DOI https://doi.org/10.5281/zenodo.10049652#170

TWIST, 2024, Vol. 19, Issue 2, pp. 375-382

TWIST

Journal homepage: www.twistjournal.net

Investigation of Perishable Stochastic Inventory System in an Infinite Pool System:
An Effective Cost Optimization Model

Sunjida Haque*
Department of Mathematics, Jagannath University, Dhaka, Bangladesh
[**Corresponding author*]

Mohammad Ekramol Islam
Department of Mechanical Engineering, Sonargaon University, Bangladesh

Md. Rezaul Karim
Department of Mathematics, Jagannath University, Dhaka, Bangladesh

Mehedi Hasan
Department of Physics and Astronomy, The University of Georgia, USA

Abstract
An (s, S) inventory system with service facilities has been examined in this study. Demands arrive as a Poisson process with parameter λ (>0) to an infinite capacity pool at any given time t. When the Inventory is greater than the buffer size a customer will transfer to the buffer with a rate ϕ. The service time is considered to be exponentially distributed with parameter μ. The inventory level is likewise presumed to be S at first. When the inventory level reaches s as a result of service, or due to perishability of the inventory, a replenishment order is taken place. With the parameter β, the lead time is exponentially distributed. In this final model, a stability condition based on that same system performance measure has been investigated. Some numerical illustrations are provided and sensitivity analyses are made concerning different parameters involved in the present system.

Keywords
Stochastic Inventory System, Finite Buffer, Infinite Pool, Inventory Model

INTRODUCTION

The indefinite lifetime of products while in storage is one of the fundamental presumptions implicit in the majority of inventory systems [1-2]. Perishability's impact on many inventory systems, yet, cannot be disregarded. Foods, film for cameras, and electronics are common examples of products with a finite lifespan. In each of these cases, leaving perishability out of the model results in an erroneous performance evaluation of the inventory system [3-5].

In the last few years, experts have paid a lot of attention to the analysis of perishable inventory systems. Most models established an instantaneous supply of order in the case of continuous review perishable inventory models with random life periods for the goods [6-7].

Manuel et al. [8-9], Padmavathi et al. [10], Radhamani et al. [11], and Yadavalli et al. [12] analyzed customers who were unable to meet their demands either the things they needed were unavailable or all the servers were occupied. These consumers join an infinitely large orbit and receive their services at random intervals. The service duration is exponential, and the positive and negative requests follow Markovian Arrival Process (MAP).

A perishable inventory system with a service facility and a finite supply is analyzed by Lawrence et al. [13]. They assumed that the lead time and service time follow a phase-type distribution and those demands are produced by a finite homogenous population.

On the other hand, this study has looked at a (s, S) inventory system that includes service facilities. An infinity pool capacity was considered. We derived and obtained a stability condition based on that same system performance measure. Some numerical illustrations are provided and sensitivity analyses are made concerning different parameters involved in the present system. The model has been illustrated in Fig. 1.

