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RESEARCH ARTICLE

An integrated inventory system for profit maximization considering partial demand satisfaction

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Abstract

To evaluate and substantiate the importance of investments in enterprise resource planning within an inventory system facing shortages, with the objective of maximizing profit and enhancing operational efficiency and decision-making accuracy. An inventory framework that considers shortages is developed with investments in advanced systems and is examined using two methods, namely with and without enterprise resource planning investments. This study formulates an integrated inventory system and comparative analysis has been made to study the effectiveness of the systems under two categories namely (i) an inventory system under shortages and without the investment of enterprise resource planning and (ii) an inventory system considering shortages and with the integration of enterprise resource planning investment by using secondary data from Umakanta Mishra's research. A computational example is presented to show the efficiency of the systems under shortages and the results show that the total profit with and without the integration of Enterprise Resource Planning is $290072.873 and $289358.716, respectively. The findings suggest that incorporating investments in Enterprise Resource Planning into an inventory system that accounts for shortages significantly enhances economic performance by optimizing profit and supply chain processes. The efficiency of Enterprise Resource Planning in an inventory system under the consideration of shortages to optimize profit-enhancing operational efficiency is not yet explored in existing literature.

Keywords: Inventory system, Shortages, Non-deterioration, Enterprise resource planning, Profit maximization, Partial demand satisfaction.
关键词： 库存系统、短缺、不变质、企业资源计划、利润最大化、部分需求满足。

Introduction

In the current competitive and swiftly changing business landscape, inventory management has emerged as a fundamental element of success for manufacturing companies and supply chain networks. Proper inventory administration not only guarantees the timely availability of products to satisfy consumer demand but also greatly influences on cost reduction, client happiness, and the efficient application of resources. The changing nature of market demands, combined with increased globalization and technical breakthroughs, has heightened the need for inventory systems that go beyond traditional systems. Traditional inventory systems, which are primarily concerned with balancing purchasing and storing costs, are no longer adequate to manage the complexities of modern supply chains, which require agility, reactivity, and real-time decision-making. One of the most serious difficulties that industries face today is maintaining inventory when there are shortages or when only a portion of demand can be met. Shortages can have serious repercussions, such as missed sales, decreased consumer loyalty, ineffective operations, and financial losses. As a result, managing inventory strategies under shortage conditions is critical for sustaining competitiveness, economic viability, and customer trust.

A comprehensive literature study has focused on the evolution and problems of shortage cost modeling in inventory management, emphasizing its importance in increasing system efficiency and decision-making accuracy. (Mohamed Haythem Selmi et al., 2019). An inventory system was created to solve non-instantaneous deterioration and quality assessment under carbon emission limits, which included complete backordering shortages (Rajesh Kumar Mishra and Vinod Kumar Mishra, 2022). A system was developed that integrates controllable non-instantaneous deterioration with environmental emission considerations

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in the inventory system (Umakanta Mishra et al., 2020). While many studies have been conducted on inventory systems that account for shortages, backordering, and partial demand satisfaction, there is still a significant gap in the literature regarding how advanced information systems can be incorporated into such systems to improve both functional and financial results. Heibatolah Sadeghi et al., (2021) formulated an -inventory system considering shortages and discrete delivery orders. Luis A. San-Jose et al., (2022) proposed a profit-oriented inventory system that incorporates time-varying demand, partial backordering, and a discrete inventory cycle. A system was designed with discrete scheduling intervals, time-varying demand, and a provision for backlogged shortages (Luis A. San-Jose et al., 2019).

