

ANALYSIS ON THE DETERMINISTIC INVENTORY MODEL WITH CONSTANT DEMAND

Submitted in partial fulfillment of the requirements for the award of Master of Science

Degree in Mathematics

By

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**DEPARTMENT OF MATHEMATICS SCHOOL OF SCIENCE AND
HUMANITIES**

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

Accredited with Grade “A” by

NAAC I 12B Status by UGC I Approved by AICTE

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BONAFIDE CERTIFICATE

This is to certify that this project report is the bonafide work of YUVARANI. P (41630007) who carried out the project entitled "ANALYSIS ON THE DETERMINISTIC INVENTORY MODEL WITHCONSTANT DEMAND" under our supervision from JANUARY 2023 to APRIL 2023.

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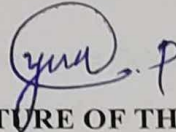
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DECLARATION

I YUVARANI. P (41630007) hereby declare that the project report titled
"ANALYSIS ON THE DETERMINISTIC INVENTORY MODEL WITH CONSTANT
DEMAND" done by me under the guidance of Dr. P. MUNIAPPAN (Internal) at
SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY submitted in
partial fulfillment of the requirements for the award of Master of Science Degree in
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SIGNATURE OF THE CANDIDATE

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ABSTRACT:

In this project, we develop optimum inventory quantity model with constant demand. In General inventory control is a major element of an efficient operation for any business that buys and resells goods. In this motive we develop Mathematical inventory model with varying holding cost, shortage cost and fixed transportation cost. We obtain buyer economic order quantity and minimum total inventory cost. And also, this project we focus on the manufacturer - buyer inventory cost, which makes more profit. This model shows that determination of saving percentage when holding cost and shortage cost increases, which gives more benefit compare with manufacture. Graphical represent illustrates this model

Key words: Inventory control, Shortages. Holding cost, Constant demand.

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CHAPTER 1

1. INTRODUCTION

An inventory may be defined as an idle resource that possesses economic value. It is an item stored fulfills the present and future demand. Such Items may be materials, machines, money or even human resources. In any business, typical goals of inventory management include maintaining low inventory holding costs while also meeting all customer demand for goods. Many companies rely on computer software programs for inventory management.

Whitin [1] was the first to initiate and studied about deteriorating products in inventory model. In day-by-day existence, the deterioration of items is a common factor. Generally, deterioration indicates the decline of the products. Research and discussions on deteriorating product with varying demand patterns are carried by many researchers on various Average Inventory models.

Aggarwal et al. [2] considered the deteriorating product by introducing delay credit period.

P. Muniappan et al. [3] analysed an EOQ model for deteriorating products applying time-dependent deteriorating rate. In their analysis they used different credit payment options which resulted in the benefit of both buyer and vendor.

B. Sarkar et al. [4] established an enhanced inventory model when vendors were facing partial backlogging. For model formulation time varying deterioration and stock-dependent demand where considered.

Shi Sankar Sana [5] discussed Price-sensitive demands for perishable product.

Swaminathan et al. [6] developed optimum production inventory model with deteriorating items, this model resulted in minimum inventory production cost and benefit of manufacturer.

P. Muniappan et al. [7] developed mathematical model for computing optimal replenishment polices, it resulted in best accurate ordering period to run the business in positive manner.

Ravithammal et al. [8] studied two ware house supply chain models. This model deals with the manufacturer who consumes first rental warehouse and then their own warehouses because of space adequacy. For analysis the deteriorating items were considered as ramp- type demand.

Ravithammal et al. [9] analyzed an integrated optimum production inventory system which develops vendor buyer coordination strategy. The buyer himself reworks or screens the damaged products. In this case the buyer and vendor both benefited compared with non-coordination strategy.

1.1. TYPES OF INVENTORIES

1.1.1. RAW MATERIALS

The materials, components, fuels etc. used in the manufacturing of products.

