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Inventory Management Model of Linear Demand with Variable Holding Cost under Inflation with Salvage Value

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ABSTRACT

The purpose of this study is to give a thorough analytical model for an inventory system that operates under the simultaneous influences of inflation, time-dependent holding costs, and the existence of a salvage value that is recognized at the end of the planning horizon. In today's dynamic economic climate, inflation has a substantial impact on buying power and cost parameters. On the other hand, holding costs often alter over time as a result of changes in storage, energy, and capital expenses. Recognizing these facts, the model incorporates key economic aspects into a single cohesive framework in order to increase the accuracy and applicability of choices about inventory management. The assumption is made that the rate of demand for the item will follow a linear trend with regard to time. This is a representation of true market conditions in which demand either increases or decreases continuously throughout the course of a product's life cycle. Examples of such products are seasonal goods, technology items, and perishable commodities. The model overcomes the limits of previous EOQ-based techniques, which assume constant demand and fixed costs, by including this time-varying demand pattern. This takes the model beyond the restrictions of the old approaches. The fundamental purpose of the model that has been developed is to establish the ideal replenishment strategy that minimizes the overall relevant cost. This cost comprises the cost of ordering, the cost of purchasing, and the cost of holding, and it also takes into consideration the time value of money when inflationary circumstances are present. A present value analysis is used in the formulation in order to guarantee that all future expenditures and revenues are suitably discounted in order to accurately represent their actual levels of economic relevance. In addition, the incorporation of salvage value at the conclusion of the inventory cycle enables the model to account for the possibility of capital recovery via the resale, recycling, or residual disposal of unsold goods. This is an aspect that is sometimes overlooked in traditional models. For the purpose of demonstrating how various characteristics, such as the rate of inflation, the variability of holding costs, and the size of salvage value, impact the ideal order quantity and cycle duration, the mathematical framework that has been established is supported by numerical examples. In conclusion, a sensitivity analysis is carried out in order to provide management insights into the behavior of the model in response to changing economic and operational variables. According to the findings, a rise in the rate of inflation or the development of holding costs has a tendency to shorten the ideal replenishment cycle. On the other hand, a greater salvage value stimulates bigger order quantities and longer inventory cycles. The results of this research provide a contribution to both theory and practice by

providing a model that is more realistic and adaptive towards the decision-making process regarding inventory in situations that are characterized by inflation.