Enterprise resource planning (ERP) systems have developed as transformative tools that provide real-time insight, smooth integration, and centralized control over a wide range of company processes, such as procurement, manufacturing, inventory management and distribution. Shadrack Katuu (2020) analyzed the past, present and future of ERP. ERP systems enable firms to streamline operations by integrating information across departments, allowing for precise demand forecasting, effective resource allocation, and efficient handling of supply chains. The efficiency and effectiveness of inventory management were analyzed by optimizing the supply chain through the implementation of Enterprise Resource Planning (ERP) technology (Rubel, 2021). Critical success factors for implementing Enterprise Resource Planning (ERP) systems in sustainable corporations were analyzed to enhance system effectiveness and long-term viability (Shaio Yan Huang et al., 2019). By investing in ERP systems, businesses can more effectively handle inventory levels, increase service quality, and mitigate the negative effects of shortages through proactive and data-driven choice-making. The relationship between ERP quality and organizational performance was investigated, with an emphasis on technical qualities as opposed to information and service elements (Amer Balic et al., 2022). While previous research has investigated the contribution of information systems and technological advances in improving supply chain performance, a few studies have concentrated on the implementation of ERP investments into inventory systems operating in the face of shortages or partial demand fulfillment. Furthermore, existing systems infrequently integrate ERP systems with financial processes such as prepayments and technology-induced cost reductions, particularly under a no deterioration assumption in an inventory system. This study seeks to address a significant gap by developing a comprehensive ERP-enabled inventory system for environments that are susceptible to shortages.

Addressing this gap is vital, since integrating ERP systems into inventory management choices has the ability to achieve dual objectives: financial efficiency through profit maximization and managerial efficiency through increased supply chain agility and resilience. Businesses that use ERP systems can not only enhance forecasting accuracy and inventory control, but also make more informed choices on prepayments and shortage management, resulting in superior company performance. To this purpose, the current study suggests creating an integrated inventory system that clearly includes shortages, prepayments and ERP investments. The system aims to give a comparative examination of two alternative approaches:

- An inventory system that considers for shortages without ERP investment, and
- An inventory system that incorporates shortages alongside ERP investment.

The study's comparison approach tries to analytically demonstrate how ERP implementation can improve overall profit, resource usage, and supply chain efficiency.

In accordance with this objective, the investigation is guided by the following research questions:

- How might integrating ERP into an inventory system with shortages improve overall profitability and efficiency?
- What is the comparative impact of implementing ERP versus not implementing ERP on the economic and operational performance of the inventory system under partial demand satisfaction?
- How does the suggested integrated system help managers balance inventory costs, shortages, and technology investments?

By systematically addressing these research issues, the study offers useful managerial insights in addition to adding to the expanding corpus of knowledge on intelligent and responsive inventory management. These insights are intended to assist stakeholders in strategically aligning technological investments, such as ERP systems, with their company's objectives of profitability, efficiency, and resilience, providing a competitive advantage in today's dynamic and interconnected markets.

Methodology

An integrated inventory framework was developed by incorporating Enterprise resource planning systems. This study compared two strategies namely (i) an inventory system under shortages and without the investment of Enterprise Resource Planning and (ii) an inventory system considering shortages and with the integration of Enterprise Resource Planning investment. To demonstrate the efficiency of the proposed system, secondary data from the research of Umakanta Mishra's were utilized, and improving resource utilization, and enhancing operational efficiency under conditions of inventory shortages or partial demand satisfaction. The notations, assumptions and mathematical formulations used to formulate the proposed system are detailed below.

Notations:

The notation in this paper is as follows:

Notations	Descriptions
t_1	Discrete time of cycle
s	Discrete price for sale
φ_t	Environment emissions cost
O_0	Cost incurred per ordering cycle
φ_t^0	The actual average carbon emission price for a product unit (\$/kg/time unit)
X	Carbon cap (kg/unit)
e	Carbon emissions linked with each unit purchased
O	Cost incurred per order
O_0	Constant ordering cost
ν	Opportunity cost associated with capital investment
h_c	Fixed holding cost
p_c	Unit purchase cost $(s > p_c)$
Q	Quantity ordered
q	Equal prepayments before getting Q
ψ	Cost of acquisition to be prepaid $(0 \le \psi \le 1)$
l	Prepayment period (year) length
R	Interest Rate on Capital (\$/per year), where $0 \le R \le 1$
$A(O)$	Capital investment
I_E	amount of capital investment on Enterprise resource planning
m	effectiveness of Enterprise resource planning in lowering the costs
ε	proportion of costs after investments in Enterprise resource planning
α	proportion of partial demand satisfaction
c_b	unit backordering cost
c_l	unit lost sales cost
β	backordering fraction
Z	Overall profit rate achieved when $t_1 < \gamma$