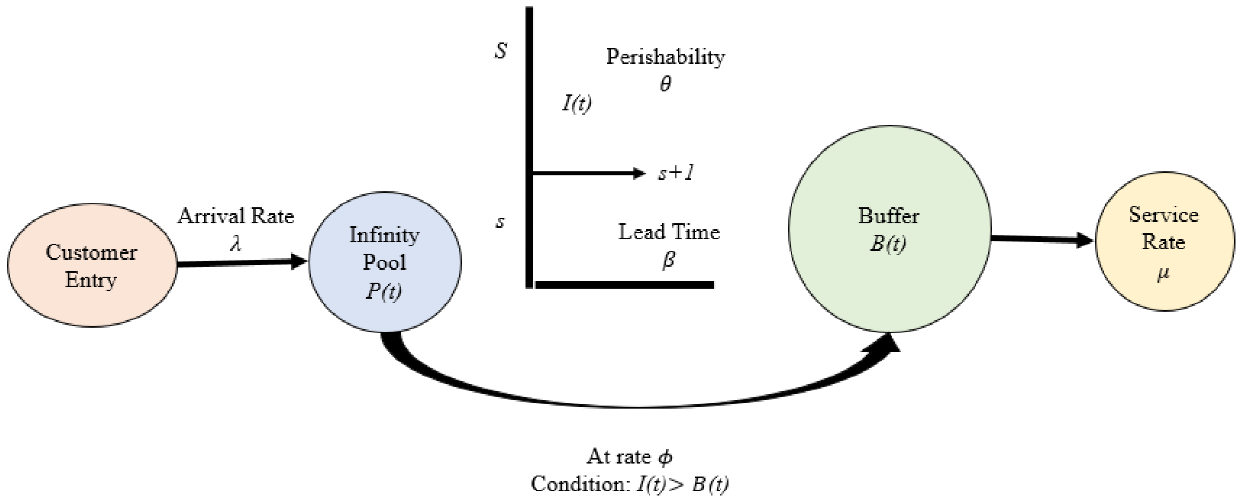

Fig. 1 The proposed perishable stochastic inventory system without reneging

NOTATIONS AND ASSUMPTIONS OF THE INVENTORY SYSTEM

The notation for the formulation of the inventory model is the following:

- i) $P(t)$ = Number of customers in the pool at time t
- ii) $B(t)$ = Number of customers in the buffer at time t
- iii) $I(t)$ = Inventory level at time t
- iv) λ = Arrival of demands follows the Poisson process
- v) μ = Service time follows an exponential distribution
- vi) β = Lead time is exponentially distributed
- vii) Initially, the system is in order level S
- viii) Replenishment takes place when the inventory level is depleted to re-order level s

It is assumed that, if $I(t) > B(t)$, the primary arrival is directed to the buffer from the pool with a rate ϕ.

- ix) θ = Perishable rate
- x) e is a unit column vector.

MODEL AND ANALYSIS

An (s, S) inventory system with service facilities has been examined in this study. Demands arrive as a Poisson process with parameter λ (>0) to an infinite capacity pool at any given time t. Pooled customers are transferred to the buffer taken for service with a rate ϕ. With parameter μ, the service time is considered to be exponentially distributed. The inventory level is likewise presumed to be S at first. When the inventory level reaches s as a result of service, a replenishment order is placed. With the parameter β, the lead time is exponentially distributed. With parameter θ, an item from inventory may expire. The whole process can be expressed in the flowchart given in Fig. 2.

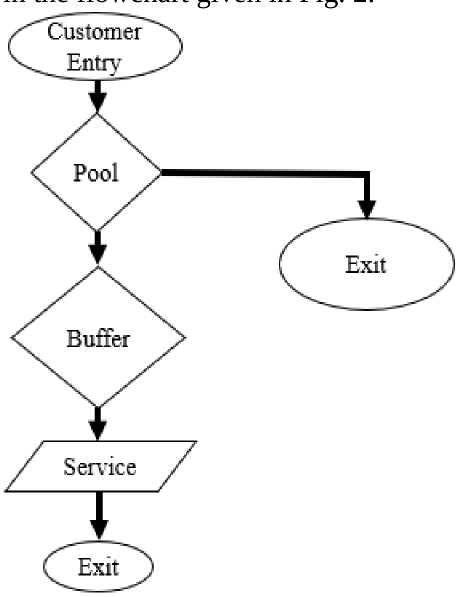

Fig. 2 Flowchart of the perishable stochastic inventory system without reneging

MATHEMATICAL TERMINOLOGY

Here $\{P(t), I(t), B(t) = (i, j, k) | 0 \leq i \leq \infty; 0 \leq j \leq S;\ 0 \leq k \leq S\}$ formed a three-dimensional Markov process with state space-

$$E = E_1 \times E_2 \times E_3$$

with $E_1 = \{0,1, \ldots . \infty\}; E_2 = \{0,1, \ldots . S\}; E_3 = \{0,1, \ldots . S\}$

THE INFINITESIMAL GENERATOR OF THE PROCESS

$\widetilde{A} = (a(i, j, k{:}\, l, m, n); (i, j, k), (l, m, n) \in E)$ can be obtained using the following arguments-

1. The arrival of the demand makes a transition from-

$$(i, j, k) \rightarrow (l = i + 1, m = j; n = k) \text{ if } 0 \leq i \leq \infty; 0 \leq j \leq S; 0 \leq k \leq S$$

2. The pool customer makes a transition to buffer leaving the pool size less by one as a first come first serve basis.

$$(i, j, k) \rightarrow (l = i - 1, m = j; n = k + 1) \text{ if } 1 \leq i \leq \infty;\ 1 \leq j \leq S; 0 \leq k \leq S - 1$$