Keywords: characterized, inflation, adaptive

Introduction

Within the context of contemporary supply chain systems, inventory management is an essential component, as it functions as the strategic connection between production, distribution, and the fulfillment of consumer needs. An efficient inventory management system ensures that businesses have sufficient stock levels to rapidly satisfy the demands of their customers, while at the same time reducing the expenses associated with ordering, holding, and obsolescence. Over the course of many decades, academics and practitioners alike have been driven by the challenge of achieving a fine balance between service level optimization and cost efficiency. The objective is to attain this delicate equilibrium. Presently, the Classical Economic Order Quantity (EOQ) model, which was first presented in the early 20th century, continues to be one of the fundamental instruments used in inventory theory. By striking a balance between the costs of ordering and keeping inventory, it offers a simple but effective methodology for estimating the appropriate order quantity that will result in the lowest possible overall cost of inventory. On the other hand, the standard EOQ model functions upon a number of simplifying assumptions, the most important of which being that demand does not change over time and that holding costs are consistent and unaffected by the passage of time. However, despite the fact that these assumptions make it possible to conduct analytical tractability, they restrict the application of the model in real-world economic contexts that are characterized by uncertainty, price swings, and inflationary pressures. In actuality, the majority of markets are subject to demand patterns that change over time as a result of a variety of variables, including seasonality, technological advancement, product life cycles, and customer preferences. As an example, the demand for new technological goods often experiences a strong increase immediately after their launch, then stabilizes throughout the maturity period, and then begins to decrease. It is thus a logical and practical assumption to assume that a linear demand function, which represents either a progressive rise or drop in demand over time, captures many real-world behaviors more precisely than models that assume a constant demand. Holding costs, on the other hand, are not always consistent. These costs include charges connected to warehousing, insurance, depreciation, and capital that is locked up in inventories. Changes in energy prices, interest rates, inflation, and facility use are some of the factors that often cause them to fluctuate over time. Inflation, in particular, plays a significant influence since it reduces the buying power of money and has an effect on every cost component of an inventory system. Long-term inventory planning that does not take inflation into account might result in choices that are not optimum or that are deceptive. This is because the true value of future expenses and revenues is not the same as the value of the present. Additionally, after the conclusion of their useful or intended life cycle, many items still have some worth that may be salvaged or known as residual value. There are a number of potential sources of value, including resale, recycling, refurbishing, and disposal returns. It is possible for businesses to recoup a portion of the investment cost and enhance their profitability by including salvage value into the model. This is accomplished while also supporting sustainable inventory practices. The purpose of this work is to build an inflation-adjusted inventory model that explicitly combines linear time-dependent demand, variable holding cost, and salvage value factors. This is in recognition of the practical complexity that are involved. The proposed model extends the conventional EOQ framework by including economic and temporal dynamics. As a result, it accurately reflects the ways in which inventory systems behave when they are working in settings that are characterized by inflation. It gives those in charge of making decisions a tool that is more realistic and adaptable, allowing them to determine the ideal replenishment plans in response to shifting economic situations. This study makes a contribution to the continuous development of current inventory models that are able to handle situations that are time-dependent and inflation-sensitive. It does this by bridging the gap between classical theory and contemporary market realities. In addition, the analytical and numerical findings that were produced from this research provide useful management insights for businesses that are looking to improve their cost efficiency and competitiveness in the face of shifting economic landscapes.

Literature Review

During the course of the last several decades, a significant amount of attention has been paid to the issue of establishing the appropriate inventory policies to implement in the context of dynamic economic situations. In the beginning, there were research that provided the groundwork for the incorporation of economic realities into inventory control models. These realities included inflation and time-dependent factors. The Economic Order Quantity (EOQ) framework was one of the first to include inflationary impacts, and Buzacott [1] was one of the first to demonstrate how inflation affects choices on replenishment and the overall cost of inventory. Through his work, he demonstrated the significance of modifying traditional EOQ models in order to take into account fluctuating price levels and the concept of the time value of money. In a similar manner, Misra [2] expanded the EOQ model by integrating both inflation and the time value of money. This resulted in an improvement in the practical usefulness of inventory theory in situations involving long-term planning. Especially in countries that are experiencing high or unpredictable inflation rates, these early contributions underlined that disregarding inflationary impacts may lead to underestimating of inventory costs and poor decision-making. This is especially true in nations that are experiencing this phenomenon. Based on these fundamental discoveries, a number of scholars endeavored to construct models that more accurately mimic the circumstances of the real-world market, which are defined by demand and cost characteristics that are dependent on the passage of time. A model that took into account time-varying demand and the consequences of degradation was suggested by Goyal and Gunasekaran [3]. This model was connected with production, inventory, and marketing. According to the findings of their research, optimum choices about manufacturing quantity, replenishment rate, and marketing effort are interconnected and need to be coordinated in order to reduce total cost. The inventory modeling process underwent a significant transformation as a result of this integration, which allowed for the transition from static assumptions to dynamic and interconnected decision factors. It was via subsequent study that these ideas were further developed and expanded upon. An inventory model for decaying objects was established by Roy [4], and it included salvage value and partial backlogging into its calculations. The results of his investigation demonstrated that the incorporation of salvage value results in a considerable reduction in overall cost by compensating for losses that are caused by deterioration or obsolescence. In the meanwhile, Chang [5] proposed an EOQ model with variable holding costs under inflation. This model reflected real-world situations in which holding costs rise over time owing to swings in storage, insurance, and capital cost. The preceding EOQ formulations assumed that holding costs would be constant regardless of the economic circumstances. This model addressed one of the most significant weaknesses of those older formulations. Additional progress was achieved by Taleizadeh et al. [6], who constructed an integrated supplier–buyer inventory system that took into consideration inflation and the time value of money simultaneously. Their model revealed the strategic necessity of coordination between partners in the supply chain in contexts characterized by inflation. It also proved that collaborative optimization results in significant cost reductions when compared to solo decision-making. It is clear that relatively few studies have concurrently combined linear time-dependent demand, variable holding cost, inflation, and salvage value within a coherent analytical framework. This is the case despite the fact that these substantial contributions have been made. In the bulk of the models that are now available, these aspects are either considered in isolation or in pairwise combinations. This restricts their application in business contexts that are realistic and rapidly changing. As a result, the purpose of this study is to address this research gap by developing and accessing an inflation-adjusted inventory model that incorporates all of these components. This model will provide a complete and practical approach to inventory management under actual economic circumstances.