Assumptions

- The study requires a single, non-instantaneous degrading item.
- There is zero lead time.
- The ordering cost O represents a capital investment decision and plays a crucial role in determining the reorder point. Therefore, $A(O)$ is capital investment for minimizing order costs $A(O)=\frac{1}{\mu}\log\left(\frac{O_0}{O}\right)t_1$, for $0 < O \le O_0$, where t_1 is the total duration of the cycle and where μ is a percentage in reduction in order cost. The capital expenditure to manage O is $\frac{\nu}{\mu}\log\left(\frac{O_0}{O}\right)t_1$, where ν is the yearly opportunity cost.
- The system experiences demand at a rate of $D(s,t)=d(s)\left[I(t)\right]^{\lambda}, 0 \le I(t) \le t_1;\ I(t)$ represents the inventory level $0 \le \lambda << 1$ is the metric of demand used to change the stock level. Furthermore, the demand scale factor is $d(s)(>0)$, a linear pricing function is more relevant than fixed demand in everyday situations. The market demand rate is $d(s)=a-bs$ where $a>0$ is a scaling factor, $b>0$ is the elasticity coefficient and fulfilled price $s<\frac{a}{b}$. These kinds of rates of demand $D(s,t)$ are decreasing returns (decreases for greater inventory levels with marginal increases in demand rate).
- A nonlinear stock function is represented by $h_c\left[S(t)\right]^{\sigma}$, where $h_c(>0)$ is a scalability constant for holding costs, and $\sigma(>0)$ signifies holding cost elasticity.
- The environmental emission cost φ_t is incorporated into the proposed system as a decision variable. If $i(\varphi_t)$ is an investment to reduce environmental emissions costs, then $i(\varphi_t)=\frac{1}{\zeta}\log\left[\frac{\varphi_t^0}{\varphi_t}\right]t_1$, for $0 < \varphi_t \le \varphi_t^0$, where ζ is a reduced environmental emissions costs φ_t per dollar to rise $i(\varphi_t)$ and t_1 is the Overall cycle time. The environmental emission price $i(\varphi_t)$ is a one-time expenditure that will provide higher returns in the future. Thus, the yearly investment cost is $\tau i(\varphi_t)=\frac{\tau}{\zeta}\log\left[\frac{\varphi_t^0}{\varphi_t}\right]t_1$, where τ is an opportunity cost.
- Shortages are allowed.
- The system considers a non-deteriorating item. Hence, the deterioration rate is assumed to be zero.
- α is considered to be a proportion of expected cycle demand that is fulfilled directly through ordering and $\alpha \in (0,1]$. If $\alpha = 1$, no shortage occurs and $\alpha < 1$, deliberate shortage will occurs.
- The firm adopts Enterprise Resource Planning (ERP) to enhance coordination, improve decision-making, and reduce operational inefficiencies across the inventory system. This centralized system minimizes shortages, prevents overstocking, and reduces the overall cost associated with inventory mismanagement. The fraction of average shortage and ordering cost reduction resulting from ERP implementation is represented by $F=\varepsilon(1-e^{-mI_E})$, where ε, m, I_E are defined in the notation section. The use of ERP ensures a more efficient, responsive, and sustainable inventory management system by optimizing resource allocation and promoting operational transparency.

Mathematical Formulation

The greenhouse vendor prepays the supplier $\kappa p_c Q$ in q equivalent installments in l years earlier to the time of delivery, and pays the needed balance $(1-\kappa)p_c Q$ instantly once they receive Q units at time zero. The stock level is reducing according to the rate of demand $d(s)[S(t)]^{\lambda}$ in period $0 \le t \le \gamma$. There does not exist deterioration rates and no need to spend in preservation techniques. The variation in stock level in $[0, t_1]$ is solely due to demand, with the condition $S(t_1) = 0$ in this instance.