3. When $B(t) \leq I(t)$, perishability of inventory is a transition reducing the size of the inventory by one unit.

$$(i, j, k) \rightarrow (l = i, m = j - 1; n = k) \text{ if } 0 \leq i \leq \infty; 1 \leq j \leq S;\ 0 \leq k \leq S - 1$$

4. If the inventory and buffer are the same size and greater or equal to one then service occurred.

$$(i, j, k) \rightarrow (l = i, m = j - 1; n = k - 1) \text{ if } 0 \leq i \leq \infty;\ 1 \leq j \leq S;\ 1 \leq k \leq S$$

5. Replenishment takes place only when inventory is less or equal to the re-order level s

$$(i, j, k) \rightarrow (l = i, m = j + \beta; n = k) \text{ if } 0 \leq i \leq \infty;\ 0 \leq j \leq s;\ 0 \leq k \leq S - 2$$

Now, the infinitesimal generator $\tilde{A}$ can be conveniently expressed as a partition matrix-

$$\widetilde{A} = A_{i,j}$$

$$\widetilde{A} = \begin{cases}
\lambda : & \begin{array}{l} l = i + 1; i = 0, \ldots, \infty \\ m = j;\ j = 0, \ldots, S \\ n = k; k = 0, \ldots, S \end{array} \\
\beta : & \begin{array}{l} l = i; i = 0, \ldots, \infty \\ m = j + \beta; j = 0, \ldots, s \\ n = k; k = 0, \ldots \infty \end{array} \\
\mu : & \begin{array}{l} l = i; i = 0, \ldots, \infty \\ m = j - 1; j = s = 1, \ldots, S \\ n = k;\ k = 1, \ldots, S - 1 \end{array} \\
\theta : & \begin{array}{l} l = i; i = 0, \ldots, \infty \\ m = j - 1\ ;\ j = 0, \ldots, S \\ n = k - 1; k = 0, \ldots \infty \end{array} \\
\Phi : & \begin{array}{l} l = i - 1; i = 0, \ldots, \infty \\ m = j;\ j = 0, \ldots, S \\ n = k + 1\ ; k = 0, \ldots, S - 1 \end{array} \\
\theta + \mu : & \begin{array}{l} l = i; i = 0, \ldots, \infty \\ m = j - 1\ ;\ j = 0, \ldots, S \\ n = k - 1; k = 0, \ldots, S \end{array} \\
-(\lambda + \beta): & \begin{array}{l} l = i; i = 0, \ldots, \infty \\ m = j;\ j = 0, \ldots, s \\ n = k; k = 0 \end{array} \\
-(\lambda + \theta + \beta): & \begin{array}{l} l = i; i = 0 \\ m = j;\ j = s \\ n = k; k = 0 \end{array} \\
-(\lambda + \theta + \mu + \beta): & \begin{array}{l} l = i\ ; i = 0, \ldots, \infty \\ m = j;\ j = s \\ n = k; k = 1 \end{array} \\
-(\lambda + \theta + \mu): & \begin{array}{l} l = i\ ; i = 0, \ldots, \infty \\ m = j;\ j = s + 1, \ldots, S \\ n = k; k = 1, \ldots, S \end{array} \\
-(\lambda + \theta): & \begin{array}{l} l = i\ ; i = 0 \\ m = j;\ j = s + 1, \ldots, S \\ n = k; k = 0 \end{array} \\
-(\lambda + \theta + \beta + \Phi): & \begin{array}{l} l = i\ ; i = 0, \ldots, \infty \\ m = j;\ j = s \\ n = k; k = 0 \end{array} \\
-(\lambda + \theta + \Phi): & \begin{array}{l} l = i\ ; i = 0, \ldots, \infty \\ m = j;\ j = s + 1, \ldots, S \\ n = k; k = 0 \end{array} \\
-(\lambda + \theta + \mu + \Phi): & \begin{array}{l} l = i\ ; i = 0, \ldots, \infty \\ m = j;\ j = s + 1, \ldots, S \\ n = k; k = 1, \ldots, S - 1 \end{array}
\end{cases}$$