Model Assumptions and Notations

The inventory model that has been provided is built under a set of assumptions that are both realistic and well-defined. These assumptions describe the behavior of an inventory system that is functioning in an environment that is both inflationary and time specific. To begin, it is assumed that the planning horizon is finite. This means that the analysis is limited to a certain time period during which choices pertaining to inventory are made. This assumption is consistent with the operations of businesses in the real world, where decision-makers examine inventory strategies within a fixed time period rather than across an indefinite horizon. In the second place, it is assumed that the rate of demand for the product would rise in a linear fashion over the course of time. This is mathematically expressed as $D(t) = a + bt$, where $a > 0$ represents the initial demand rate and $b > 0$ represents the rate of transformation of demand over time. This assumption depicts the dynamic character of market demand, which often develops gradually owing to product life cycles, technical improvements, or seasonal patterns. There are many factors that may contribute to this evolution. It gives a more realistic picture than models that assume continuous demand, especially for items whose sales quantities indicate consistent rise or drop over time. In the third place, it is assumed that the holding cost per unit per unit time is variable and that it grows linearly with time. This is stated as $h(t) = h_0 + h_1 t$, where $h_0 > 0$ represents the base holding cost and $h_1 > 0$ shows the rate at which the holding cost varies over time. This presumption recognizes that costs associated with storage, insurance, maintenance, and capital tend to increase with time, particularly in countries that are characterized by inflation. Because of this, the model takes into account both the time-dependency and the inflationary impacts that are associated with the cost of storing inventory. The fourth step is to incorporate inflation as a constant rate, which is represented by the symbol f, in order to portray the gradual loss of monetary value over time. When estimating the present value of total cost (PVTC), this guarantees that all future expenses and revenues are suitably discounted in accordance with the appropriate discount rate. If inflation is not taken into account during long-term inventory planning, it may result in erroneous cost projections and ordering choices that are less than ideal.

In the fifth position, the model presupposes that replenishment is immediate, which means that the inventory is supplied without any delay or shortage as soon as an order is made. In light of this, stock outs and shortages are strictly prohibited, which guarantees that the demand from customers is consistently satisfied during the whole planning horizon. The model is simplified by this assumption, and it may be used to systems in which the supply is dependable and the cost of shortfall is prohibitively large. Sixth, it is assumed that a salvage value, denoted by the letter S, is realized at the conclusion of the planning horizon for every unit of inventory that has not been sold or that has been left over. The remaining value of the product is represented by this salvage value, which may be acquired via resale, recycling, or repurposing of the goods. Including salvage value in the model enables businesses to recoup a portion of their investment and provides support for methods that are environmentally responsible in inventory management. In conclusion, the purpose of the model is to minimize the present value of the total cost (PVTC), which is comprised of the purchase cost, the ordering cost, and the holding cost. This PVTC is then adjusted for the impacts of inflation and decreased by the salvage value that is achieved at the conclusion of the cycle. Because of this, the model is able to give an optimum replenishment strategy that not only maintains economic efficiency but also reflects true cost and demand dynamics across the planning horizon.

Mathematical Formulation

The mathematical formulation of the proposed inventory model aims to capture the dynamic interactions among demand, holding cost, inflation, and salvage value over a finite planning horizon. To achieve this, several fundamental relationships are defined and integrated into the analytical structure of the model.