$$\frac{dS(t_1)}{dt} = -D(s,t), \; 0 \le t \le \gamma$$

The initial and boundary conditions are $I(0) = Q, I(t_1) = 0.$
The order quantity is evaluated by
$Q = \alpha D_{cycle}$ where $D_{cycle} = [d(s)(1-\lambda)]^{\frac{1}{1-\lambda}} t_1^{\frac{1}{1-\lambda}}$ and α is a proportion of expected cycle demand that is fulfilled directly through ordering.
i.e. $Q = \alpha[d(s)(1-\lambda)]^{\frac{1}{1-\lambda}} t_1^{\frac{1}{1-\lambda}}$ where $\alpha \in (0,1]$
Total shortage costs is evaluated by $(1-\alpha)D_{cycle}[c_b\beta + c_l(1-\beta)]$

Now, the overall annual profit comprises the following components:

- O is cost incurred per order
- $h_c S_{h_c}$ is inventory holding expense
- $p_c Q$ is acquisition cost
- $\varphi_t X t_1$ is cost of carbon permits
- $\varphi_t e Q$ is cost incurred from carbon emissions
- $\frac{\tau}{\zeta}\log\left[\frac{\varphi_t^0}{\varphi_t}\right] t_1$ is cost of reducing environmental emissions
- $sQ_s = sQ - sQ_d$ is revenue from sales
- $C_c = R\left[\frac{\kappa p_c Q}{q}\left(\frac{l}{q}\right)(1+2+3\ldots\ldots\ldots\ldots+q)\right] = \frac{(n+1)(\kappa l R p_c Q)}{2q}$ is capital cost per cycle.
- $c_b\beta(1-\alpha)D_{cycle}$ is the backordering cost
- $c_l(1-\beta)(1-\alpha)D_{cycle}$ is the lost sales cost

System that considers for shortages without any investment

Hence the optimization problem for shortages is given by,

Maximum Z subject to constraints

$$Z = \frac{1}{t_1}\begin{bmatrix} sQ - O - h_c S_h - p_c Q - (s + d_c)Q_d - \dfrac{(q+1)(\kappa l R p_c Q)}{2q} - \varphi_t e Q \\ -\dfrac{\tau}{\zeta t_1}\log\left[\dfrac{\varphi_t^0}{\varphi_t}\right] t_1 + \varphi_t X t_1 - (1-\alpha)D_{cycle}\left[c_b\beta + c_l(1-\beta)\right] \end{bmatrix} \quad (1)$$

The objective is to maximize the new profit per unit time by adding the capital investment cost $\frac{\nu}{\mu}\log\left(\frac{O_0}{O}\right)t_1$ to reduce O. Hence, the new profit per unit time is

$$Z = \frac{1}{t_1}\begin{bmatrix} sQ - O - \dfrac{\nu}{\mu}\log\left(\dfrac{O_0}{O}\right)t_1 - h_c S_h - p_c Q - (s + d_c)Q_d - \dfrac{(q+1)(\kappa l R p_c Q)}{2q} - \varphi_t e Q \\ -\dfrac{\tau}{\zeta t_1}\log\left[\dfrac{\varphi_t^0}{\varphi_t}\right] t_1 + \varphi_t X t_1 - (1-\alpha)D_{cycle}\left[c_b\beta + c_l(1-\beta)\right] \end{bmatrix} \quad (2)$$

The total profit per unit time taking shortages into account and excluding any investment is given by

$$Z = \frac{1}{t_1}\begin{bmatrix} \left[s - p_c - \dfrac{(q+1)(\kappa l R p_c)}{2q} - \varphi_t e\right]\left[d(s)(1-\lambda)\right]^{\frac{1}{1-\lambda}} t_1^{\frac{1}{1-\lambda}} - \dfrac{\nu}{\mu}\log\left(\dfrac{O_0}{O}\right)t_1 - O - \dfrac{\tau}{\zeta}\log\left[\dfrac{\varphi_t^0}{\varphi_t}\right]t_1 \\ +\varphi_t X t_1 - \dfrac{h_c\left[d(p)(1-\lambda)\right]^{\frac{\sigma+1-\lambda}{1-\lambda}}}{d(p)(\sigma+1-\lambda)} t_1^{\frac{\sigma+1-\lambda}{1-\lambda}} - (1-\alpha)D_{cycle}\left[c_b\beta + c_l(1-\beta)\right] \end{bmatrix} \quad (3)$$

Solution procedure for a no-deterioration case considering shortages without investments when $t_1 < \gamma$

The following theorems are proved for unique optimum solutions.