The infinitesimal generator matrix $\widetilde{A}$ of this process has the following block tridiagonal matrix structure-

$$\tilde{A}=\begin{bmatrix} B_0 & A_0 & 0 & 0 & 0 & 0 & \cdots & \cdots \\ A_2 & A_1 & A_0 & 0 & 0 & 0 & \cdots & \cdots \\ 0 & A_2 & A_1 & A_0 & 0 & 0 & \cdots & \cdots \\ 0 & 0 & A_2 & A_1 & A_0 & 0 & \cdots & \cdots \\ 0 & 0 & 0 & A_2 & A_1 & A_0 & \cdots & \cdots \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \cdots & \cdots \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \cdots & \cdots \end{bmatrix}$$

where $A_{j,m}$ is a sub-matrix, which is given by-

$$A_{j,m}=\begin{pmatrix} B_0 & if\ m=j;j=0 \\ A_0 & if\ m=j+1\,;j\geq 0 \\ A_2 & if\ m=j-1;j\geq 0 \\ A_1 & if\ m=j;\ j\geq 1,\dots,S-1 \end{pmatrix}$$

$$B_0=\begin{pmatrix} (g,h)\to(g,h):-(\lambda+\beta) & if\ g=0;\ h=0 \\ (g,h)\to(g,h):-\ (\lambda+\theta+\beta) & if\ g=s;h=0 \\ (g,h)\to(g,h):-\ (\lambda+\theta+\beta+\mu) & if\ g=s;h=1 \\ (g,h)\to(g,h):-\ (\lambda+\theta) & if\ g=s+1,\dots,S;h=0 \\ (g,h)\to(g,h):-\ (\lambda+\theta+\mu) & if\ g=s+1,\dots,S;h=1,\dots,S \\ (g-1,h)\to(g,h):\ \theta & if\ \ g=s\dots S;h=0,\dots,S-1 \\ (g,h)\to(g+\beta,h):\beta & if\ \ g=0,\dots,s;h=0{,}1 \\ (g,h)\to(g-1,h-1):\mu & if\ g=s+1,\dots,S,h=1,\dots,S-1 \\ (g,h)\to(g-1,h-1):\mu+\theta & if\ \ g=s,\dots,S;h=1,\dots,S \\ All\ other\ elements\ are:0 & elsewhere \end{pmatrix}$$

$$A_0=diag(\lambda,\lambda,\dots\dots,\lambda)$$

$$A_1=\begin{pmatrix} (g,h)\to(g,h):-(\lambda+\beta) & if\ h=0 \\ (g,h)\to(g,h):-\ (\lambda+\theta+\beta+\Phi) & if\ g=s;h=0 \\ (g,h)\to(g,h):-\ (\lambda+\theta+\beta+\mu) & if\ g=s;h=1 \\ (g,h)\to(g,h):-\ (\lambda+\theta+\Phi)\ if\ \ g=s & if\ g=s+1,\dots,S;h=0 \\ (g,h)\to(g,h):-\ (\lambda+\theta+\mu+\Phi) & if\ g=s+1,\dots,S;h=1,\dots,S-1 \\ (g,h)\to(g,h):-\ (\lambda+\theta+\mu) & if\ g=s+1,\dots,S,h=2,\dots,S \\ (g-1,h)\to(g,h):-\theta & if\ \ g=s\dots S;h=0,\dots,S-1 \\ (g,h)\to(g+\beta,h):\beta & if\ \ g=0,\dots,s;h=0{,}1 \\ (g,h)\to(g-1,h-1):\mu & if\ g=s+1,\dots,S,h=1,\dots,S-1 \\ (g,h)\to(g-1,h-1):\mu+\theta & if\ \ g=1\dots S;h=1,\dots,S \\ All\ other\ elements\ are:0 & elsewhere \end{pmatrix}$$

$$A_2=(g,h)\to(g,h+1:\Phi)\qquad if g=1,\dots,S;h=0,\dots,S-1$$

Therefore, the partitioned matrix can be defined as-

$$\tilde{A}=\begin{pmatrix} g\to g\,;\ \ is\ \ B_0 & if\ g=0 \\ g\to g+1;\ \ is\ \ A_0 & if g\geq 0 \\ g\to g-1;\ \ is\ \ A_2 & if\ g\geq 1 \\ g\to g;\ \ is\ \ A_1 & if\ g\geq 1,\dots,S \end{pmatrix}$$