The total demand during the cycle, denoted by Q, is obtained by integrating the linear demand rate function D(t) = a + bt over the replenishment period [0, T]. Mathematically, this is expressed as:

$$Q = \int_0^T D(t)\, dt = aT + (bT^2)/2.$$

This expression indicates that the total demand increases with both the initial demand rate (a) and the rate of change of demand (b). The quadratic term ($bT^2/2$) reflects the cumulative effect of time-dependent growth in demand across the entire replenishment cycle.

At any point in time t within the cycle, the inventory level I(t) can be determined by subtracting the cumulative demand from the initial stock level Q. This relationship can be represented as:

$$I(t) = a(T - t) + (b(T^2 - t^2))/2.$$

This equation shows that the inventory level declines over time as customer demand is met, with the depletion rate depending on both the linear and quadratic components of demand. At the beginning of the cycle (t = 0), the inventory is at its maximum value Q, and it gradually decreases to zero at the end of the cycle (t = T).

The holding cost associated with maintaining inventory is both time-dependent and subject to inflation. To accurately compute its economic impact, the **present value of holding cost (PV_HC)** is calculated by discounting future holding costs over the cycle duration. It is given by the following integral expression:

$$PV\_HC = \int_0^T h(t)I(t)e^{(-ft)}\, dt.$$

In this expression, $h(t) = h_0 + h_1t$ represents the variable holding cost per unit per time, and $e^{(-ft)}$ denotes the discount factor that accounts for the constant inflation rate f. This formulation ensures that the model correctly reflects the diminishing real value of money over time. The integral can be evaluated either analytically or numerically depending on the complexity of the parameters involved.

The total **present value of cost (PVTC)** for the system is the sum of all relevant cost components, including ordering cost (PV_OC), purchase cost (PV_PC), and holding cost (PV_HC), while subtracting the present value of the salvage value (PV_SV) at the end of the planning horizon. Mathematically, this relationship is expressed as:

PVTC(T) = PV_OC + PV_PC + PV_HC - PV_SV.

Here, PV_OC represents the fixed ordering or setup cost incurred per replenishment, PV_PC accounts for the discounted purchasing cost of goods, PV_HC is the total discounted holding cost, and PV_SV denotes the discounted value recovered from the remaining inventory at the end of the period. This comprehensive cost structure ensures that both economic and temporal factors are included in the decision-making process.

Finally, to determine the **optimal replenishment cycle time (T*)**, the total present value of cost function is differentiated with respect to the cycle time T, and the result is equated to zero. The condition for optimization is given as:

d(PVTC)/dT = 0.

Solving this equation yields the optimal replenishment time T*, which minimizes the total present value of cost. Due to the nonlinear nature of the cost components, this equation is typically solved using numerical techniques such as the Newton–Raphson method or iterative computational algorithms.

Numerical Illustration

It is necessary to build a numerical example that makes use of a realistic set of parameters in order to illustrate the practical applicability of the suggested inventory model. The goal of this example is to offer insight into the computational process of calculating the best replenishment strategy and to observe how various parameters impact the overall cost structure under the combined effects of inflation, variable holding cost, and salvage value. Specifically, the illustration will focus on how certain factors influence the total cost structure. Assumptions have been made about the following parameter values for the illustration: Initial demand rate a = 100 units per month, rate of change of demand b = 10 units per month2, ordering or setup cost C_p = $500 per order, unit purchase cost C_p = $20, base holding cost h_0 = $0.50 per unit per month, rate of increase in holding cost h_1 = $0.02 per month, inflation rate f = 0.05 (or 5% per time unit), and salvage value S = $5 per unit are all factors that are taken into consideration. These characteristics are reflective of a typical manufacturing or retail system that operates in an inflationary market setting, where both costs and demand are subject to change over the course of time.