Theorem 1: For any discrete value of t_1, s and O is fixed and the profit Z is concave in φ_t.

The optimum solution of φ_t is found from $\dfrac{\partial Z}{\partial \varphi_t} = 0$.

$$\frac{-e\alpha\left[d(s)(1-\lambda)\right]^{\frac{1}{1-\lambda}} t_1^{\frac{1}{1-\lambda}} + \dfrac{\tau t_1}{\zeta \varphi_t}}{t_1} + X = 0 \quad (4)$$

Theorem 2: For any discrete value of t_1, s and φ_t is fixed and the profit Z is concave in O.

The solution for O is $\dfrac{\partial Z}{\partial O} = 0 \Rightarrow -1 + \dfrac{\nu}{\mu O} = 0$ (5)

Theorem 3: The greenhouse retailer's profit function is concave with respect to both φ_t and O for any given discrete value of t_1 and s.

Algorithm 1: This algorithm is developed based on the previously discussed theorems to obtain the global optimal solution.

Step 1. Let

$a = 2000, b = 4, \lambda = 0.06, \gamma = 0.4, \tau = 0.8, \zeta = 0.001, e = 2, \nu = 0.7,$
$\mu = 4, p_c = 2, \kappa = 0.5, l = 0.4, R = 0.4$
$\sigma = 1.2, q = 8, h_c = 0.2, X = 4, \varphi_t^0 = 4, O_0 = 4, m = 0.7,$
$\varepsilon = 0.3, \alpha = 0.7, \beta = 0.85, c_b = 4, c_l = 8$

Step 2. Set $t_1 = 13$ and $s = 13$.

Step 3. Calculate φ_t and O from equation (4) and (5), respectively. Then, determine the optimal $Q = \alpha\left[d(s)(1-\lambda)\right]^{\frac{1}{1-\lambda}} t_1^{\frac{1}{1-\lambda}}$ and Z from equation(3).

Step 4. Increase $t_1 = t_1 + 1$ at $s = 240$ and repeat Step 3 until to the maximum value of Z is achieved.

Step 5. Record the updated values of t_1^*, φ_t, O, Q and Z when $s = 240$ from Step 4 and proceed to Step 6.

Step 6. Increase $s = s + 1$ and taking the new values of t_1^* from Step 5, record φ_t, O, Q and Z again. Repeat Step 6 until the optimum value of Z is attained.

Step 7. Find optimum values of $t_1^*, s^*, \varphi_t^*, O^*, Q^*$ and Z.

Step 8. Stop.

System that incorporates shortages alongside ERP investment:

Hence the optimization problem for shortages with the integration of ERP investment is given by,

Maximum Z subject to constraints

$$Z=\frac{1}{t_1}\left[\begin{array}{l} sQ-O\left(1-\varepsilon\left(1-e^{-mI_E}\right)\right)-h_cS_h-p_cQ-\left(s+d_c\right)Q_d-\frac{(q+1)(\kappa lRp_cQ)}{2q}-\varphi_t eQ \\ -\frac{\tau}{\zeta t_1}\log\left[\frac{\varphi_t^0}{\varphi_t}\right]t_1+\varphi_t Xt_1-\left(1-\alpha\right)D_{cycle}\left[c_b\beta+c_l\left(1-\beta\right)\right]\left(1-\varepsilon\left(1-e^{-mI_E}\right)\right)-I_Et_1 \end{array}\right] \tag{6}$$

The objective is to maximize the new profit per unit time by adding the capital investment cost $\frac{\nu}{\mu}\log\left(\frac{O_0}{O}\right)t_1$ to reduce O. Hence, the new profit per unit time is

$$Z=\frac{1}{t_1}\left[\begin{array}{l} sQ-O\left(1-\varepsilon\left(1-e^{-mI_E}\right)\right)-\frac{\nu}{\mu}\log\left(\frac{O_0}{O}\right)t_1-h_cS_h-p_cQ-\left(s+d_c\right)Q_d-\frac{(q+1)(\kappa lRp_cQ)}{2q}-\varphi_t eQ \\ -\frac{\tau}{\zeta t_1}\log\left[\frac{\varphi_t^0}{\varphi_t}\right]t_1+\varphi_t Xt_1-\left(1-\alpha\right)D_{cycle}\left[c_b\beta+c_l\left(1-\beta\right)\right]\left(1-\varepsilon\left(1-e^{-mI_E}\right)\right)-I_Et_1 \end{array}\right] \tag{7}$$