STABILITY CONDITION

Let $A=A_0+A_1+A_2$ be the generator matrix of steady-state probability vector χ. That is, χ fulfills the conditions $\chi A=0\ and\ \ \chi e=1$, where e is a column vector of 1's in the proper order. The queuing system is stable if and only if

$$\chi A_0 e<\chi A_2 e$$

According to the structure of the model, the stability condition of the queuing system under consideration may be determined as

$$\lambda\sum_{i=0}^{\infty}\sum_{j=0}^{S}\sum_{k=0}^{S}\chi(\mathrm{i,j,k})<\ \phi\sum_{i=0}^{\infty}\sum_{j=s}^{S}\sum_{k=0}^{S}\chi(\mathrm{i,j,k})+\ \ \phi\sum_{i=0}^{\infty}\sum_{j=s+1}^{S}\sum_{k=0}^{S}\chi(\mathrm{i,j,k})+\ \phi\sum_{i=0}^{\infty}\sum_{j=s+1}^{S}\sum_{k=s}^{S}\chi(\mathrm{i,j,k})$$
$$+\sum_{i=0}^{\infty}\sum_{j=s+2}^{S}\sum_{k=0}^{S}\chi(\mathrm{i,j,k})+\ \phi\sum_{i=0}^{\infty}\sum_{j=s+1}^{S}\sum_{k=s}^{S}\chi(\mathrm{i,j,k})+\ \phi\sum_{i=0}^{\infty}\sum_{j=s+2}^{S}\sum_{k=0}^{S}\chi(\mathrm{i,j,k})$$

THE STEADY-STATE ANALYSIS OF THE MODEL

The steady-state probability vector of $\tilde{A}$ under the stability criterion is determined in this section. The structure of the rate matrix $\tilde{A}$ shows that $\{(P(t), I(t), B(t), t \geq 0\}$ is a continuous time Markov chain with state space given by

$$E = E_1 \times E_2 \times E_3$$

The steady-state probability vector-

$$\chi = (\chi(0), \chi(1), \chi(2), \chi(3), \dots \dots \dots, \chi(9))$$

That is, χ satisfies the conditions-

$$\chi\tilde{A} = 0 \text{ and } [\sum_{i=0}^{\infty}\sum_{j=1}^{S}\sum_{k=1}^{S}\chi(i,j,k)]\, e = 1$$

And the vector can be partitioned as-

$$\chi(i) = (\chi(i,j,k); i \geq 0; 0 \leq j \leq S, 0 \leq k \leq j)$$

And the components are given by-

$$\chi(\mathrm{i}) = \chi(0)\,\mathrm{R}^{i},\ \mathrm{i} \geq 0$$

where R is the minimal nonnegative solution of the matrix quadratic equation-

$$A_2 + \mathrm{R}A_1 + A_0 = 0$$

The vector $\chi(0)$ can be calculated using the equation $\chi(0)[\,B_0 + \mathrm{R}A_2]$ together with the normalizing condition-

$$\chi(0)\,(I - R)^{-1} = 1.$$

The properties of the aforementioned terms and their applications to the theory of queues are deduced and demonstrated by Neuts [14] in depth. To determine the rate R, one can compute it using an exponential reduction method.

SYSTEM PERFORMANCE MEASURES

Some system performance measures are given below-

i) The probability mass function of the number of customers in the pool: The probability that there are i, customers, in the pool is given by

$$\chi(i)e = \chi(0)R^{i}e; i \geq 0$$

ii) Expected number of customers in the pool is-

$$\mathrm{P}_1 = \sum_{i=0}^{\infty} i\,\chi(i)e = \chi(0)R(I - R)^{-2}e$$

iii) Expected Inventory level in the system is-

$$\mathrm{P}_2 = \sum_{i=0}^{\infty}\left[\sum_{j=1}^{S} j \sum_{k=1}^{j}\chi(i,j,k)\right] e$$

iv) Expected customer Arrival rate to the pool is-

$$\mathrm{P}_3 = \lambda\sum_{i=0}^{\infty}\left[\sum_{j=0}^{S}\sum_{k=0}^{S}\chi(i,j,k)\right] e$$