1.1.2. WORK – IN – PROGRESS (WIP)

Partly finished goods and material such assemblies, etc. held between manufacturing stages.

1.1.3. FINISHED GOODS

Completed products ready for sale or distribution.

The particular item included in each classification depend on the particular firm. What would be classified as finished product for one company might be classified as raw materials for another.

1.2. VARIOUS TYPES OF COSTS

1.2.1. ORDERING COSTS

Ordering costs also known as setup costs. Cost of procurement and inbound logistics costs form a part of ordering cost. Ordering cost is dependent and various based on two factors- the cost of ordering excess and the cost of ordering too less.

Both these factors move in opposite directions to each other. Ordering excess quantity will result in carrying cost inventory. Whereas ordering less in will result in increase of replacement cost and ordering cost.

These two above costs together are called Total Stocking Costs. If you plot the order quantity vs. the TSC, you will see the graph declining gradually until a certain point after which with every increase in quantity the TSC will proportionately show an increase.

This functional analysis and cost implications from the basis of determining the inventory procurement decision by answering the two basic fundamental questions – How Much to Order and When to Order, how much to order is determined by arriving at the Economic Order quantity or EOQ.

Examples for ordering costs

1. Clerical costs of preparing purchase orders

There are many kinds of clerical costs, such as invoice processing, accounting, and communication costs.

2. Cost of finding suppliers and expediting order

Costs spent on these will likely be inconsistent, but they are important expenses for the business.

3. Transportation costs

The costs of moving the goods to the warehouse or store. These costs are highly variable across different industries and items.

4. Receiving costs

These include costs of unloading goods at the warehouse, and inspecting the goods to make sure they are the correct items and free of defects.

5. Cost of electronic data interchange (EDI)

These are systems used by large businesses and especially retailers, which allow ordering process costs to be significantly reduced.

1.2.2. HOLDING COSTS

Inventory Storage cost

Inventory storage costs typically include Cost of Building Rental and facility maintenance and related costs. Cost of Material Handling Equipment's, IT Hardware and applications, including cost of purchase, depreciation or rental or lease as the case may be. Further costs include operational costs, consumables, communication costs and utilities, besides the cost of human resources employed in operations as well as management

Cost of Capital:

Includes the costs of investments, interest on working capital, taxes on inventory paid, insurance costs and other costs associate with legal liabilities. The inventory storage costs as well as cost of capital is dependent upon and varies with the management to manage inventory in house or through outsourced vendors and third-party service providers.

EXAMPLES OF HOLDING COST:

1. Inventory financing costs:

This includes everything related to the investment made in inventory, including costs like interest on working capital Financing costs can be complex depending on the business.

2. Opportunity cost of the money invested in inventory:

This is found by factoring in the lost alternatives of tying money up in inventory, such as investing in term deposits or mutual funds.

3. Storage Space Costs:

These are costs related to the place where the inventory is stored and will vary by location. There will be the cost of the storage facility itself, or lease payments if it is not owned. Then there are facility maintenance costs like lighting, heating, and ventilation. Depreciation and property taxes are also included in this.

4.Inventory services costs:

This includes the cost of the physical handling of the goods, as well as insurance, security, and IT hardware, and application if these are used. Expenses related to inventory control and cycle counting are further examples.

5. Inventory risk costs:

A major cost is shrinkage, which is the loss of products between purchasing from the supplier and final sale due to any number of reasons: theft, vendor fraud, shipping errors, damage in transit or storage. The other main example is obsolescence, which is the cost of goods going past their use by dates, or otherwise becoming outdated.