The total profit per unit time accounting for shortages and incorporating the ERP system is expressed as

$$Z=\frac{1}{t_1}\left[\begin{array}{l} \left[s-p_c-\frac{(q+1)(\kappa lRp_c)}{2q}-\varphi_t e\right]\left[d(s)(1-\lambda)\right]^{\frac{1}{1-\lambda}}t_1^{\frac{1}{1-\lambda}}-\frac{\nu}{\mu}\log\left(\frac{O_0}{O}\right)t_1-O\left(1-\varepsilon\left(1-e^{-mI_E}\right)\right)-\frac{\tau}{\zeta}\log\left[\frac{\varphi_t^0}{\varphi_t}\right]t_1 \\ +\varphi_t Xt_1-\frac{h_c\left[d(p)(1-\lambda)\right]^{\frac{\sigma+1-\lambda}{1-\lambda}}}{d(p)(\sigma+1-\lambda)}t_1^{\frac{\sigma+1-\lambda}{1-\lambda}}-(1-\alpha)D_{cycle}\left[c_b\beta+c_l(1-\beta)\right]\left(1-\varepsilon\left(1-e^{-mI_E}\right)\right)-I_Et_1 \end{array}\right] \tag{8}$$

Solution Procedure for a No-Deterioration Case Considering Shortages with ERP Integration when $t_1<\gamma$

The optimum solution of φ_t and O are given by equations (4) and (5) respectively and the following theorem is proved for unique optimum solution of I_E.

Theorem 4: For any positive value of I_E, the profit function Z is concave.

The optimum solution of I_E is found from $\frac{\partial Z}{\partial I_E}=0$. The solution for I_E is

$$\frac{1}{t_1}\left[O\varepsilon me^{-mI_E}+\left[(1-\alpha)\left[d(s)(1-\lambda)\right]^{\frac{1}{1-\lambda}}t_1^{\frac{1}{1-\lambda}}(c_b\beta+c_l(1-\beta))\right]\varepsilon me^{-mI_E}-t_1\right]=0 \tag{9}$$

Algorithm 2: This algorithm aims to derive the global optimal solution, developed from the preceding theorems.

Step 1. Let

$a=2000, b=4, \lambda=0.06, \gamma=0.4, \tau=0.8, \zeta=0.001, e=2, \nu=0.7,$
$\mu=4, p_c=2, \kappa=0.5, l=0.4, R=0.4$
$\sigma=1.2, q=8, h_c=0.2, X=4, \varphi_t^0=4, O_0=4, m=0.7,$
$\varepsilon=0.3, \alpha=0.7, \beta=0.85, c_b=4, c_l=8$

Step 2. Set $t_1=13$ and $s=13$.

Step 3. Calculate φ_t, O and I_E from equation (4), (5) and (9) respectively. Then, determine the optimal $Q=\alpha\left[d(s)(1-\lambda)\right]^{\frac{1}{1-\lambda}}t_1^{\frac{1}{1-\lambda}}$ and Z from equation(3).

Step 4. Increase $t_1=t_1+1$ at $s=240$ and repeat Step 3 until to the maximum value of Z is achieved.

Step 5. Record the updated values of $t_1^*, \varphi_t, O, I_E, Q$ and Z when $s=240$ from Step 4 and proceed to Step 6.

Step 6. Increase $s=s+1$ and taking the new values of t_1^* from Step 5, record φ_t, O, I_E, Q and Z again. Repeat Step 6 until the optimum value of Z is attained.

Step 7. Find optimum values of $t_1^*, s^*, \varphi_t^*, O^*, I_E^*, Q^*$ and Z.

Step 8. Stop.