v) Expected number of customers in the buffer is-

$$\mathrm{P}_4 = \sum_{i=0}^{\infty}\left[\sum_{j=1}^{S} j \sum_{k=1}^{j} k\,.\chi(i,j,k)\right] e$$

vi) Expected number of customers served in the system-

$$\mathrm{P}_5 = \mu\sum_{i=0}^{\infty}\left[\sum_{j=1}^{S}\sum_{k=1}^{j}\chi(i,j,k)\right] e$$

vii) Average quantity perished to the system is-

$$\mathrm{P}_6 = \theta\sum_{i=0}^{\infty}\left[\sum_{j=1}^{S} j \sum_{k=1}^{j}\chi(i,j,k)\right] e$$

viii) Average rate of pooling customer transfer to the buffer: The Expected rate that a pool customer will enter the buffer is-

$$P_7 = \Phi \sum_{i=0}^{\infty} \left[\sum_{j=1}^{S} \sum_{k=1}^{j} \chi(i,j,k) \right] e$$

COST FUNCTION OF THE SYSTEM

The following formula has been used to analyze the total cost to various performance measures-

Total Cost, $TC = C_1 P_1 + C_2 P_2 + C_3 P_3 + C_4 P_4 + C_5 P_5 + C_6 P_6 + C_7 P_7$

Here

- C_1 = Cost of Pool customers in the system
- C_2 = Inventory holding cost of the system
- C_3 = Customer Arrival cost in the system
- C_4 = Buffer customer costs in the system
- C_5 = Service cost of the system
- C_6 = Perishability cost of the system
- C_7 = Cost of transferring a customer from poo to buffer in the system

NUMERICAL ILLUSTRATION

Several numerical results have been discussed in this part to conduct several related analyses-

$$S = 3, s = 1,$$
$$Q = 2, \lambda = 0.4, \beta = 0.6, \theta = 0.3, \mu = 0.8, \Phi = 0.7$$
$$c_1 = 1,\ c_2 = 2,\ c_3 = 3,\ c_4 = 1,\ c_5 = 2,\ c_6 = 3,\ c_7 = 1$$

Table 1 Arrival rate vs different performance measures

	$\boldsymbol{\lambda_1 = 0.1}$	$\boldsymbol{\lambda_2 = 0.2}$	$\boldsymbol{\lambda_3 = 0.3}$	$\boldsymbol{\lambda_4 = 0.4}$	$\boldsymbol{\lambda_5 = 0.5}$
P1	8.4615	8.4615	8.4615	8.4615	8.4615
P2	1.5216	1.5216	1.5216	1.5216	1.5216
P3	0.13659	0.18212	0.18212	0.27318	0.31871
P4	1.279	1.279	1.279	1.279	1.279
P5	0.3437	0.3437	0.3437	0.3437	0.3437
P6	0.4565	0.4565	0.4565	0.4565	0.4565
P7	0.3187	0.3187	0.3187	0.3187	0.3187

Table 2 Service rate vs different performance measures

	$\boldsymbol{\mu_1 = 0.2}$	$\boldsymbol{\mu_2 = 0.3}$	$\boldsymbol{\mu_3 = 0.4}$	$\boldsymbol{\mu_4 = 0.5}$	$\boldsymbol{\mu_5 = 0.6}$
P1	8.4615	8.4615	8.4615	8.4615	8.4615
P2	1.5216	1.5216	1.5216	1.5216	1.5216
P3	0.1821	0.1821	0.1821	0.1821	0.1821
P4	1.279	1.279	1.279	1.279	1.279
P5	0.21485	0.25782	0.30079	0.34376	0.38673
P6	0.4565	0.4565	0.4565	0.4565	0.4565
P7	0.3187	0.3187	0.3187	0.3187	0.3187

Table 3 Replenishment rate vs different performance measures

	$\boldsymbol{\theta_1 = 0.1}$	$\boldsymbol{\theta_2 = 0.2}$	$\boldsymbol{\theta_3 = 0.3}$	$\boldsymbol{\theta_4 = 0.4}$	$\boldsymbol{\theta_5 = 0.5}$
P1	8.4615	8.4615	8.4615	8.4615	8.4615
P2	1.5216	1.5216	1.5216	1.5216	1.5216
P3	0.1821	0.1821	0.1821	0.1821	0.1821
P4	1.279	1.279	1.279	1.279	1.279
P5	0.3437	0.3437	0.3437	0.3437	0.3437
P6	0.30426	0.45639	0.60852	0.76065	0.91278
P7	0.3187	0.3187	0.3187	0.3187	0.3187