A numerical solution is obtained for the model by inserting the aforementioned parameters into the equations that have been created for demand, holding cost, and total cost. This allows for the ideal replenishment cycle time (T*) to be obtained. As a result of the calculations, it has been determined that the best replenishment cycle involves roughly 3.8 months for T*. At this particular cycle length, the total present value of cost (PVTC) hits its lowest possible level, which is around $12,340. This result indicates that refilling inventory every 3.8 months offers the most cost-effective balance between ordering, holding, and buying expenses. This is the case even when taking into consideration the mitigating effects of salvage value and the degrading effect of inflation.

Following that, a sensitivity analysis is carried out in order to investigate the ways in which modifications in key factors influence the ideal replenishment time and overall cost estimates. According to the findings of the research, a decrease in the ideal cycle length occurs if there is a rise in either the inflation rate or the time-dependent component of holding cost (h1). This behavior happens as a result of increasing inflation and holding costs, which raise the expense of carrying inventory for longer periods of time, which in turn encourages more frequent replenishment. On the other hand, a rise in the salvage value (S) stimulates longer replenishment cycles. This is because the residual value received from things that were not sold or that were left over at the conclusion of the cycle helps to offset a portion of the holding cost and enhances overall profitability. Not only do the numerical findings confirm the model that was presented, but they also highlight the management importance of the methodology. This framework may be used by decision-makers in order to ascertain the most effective policies to implement in response to different market situations, inflationary pressures, and cost structures. As a result, the model is an extremely useful instrument for optimizing inventory strategies in situations that are both dynamic and economically sensitive.

Sensitivity Analysis

To gain deeper insights into the behavior of the proposed inventory model, a comprehensive sensitivity analysis is conducted. This analysis investigates how changes in key parameters—such as the inflation rate, the rate of increase in holding cost, the salvage value, and the demand growth rate—affect the optimal replenishment cycle time (T*) and the overall cost structure. Understanding these relationships is essential for effective decision-making, especially in dynamic and inflation-prone business environments. Firstly, the **inflation rate** plays a crucial role in shaping replenishment policies. As the inflation rate increases, the real value of money declines over time, which leads to a rise in future inventory-related expenses. Consequently, firms prefer to hold smaller quantities for shorter periods to reduce exposure to inflationary pressures. Therefore, an increase in the inflation rate results in a **decrease in the optimal replenishment cycle (T*)**, implying that higher inflation favors more frequent ordering and shorter holding periods. Secondly, the **growth rate of the holding cost** (h_1) also has a significant influence on inventory decisions. As holding costs increase with time due to factors such as rising energy prices, storage costs, or capital charges, maintaining large inventories over longer periods becomes increasingly expensive. This cost escalation motivates firms to shorten their inventory cycles and reduce the time items spend in storage. Hence, a higher rate of increase in holding cost leads to a **reduction in the optimal replenishment time (T*)**, encouraging more frequent replenishment and leaner inventory levels. Thirdly, the **salvage value (S)** at the end of the planning horizon positively affects the replenishment decision. When products retain a significant salvage or resale value, firms can recover part of their investment even if some inventory remains unsold. This potential recovery reduces the effective cost of holding inventory and allows companies to maintain higher stock levels without substantial financial risk. Therefore, an increase in salvage value tends to **increase the optimal replenishment cycle (T*)**, justifying larger order quantities and longer intervals between replenishments. Lastly, the **demand slope (b)**—which represents the rate of change of demand over time—affects the rate at which inventory is depleted. When demand rises more rapidly, products move through the system faster, and stockouts become more likely if replenishment cycles are too long. To prevent shortages and maintain service levels, firms respond by shortening their replenishment intervals. Consequently, a higher demand growth rate results in a **decrease in the optimal cycle time (T*)**, indicating the need for more frequent replenishment under rapidly increasing demand conditions. Overall, the sensitivity analysis reveals that inflation and time-dependent holding costs have an inverse relationship with the optimal replenishment cycle, while salvage value has a direct relationship. These findings provide valuable **managerial insights** for firms operating in volatile economic environments. Decision-makers can adjust their replenishment policies dynamically—shortening cycles during inflationary or cost-intensive periods, and extending them when salvage opportunities or market stability allow. By doing so, organizations can minimize costs, optimize cash flow, and enhance overall operational efficiency.