Result

A numerical analysis was conducted using Algorithms 1 and 2, along with the parameter values obtained from

Table 1: Optimal solutions derived for the system without considering investment:

System that considers for shortages without any investment					
t_1	s	φ_t	O	Q	Z
13	240	0.3202806	0.175	16261.761	286354.634
14	240	0.3187305	0.175	17595.702	287047.481
15	240	0.3173639	0.175	18935.744	287635.634
16	240	0.3160571	0.175	20281.505	288131.283
17	240	0.3148345	0.175	21632.648	288544.265
18	240	0.3136862	0.175	22988.877	288882.981
18	241	0.3149768	0.175	22894.826	288976.367
18	242	0.3162778	0.175	22800.799	289059.564
18	243	0.3175892	0.175	22706.794	289132.572
18	244	0.3189113	0.175	22612.813	289195.394
18	245	0.3202441	0.175	22518.855	289248.033
18	246	0.3215876	0.175	22424.921	289290.501
18	247	0.3229422	0.175	22331.011	289322.798
18	248	0.3243079	0.175	22237.124	289344.927
18	249	0.3256849	0.175	22143.261	289356.898
18	250	0.3270732	0.175	22049.421	289358.716

Table 2: Optimal solutions derived for the system with ERP investment

System that incorporates shortages alongside ERP investment						
t_1	s	φ_t	O	I_E	Q	Z
13	240	0.3202806	0.175	8.9281978	16261.761	287084.102
14	240	0.3187305	0.175	8.9349548	17595.702	287780.449
15	240	0.3173639	0.175	8.9412455	18935.744	288371.877
16	240	0.3160571	0.175	8.9471304	20281.505	288870.596
17	240	0.3148345	0.175	8.9526577	21632.648	289286.485
18	240	0.3136862	0.175	8.9578694	22988.877	289627.945
18	241	0.3149768	0.175	8.9520129	22894.826	289718.248
18	242	0.3162778	0.175	8.9461338	22800.799	289798.361
18	243	0.3175892	0.175	8.9402318	22706.794	289868.286
18	244	0.3189113	0.175	8.9343069	22612.813	289928.022
18	245	0.3202441	0.175	8.9283587	22518.855	289977.584
18	246	0.3215876	0.175	8.9223872	22424.921	290016.971
18	247	0.3229422	0.175	8.9163921	22331.011	290046.188
18	248	0.3243079	0.175	8.9103733	22237.124	290065.239
18	249	0.3256849	0.175	8.9043305	22143.261	290074.133
18	250	0.3270732	0.175	8.8982637	22049.421	290072.873

Umakanta Mishra et al. (2020), to examine the efficiency of ERP-integrated inventory management under shortage scenarios, both with and without ERP implementation. The system aims to maximize total profit by decreasing shortage and ordering costs, while accounting for the improvements in effectiveness enabled by ERP.

Optimal solution and comparative study:

Table 1 and Table 2 shows the efficiency of the suggested paradigm.

By adopting the suggested ERP-enabled inventory system with a shortage management allows businesses to connect their operational tactics with real-time responsiveness, improve decision-making efficacy, and boost their competitive position in a technology-driven and demand-sensitive business environment.

Discussion

There is lack of studies examined on maximizing overall profit by combining Enterprise Resource Planning (ERP) systems with shortage management tactics in inventory scenarios that assume no deterioration. Most existing studies typically regard ERP as an isolated technology framework or limit their analysis to traditional inventory systems free of shortages (Rubel, 2021). Moreover, systems that account for shortages frequently neglect the influence of ERP on enhancing decision-making, forecasting, and resource allocation (Umakanta Mishra et al., 2020). This establishes a significant research gap, as the synergistic effects of technological integration and shortage allowance on operational and economic performance are inadequately investigated. This paper formulates a comprehensive inventory system that integrates ERP investment in a shortage-allowed context, based on the realistic premise of no deterioration. The system seeks to provide useful insights into how ERP adoption enhances inventory control, lowers shortage-related expenses, and increases overall profitability.