Table 4 Reneging rate vs different performance measures

	$\boldsymbol{\Phi_1 = 0.1}$	$\boldsymbol{\Phi_2 = 0.2}$	$\boldsymbol{\Phi_3 = 0.3}$	$\boldsymbol{\Phi_4 = 0.4}$	$\boldsymbol{\Phi_5 = 0.5}$
P1	8.4615	8.4615	8.4615	8.4615	8.4615
P2	1.5216	1.5216	1.5216	1.5216	1.5216
P3	0.1821	0.1821	0.1821	0.1821	0.1821
P4	1.279	1.279	1.279	1.279	1.279
P5	0.3437	0.3437	0.3437	0.3437	0.3437
P6	0.4565	0.4565	0.4565	0.4565	0.4565
P7	0.18212	0.22765	0.27318	0.31871	0.36424

SENSITIVITY ANALYSIS

The sensitivity analysis of various performance measures vs total cost has been conducted in this part.

Table 5 Rate of different parameters vs total cost

Arrival Rate, λ	**Total Cost**	**Service Time, μ**	**Total Cost**	**Perishable Rate, θ**	**Total Cost**	**Customer transferring Rate from pool to buffer, Φ**	**Total Cost**
0.1	15.56907	0.5	15.4479	0.2	15.24888	0.4	15.56902
0.2	15.70566	0.6	15.53384	0.3	15.70527	0.5	15.61455
0.3	15.70566	0.7	15.61978	0.4	16.16166	0.6	15.66008
0.4	15.97884	0.8	15.70572	0.5	16.61805	0.7	15.70561
0.5	16.11543	0.9	15.79166	0.6	17.07444	0.8	15.75114

Mathematical expressions for the relationship between total cost with different parameters-

$$Total\ Cost_{\lambda} = 1.3659\lambda + 15.1539$$
$$Total\ Cost_{\mu} = 0.8594\mu + 15.0182$$
$$Total\ Cost_{\theta} = 4.5639\theta + 14.3361$$
$$Total\ Cost_{\Phi} = 0.4553\Phi + 15.3869$$

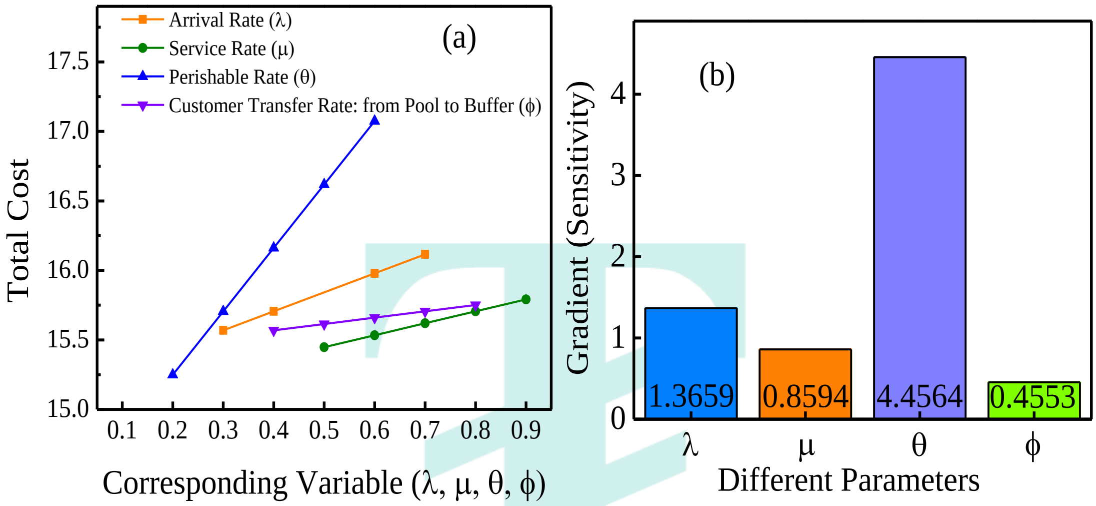

Fig. 3 (a) Graphical representation of different performance measures vs total cost and **(b)** The level of sensitivity for different parameters of this model

From Table 5, and Fig. 3, it is observed that the perishable rate has a vital impact on the system. The increase in arrival rate has an impact on higher reordering and lost sales. It also increases the cost of carrying pool and buffer customers. Due to the increase in service rate, the cost changes with the service time.