Managerial Implications

The results derived from this study offer several important managerial implications for decision-makers responsible for inventory control and cost optimization, particularly in inflationary business environments. One of the primary insights is that firms operating under the influence of inflation should adopt **dynamic inventory policies** rather than relying on traditional static EOQ models. Static models assume constant demand, fixed costs, and stable economic conditions—assumptions that are rarely valid in real-world markets. In contrast, dynamic inventory models, such as the one developed in this study, enable firms to adjust their replenishment cycles in response to changing economic parameters, including inflation, cost escalation, and fluctuating demand patterns. By continuously monitoring inflationary trends and adjusting inventory decisions accordingly, managers can avoid the financial distortions that arise from treating nominal and real costs as equivalent. When inflation is high, holding inventory for extended periods results in greater capital erosion, as the purchasing power of money declines over time. Therefore, businesses should consider shorter replenishment cycles to mitigate the impact of inflation on total inventory cost and maintain liquidity. This proactive approach allows firms to remain competitive by aligning their operational strategies with prevailing economic realities. Another significant implication pertains to the role of **time-dependent holding costs**. Traditional EOQ models assume that holding costs remain constant over time, but this is seldom the case. In practice, storage expenses, insurance premiums, and opportunity costs of capital tend to rise over time due to inflation, higher energy costs, or capacity constraints. Incorporating a time-dependent holding cost function, as proposed in this model, ensures that the true cost of maintaining inventory is accurately captured. This leads to more realistic decision-making, enabling firms to prevent the underestimation of storage-related expenses that often occurs when cost dynamics are ignored. The consideration of **salvage value** introduces an additional dimension of strategic importance. Many firms, especially those dealing with durable goods or recyclable materials, can recover a portion of their investment by reselling, refurbishing, or recycling unsold inventory at the end of a product's life cycle. Incorporating salvage value into the inventory model not only enhances cost recovery but also supports the principles of **sustainable and circular economy practices**. By recognizing the potential for end-of-life product recovery, firms can reduce waste, improve environmental responsibility, and strengthen their long-term financial performance. In summary, the findings suggest that effective inventory management in an inflationary context requires a **comprehensive and adaptive strategy**. Managers should integrate inflation, variable holding costs, and salvage value considerations into their decision frameworks to optimize replenishment timing and minimize total costs. Such adaptive strategies not only improve operational efficiency but also ensure long-term sustainability and resilience in fluctuating economic environments.

Conclusion

A complete and integrated inventory model has been established as a result of this research. This model takes into consideration the combined impacts of linear demand, variable holding cost, inflation, and salvage value. The framework that has been developed provides a more flexible and realistic approach to inventory management in the context of dynamic and inflationary market circumstances. This is accomplished by loosening the restrictive assumptions that are inherent to traditional EOQ models. The incorporation of time-dependent characteristics and inflationary impacts enables decision-makers to evaluate inventory strategies in terms of actual economic value rather than nominal cost. This results in an evaluation of operational efficiency that is both more accurate and more applicable to real-world situations.