Conclusion

This study formulates an integrated inventory system by incorporating Enterprise Resource Planning (ERP) technology and examines the impact of shortages under the assumption of no product deterioration. By integrating ERP into the inventory framework, the system improves cooperation, streamlines purchasing processes and allows for more informed decision-making. Unlike traditional systems, which frequently disregard real-time information flow and operational disturbances, this approach connects inventory control with practical issues such as shortage management and minimal financial changes such as prepayments. A numerical example is presented to show the efficiency of the systems under shortages and the results shows that the total profit with and without the integration of Enterprise Resource Planning is $290072.873 and $289358.716 respectively. The results show that combining ERP with shortage considerations considerably enhances total profit and operational response. The inclusion of shortage scenarios allows the system to represent true supply-demand imbalances, which improves its practical usefulness in volatile markets. While the system assumes deterministic demand and ignores product degradation, these simplifications provide areas for future investigation. Future research can expand on this structure by incorporating deterioration effects, increasing the system's applicability to sectors dealing with perishable goods, time-sensitive products, or items with a short shelf life, resulting in more realistic and comprehensive inventory strategies. The novelty of this work lies in its combined approach that merges ERP-driven decision assistance with real-world inventory constraints such as shortages. It provides a solid foundation for businesses looking to increase profitability while retaining operational flexibility and technology alignment in a competitive market.

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References

Balic, A., Turulja, L., Kuloglija, E., & Pejic-Bach, M. (2022). ERP quality and the organizational performance: technical characteristics vs. information and service. *Information*, *13*(10), 474. https://doi.org/10.3390/info13100474

Huang, S. Y., Chiu, A. A., Chao, P. C., & Arniati, A. (2019). Critical success factors in implementing enterprise resource planning systems for sustainable corporations. *Sustainability*, *11*(23), 6785. https://doi.org/10.3390/su11236785

Katuu, S. (2020). Enterprise resource planning: past, present, and future. *New Review of Information Networking*, *25*(1), 37-46. https://doi.org/10.1080/13614576.2020.1742770

Mishra, R. K., & Mishra, V. K. (2022). An optimum sustainable inventory model for non-instantaneous deterioration and quality assessment under carbon emissions and complete backordering shortage. *Arabian Journal for Science and Engineering*, *47*(3), 3929-3944. https://doi.org/10.1007/s13369-021-06402-z

Mishra, U., Wu, J. Z., Tsao, Y. C., & Tseng, M. L. (2020). Sustainable inventory system with controllable non-instantaneous deterioration and environmental emission rates. *Journal of Cleaner Production*, *244*, 118807. https://doi.org/10.1016/j.jclepro.2019.118807

Rubel, K. (2021). Increasing the efficiency and effectiveness of inventory management by optimizing supply chain through enterprise resource planning technology. *EFFLATOUNIA-Multidisciplinary Journal*, *5*(2), 1739-1756. https://www.researchgate.net/profile/Rubel-Amin/publication/364344395_Increasing_the_Efficiency_and_Effectiveness_of_Inventory_Management_by_Optimizing_Supply_Chain_through_Enterprise_Resource_Planning_Technology/links/65097ba982f01628f031727b/Increasing-the-Efficiency-and-Effectiveness-of-Inventory-Management-by-Optimizing-Supply-Chain-through-Enterprise-Resource-Planning-Technology.pdf

Sadeghi, H., Golpîra, H., & Khan, S. A. R. (2021). Optimal integrated production-inventory system considering shortages and discrete delivery orders. *Computers & Industrial Engineering*, *156*, 107233. https://doi.org/10.1016/j.cie.2021.107233

San-Jose, L. A., Sicilia, J., González-De-la-Rosa, M., & Febles-Acosta, J. (2019). Analysis of an inventory system with discrete scheduling period, time-dependent demand and backlogged shortages. *Computers & Operations Research*, *109*, 200-208. https://doi.org/10.1016/j.cor.2019.05.003

San-José, L. A., Sicilia, J., González-de-la-Rosa, M., & Febles-Acosta, J. (2022). Profit maximization in an inventory system with time-varying demand, partial backordering and discrete inventory cycle. *Annals of Operations Research*, *316*(2), 763-783. https://doi.org/10.1007/s10479-021-04161-6

Selmi, M. H., Jemai, Z., Grégoire, L., & Dallery, Y. (2019). Literature Review on Shortage Cost Modeling in Inventory Management. *ICORES*, 322-329. https://doi.org/10.5220/0007370203220329