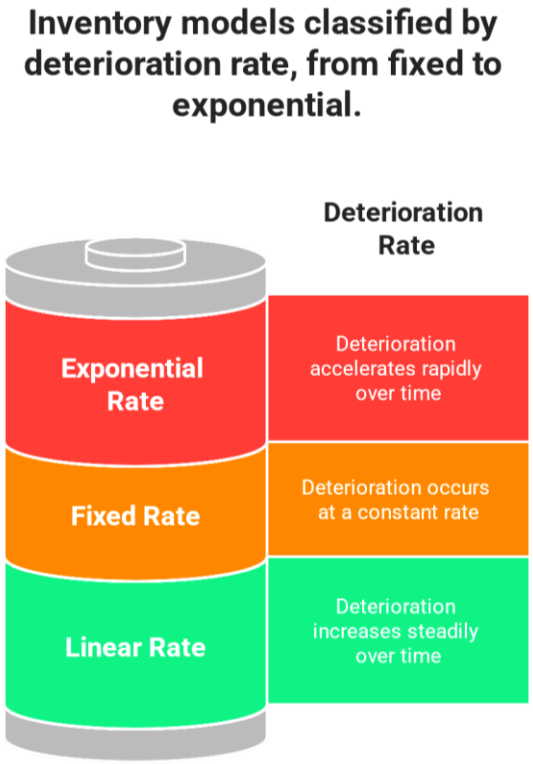
careful selection of relevant literature using targeted keywords such as "deteriorating inventory," "time-dependent demand," and "dynamic pricing." To ensure scholarly rigour, only articles published in indexed journals were included. The selected studies were then subjected to a comparative analysis, where models were classified according to deterioration behaviour (e.g., linear, exponential, and fixed rates) and demand patterns (such as trapezoidal, seasonal, and uniform). Core variables, including holding costs, shortage allowances, and backlogging policies, were examined to identify consistencies and divergences across frameworks. Through a synthesis of findings, the study distils best practices related to optimal replenishment scheduling and pricing strategies while highlighting critical limitations in current models—particularly the frequent assumption of constant deterioration rates. This structured, evidence-based approach ensures academic integrity and lays a foundation for future research incorporating empirical validation or simulation-based methods.



Findings and Discussion

The analysis reveals several key insights into inventory optimization for deteriorating items. First, replenishment strategies must be carefully aligned with product decay characteristics. Models assuming fixed deterioration rates (Sharma, 2020) indicate that shorter, more frequent replenishment cycles are

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essential for minimizing losses in rapidly perishable goods. Additionally, studies on dynamic pricing (Sharma, 2024) demonstrate that offering discounts as products near expiration can effectively stimulate demand and reduce waste. In terms of cost management, the Just-in-Time (JIT) approach is shown to lower holding costs but carries a higher risk of stockouts, particularly in volatile demand environments (Sharma, 2022). To address this trade-off, hybrid models that integrate partial backlogging with responsive pricing mechanisms have been found to offer superior cost-efficiency (Sharma & Bansal, 2016). Furthermore, incorporating advanced technologies, particularly AI-based demand forecasting tools, presents promising opportunities to improve inventory accuracy and responsiveness (Sharma, 2023). However, the practical implementation of these technologies is still constrained by organizational and infrastructural challenges, warranting further exploration in future studies.

Conclusion and Future Research

This study offers a comprehensive synthesis of a decade's research on inventory models for deteriorating goods, uncovering vital insights for enhancing supply chain performance in dynamic, real-world contexts. The findings underscore the limitations of conventional static inventory approaches, which often overlook critical factors such as perishability, time-dependent demand, and pricing variability. In contrast, contemporary models incorporating adaptive replenishment strategies (Sharma & Bansal, 2016) and time-sensitive pricing mechanisms (Sharma, 2024) demonstrate significant potential to reduce waste and boost profitability. Three key strategies emerge from the analysis: first, integrating dynamic pricing with deterioration rates helps prevent overstock and minimizes losses due to expiration (Sharma et al., 2023); second, hybrid backlogging systems offer a practical balance between customer service and cost efficiency during supply shortages; and third, demand-responsive ordering models—particularly those based on trapezoidal demand functions (Sharma, 2015)—are highly effective for managing seasonal inventory. Despite these advancements, the field still grapples with notable gaps, including reliance on theoretical modelling and limited empirical application. Future research should focus on incorporating AI-powered forecasting tools, evaluating inventory models through sustainability lenses, and conducting cross-sector case studies in industries like healthcare, agriculture, and retail. For supply chain practitioners, the implications are clear: rigid, uniform inventory systems must give way to flexible, data-informed frameworks. In an era of increasing uncertainty and demand volatility, adopting responsive and evidence-based strategies will maintain resilience and competitiveness in managing perishable goods.

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References

[1] Sharma, A. K. (2024). Time-Dependent Demand and Price Effects on Inventory Models: An Analytical Study. *Asian Journal For Convergence In Technology (AJCT) ISSN -2350-1146*, *10*(3), 1-3. https://doi.org/10.33130/AJCT.2024v10i03.001

[2] Sharma, A. K., Adil, A. K., & Dubey, S. S. (2023). Overview of advancement of inventory models for deteriorating items with time based uniform price. *International Journal of Innovative Research in Engineering*, *4*(1), 14–18.

[3] Sharma, A. K. (2022). The need for an inventory control system. *IUP Journal of Operations Management*, *21*(1), 59-63.

[4] Sharma, A. K. (2015). Analysis of deteriorating inventory model for trapezoidal type demand rate. *International Journal of Engineering Research & Management Technology*, *2*(6), 151–159.

[5] Sharma, A. K., & Bansal, K. K. (2016). Analysis of inventory model with time dependent demand under fractional backlogging. *International Journal of Education and Science Research Review*, *3*(1), 103–111.

[6] Sharma, A. K. (2020). Inventory model for fixed deterioration within vending price order rate using limited backlogging. *International Journal of Innovative Research in Technology*, *6*(9), 1–3.

[7] Sharma, A. K. (2022). Survey of development of inventory models with time-based uniform demand. In *Innovation of multidisciplinary research in present and future time* (pp. 76–81). Insta Publishing India.

[8] Sharma, A. K. (2019). An overview and study on inventory model with deteriorating items. *International Journal of Scientific Research in Engineering and Management*, *3*(10), 1–5.

[9] Sharma, A. K. (2019). On some inventory model with deteriorating objects. *International Journal for Scientific Research and Development*, *7*(8), 377–380.

[10] Sharma, A. K. (2019). An overview and study on inventory model with deteriorating items. *International Journal of Scientific Research in Engineering and Management*, *3*(10), 1–8.

[11] Sharma, A. K. (2019). Study to overview on inventory management and related models. *International Journal of Multidisciplinary Educational Research*, *8*(11)(2), 77–86.

[12] Sharma, A. K. (2015). Analysis of deteriorating inventory model for trapezoidal type demand rate. *International Journal of Engineering Research & Management Technology*, *2*(6), 151–159.

[13] Sharma, A. K., & Bansal, K. K. (2016). Analysis of inventory model with time-dependent demand under fractional backlogging. *International Journal of Education and Science Research Review*, *3*(1), 103–111.