1.2.3. SHORTAGE COSTS

Shortage or stock out cost & cost of replacement

- A. Cost of Loss, Pilferage, shrinkage and obsolescence etc.
- B. Cost of Logistics
- C. Sales discounts, volume discounts and other related costs

CHAPTER 2

2.1 FACTORS AFFECTING INVENTORY

2.1.1. FINANCIAL FACTORS

- ▶ Factors such as the cost of borrowing money to stock enough
- ▶ inventory can greatly influence inventory management. In this case, your finances may fluctuate according to the economy, and it is wise to keep an eye on changing interest rates to help plan your spending.
- ▶ The tax costs associated with stocking inventory is another factor that can influence inventory management. This is especially salient when preparing for the end of year tax returns.
- ▶ Other financial factors include the expenses associated with warehouse operations and transportation costs changes in these factors may require you to alter your inventory management processes accordingly. Fluctuations in the cost of fuel, for example, may require you to rethink your transportation methods to reduce costs. You may choose to purchase your own trucks or use outside contractors for transportation, which again will change the way you manage inventory.

2.1.2. SUPPLIERS

Suppliers can have a huge influence on inventory control. Successful businesses require reliable suppliers in order to plan spending and arrange production. An unreliable or unpredictable supplier can have huge knock-on effects for inventory control. It can be a good idea to ensure you have a reliable back up supplier to prevent product shortages or delays in the manufacturing process.

2.1.3. LEAD TIME

Lead time is the time it takes from the moment an item is ordered to the moment it arrives. Lead time will vary widely depending on the product type and the various manufacturing processes

involved, and therefore changes in these factors can require changes to inventory management.

Outsourcing manufacturing processes to other countries due to lower production costs may result in longer waiting times. Producing the same goods locally may cost more but take less time, and therefore you may need to adjust your stock levels accordingly.

2.1.4. PRODUCT TYPE

Inventory management must take into consideration the different types of products in stock. For example, some products may be perishable and therefore have a shorter shelf life than others. In this case inventory must be managed to ensure that these items are rotated in line with expiration dates.

2.1.5. MANAGEMENT

Ultimately, responsibility for managing your business' inventory sits with you and any co-owners. While you may have multiple employees acting as managers to oversee inventory processes, they typically will not have the same stake in the business as you do.

2.1.6. EXTERNAL FACTORS

There are multiple external factors that may affect inventory control. For example, economic downturns may occur and this is something that you will generally have very little control over.

Assessing the economy is a must in order to guard against stock outs or a buildup of excess inventory. Other factors may include the real estate markets or the extent of local competition. These factors are also largely out of your control, so it is a good idea to assess the external climate regularly in order to stay prepared.

CHAPTER 3

3.1 OBJECT AND SCOPE

OBJECT:

- ▶ To identify relevant approaches and techniques which have been proposed for determining safety stocks.
- ▶ To learn about the industrial sectors that have been investigated as domains for safety stocks.
- ▶ To design an effective OR-based approaches using Inventory models.
- ▶ To develop a computationally-efficient algorithm for the optimal solution.
- ▶ To discuss the research opportunities that may help to guide future researchers.

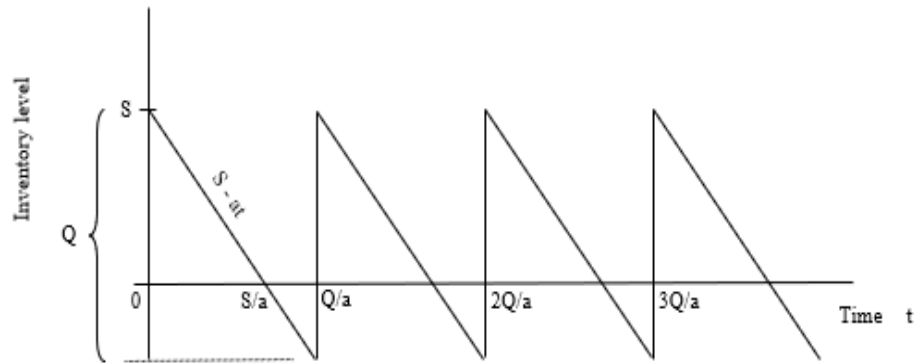
SCOPE:

- ▶ To determine the proper safety stock level for each product.
- ▶ To show the evident that safety stock impact transport system
- ▶ To identify systematic approaches for safety stock to avoid stockout risk level.