CONCLUSION

In this research work, a stochastic inventory system with perishable commodities in a service facility with a maximum capacity for inventory *S* units has been analyzed. In this model, the Poisson process is considered for the customer's arrival at the pool. The customer goes out from the buffer with any service, a transition is made by reducing the buffer size by one unit, and the inventory level is also reduced by one unit. When inventory levels exceed the number of customers in the buffer, a transition (perishability) occurs that reduces the inventory size by one unit. Considering this model, it is seen that- with the increase of arrival rate, service rate, perishability rate, and customer transfer rate from the pool to buffer the total cost increases. However, the perishability rate is found to be the most sensitive and has a high impact on the cost function. However, the customer transfer rate from pool to buffer has the least impact on the cost function.

REFERENCES

1. San-José, L.A., González-De-la-Rosa, M., Sicilia, J. et al., 'An inventory model for multiple items assuming time-varying demands and limited storage,' Optimization Letter, 16, 1935-1961, 2021.
2. Joaquín Sicilia, Luis A. San-José, David Alcaide-López-de-Pablo, Beatriz Abdul-Jalbar, "Optimal policy for multi-item systems with stochastic demands, backlogged shortages and limited storage capacity", Applied Mathematical Modelling, 108, 236-257, 2022.
3. R. Roy Chowdhury, S. K. Ghosh & K. S. Chaudhuri, "An Order-Level Inventory Model for a Deteriorating Item with Time-Quadratic Demand and Time-Dependent Partial Backlogging with Shortages in All Cycles," American Journal of Mathematical and Management Sciences, 33(2), 75-97, 2014.
4. Kenzhevayeva Z., Katayeva A., Kaikenova K., Sarsembayeva, A., Babai MZ., Tsakalerou M., Papadopoulos CT., "Inventory control models for spare parts in aviation logistics", Procedia Manufacturing, 55, 507-512, 2021.

5. Rahim FHA, Noor NM, Abdullah H, Annanurov B., “Cost Minimization of Aircraft Critical Components for Planning and Maintenance Requirements,” International Journal of Integrated Engineering, 12 (7), 40-53, 2020.
6. Seung Ho Yoo, Taesu Cheong, “Inventory model for sustainable operations of a closed-loop supply chain: Role of a third-party refurbisher,” Journal of Cleaner Production, 315, 127810, 2021.
7. Wu, L., Liu, L., Wang, Z. (2020). “Competitive remanufacturing and pricing strategy with contrast effect and assimilation effect,” Journal of Cleaner Production, 257, 120333, 2020.
8. Manuel, P., Shophia Lawrence, A., Arivarignan, G., “A stochastic perishable inventory system with random supply quantity,” International Journal of Information Management Science,” 18(4), 317–334, 2007.
9. Manuel, P., Sivakumar, B., Arivarignan, G., “A perishable inventory system with service facilities and retrial customers,” Computers and Industrial Engineering, 54(3), 484–501, 2008.
10. Padmavathi, I., Shophia Lawrence, A., Sivakumar, B., “A fnite-source inventory system with postponed demands and modifed m vacation policy,” Opsearch, 53(1), 41–62, 2016.
11. Radhamani, V., Sivakumar, B., Arivarignan, G.: An analysis of replenishment policies for perishable inventory system with postponeed demand and multiple vacations,” International Journal of Inventory Research, 3(3), 217–262, 2016.
12. Yadavalli, V.S.S., Sivakumar, B., Arivarignan, G., Olufeumi, A., “A multi server perishable inventory system with negative customers,” Computers and Industrial Engineering, 61, 254–27, 2011.
13. Shophia Lawrence, A., Sivakumar, B., Arivarignan, G., “A perishable inventory system with service facility and fnite source,” Applied Mathematical Modelling, 37(7), 4771–4786, 2013.
14. Marcel F. Neuts, “Matrix-geometric Solutions in Stochastic Models: An Algorithmic Approach,” Johns Hopkins University Press, 1981.