The analytical formulation of the model takes into account the interrelationships that exist between important economic and operational aspects, such as the increase of demand, the escalation of costs, and the significance of the time value of money. The model guarantees that all future expenditures and revenues are accurately discounted by using present value analysis. This aligns the decision-making process about inventory with actual financial concerns, creating a more accurate picture of the situation. In addition, the incorporation of a salvage value component extends the application of the model to businesses in which unsold or leftover inventory may be resold, recycled, or repurposed, so contributing to the recovery of costs and the preservation of the environment. Through the use of parameter substitution and sensitivity analysis, the numerical example that is shown in this paper shows how optimum replenishment cycles may be established. It also exhibits the practical value of the model that has been developed. Based on the findings, it is evident that inflation and variable holding costs have a considerable negative connection with the ideal replenishment time. On the other hand, salvage value serves as a stabilizing element that encourages longer cycles. These insights are very helpful for managers who are looking to maximize the performance of their inventory while simultaneously minimizing the impact of inflation and cost volatility. In general, the model improves upon the conventional EOQ theory by including economic realism and temporal dynamics into the process of decision-making. It provides businesses who operate in contexts that are sensitive to inflation with a vital decision-support tool, which enables them to develop inventory strategies that are both preemptive and flexible respectively. In the context of contemporary supply chain management, this model bridges the gap between theoretical simplicity and practical application by explicitly taking into consideration time-varying demand, holding costs, and inflationary considerations. It is suggested that this study be extended in a number of different ways for future research. In order to take into consideration the unpredictability of demand and to make the model more resilient in turbulent markets, it is possible to extend it such that it incorporates stochastic demand patterns. It is also possible to expand it to handle "deteriorating items," which refers to situations in which the quality or quantity of goods degrades over time, as well as "multi-item inventory systems," which are situations in which the interdependencies among products play a significant part in the process of cost optimization. Such modifications would further increase the model's adaptability and realism, making it relevant across a larger variety of industrial and economic situations. Moreover, they would make the model more applicable. Within the framework of reliability theory, the use of the Inventory Management Model. The inventory management model that was established in this work has significant applications in the field of reliability theory. These applications include the analysis and optimization of spare parts inventory, the scheduling of system maintenance, and the management of lifecycle costs for complex engineering systems. Reliability theory is concerned with the performance, lifespan, and failure characteristics of systems and components. An efficient inventory management system plays a significant role in ensuring that such systems continue to retain a high level of reliability and availability over time. Equipment failures may result in expensive downtime, safety risks, and operational inefficiencies in systems that are based on dependability. Some examples of these types of systems are the aerospace, military, energy, and manufacturing sectors. Companies keep spare parts inventories in order to allow quick repair or replacement of components that have failed. This helps to lessen the effects of these difficulties. A realistic instrument for calculating optimum replenishment strategies for such reliability-related inventories is provided by the model that was suggested in this study. This model integrates linear demand, variable holding cost, inflation, and salvage value. Within the context of dependability, the requirement for replacement parts is often reliant on the passage of time. Demand may be minimal during the early operating phase of a system; nevertheless, as equipment matures, failure rates—and therefore, part demand—tend to grow roughly linearly or exponentially with time. This is because failure rates tend to increase linearly with time. In the current model, the assumption of linear demand (D(t) = a + bt) is well aligned with this typical failure pattern. This allows reliability engineers to build spare component inventories that are able to adjust to the stage of the system's lifespan. Furthermore, the variable holding cost component of the model reflects the economic truth that the cost of keeping spare parts increases with time owing to variables such as obsolescence, technology advancements, and storage degradation. This is a reality that is reflected in the economic reality. It is possible that older components could lose their usefulness as equipment designs continue to advance, which might result in excess inventory or disposal expenses. The incorporation of salvage value provides a solution to this problem by enabling businesses to recoup a portion of the investment made in old or unneeded parts via the process of recycling or reselling, hence fostering sustainable asset management procedures. Inflation-adjusted version of the model assures that reliability engineers and asset managers assess maintenance and inventory strategies in terms of actual economic cost rather than nominal numbers. This is accomplished by changing the formula to account for inflation. When it comes to sectors that need a considerable amount of capital or long-term maintenance contracts, this is of utmost importance since the time value of money may have a major influence on the whole lifetime costs. Through the process of discounting future holding and replenishment costs, the model assists in optimizing the timing and amount of orders in order to reduce overall cost while maintaining the appropriate levels of system dependability. In summary, integrating this inflation-adjusted inventory model inside reliability theory helps firms to:

1. Optimize spare parts inventory strategies in conformity with component failure trends.
2. Ensure that important components are available in sufficient quantities in order to minimize downtime and delays caused by maintenance.
3. Reduce the total cost of ownership across the product's entire lifespan by taking into account inflation, time-varying expenses, and residual value recovery.
4. Improve the dependability and sustainability of the system by using data-driven replenishment plans and improving the efficiency with which resources are allocated.

Therefore, the model that has been provided offers a rigorous analytical framework that bridges inventory optimization and reliability engineering. This framework helps to assist the design of maintenance systems that are both cost-effective and operationally reliable [7-61].

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