CHAPTER 4

4. METHODOLOGY

4.1. MATHEMATICAL MODEL FORMULATION



Total cost = ordering cost + purchase cost + holding cost + shortage cost

$$\begin{array}{ccccccc}
 \swarrow & \swarrow & \swarrow & \downarrow & & & \\
 K & cQ & \frac{hS}{2} \frac{S}{a} = \frac{hS^2}{2a} & \frac{p(Q-S)}{2} \frac{(Q-S)}{a} = \frac{p(Q-S)^2}{2a} & & & \\
 \underbrace{\hspace{15em}} & & & & & & \\
 & & & \$ / \text{period} & & &
 \end{array}$$

(ordering + purchase + holding + shortage) cost per period

Total cost/unit time =

length of period

$$T = \frac{K + cQ + \frac{hS^2}{2a} + \frac{p(Q-S)^2}{2a}}{Q/a}$$

$$T(S, Q) = \frac{aK}{Q} + ac + \frac{hS^2}{2Q} + \frac{p(Q-S)^2}{2Q}$$

T is a function of S, Q

We want to minimize $T(S, Q)$: $\frac{\partial T}{\partial S} = 0$, and $\frac{\partial T}{\partial Q} = 0$

$$T(S, Q) = \frac{aK}{Q} + ac + \frac{hS^2}{2Q} + \frac{p(Q-S)^2}{2Q}$$

$$\frac{\partial T}{\partial S} = \frac{hS}{Q} - \frac{p(Q-S)}{Q} = 0$$

$$(Q-S) = hS/p$$

$$Q = S(h+p)/p$$

$$\frac{\partial T}{\partial Q} = -\frac{aK}{Q^2} - \frac{hS^2}{2Q^2} + \frac{p(Q-S)}{Q} - \frac{p(Q-S)^2}{2Q^2} = 0$$

$$2aK + hS^2 + p(Q-S)^2 = 2p(Q-S)Q$$

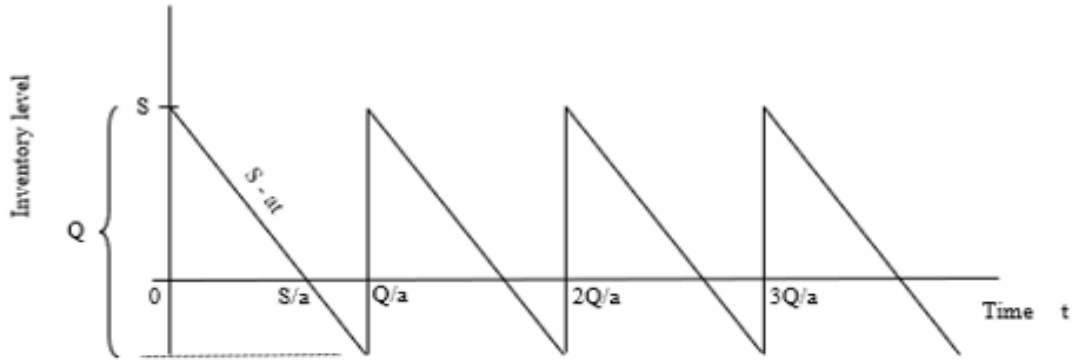
$$2aK + hS^2 + p(Q-S)^2 = 2p(Q-S)Q$$

$$(Q - S) = h S/p \quad \Rightarrow \quad Q = S (h + p)/p$$

$$\Rightarrow 2aK + hS^2 + \frac{h^2 S^2}{p} = \frac{2h(h+p)S^2}{p}$$

$$\Rightarrow 2apK + phS^2 + h^2 S^2 = 2h(h + p)S^2$$

$$\text{Solving: } S^* = \sqrt{\frac{2aK}{h}} \sqrt{\frac{p}{p+h}} \quad \text{and} \quad Q^* = \sqrt{\frac{2aK}{h}} \sqrt{\frac{p+h}{p}}$$



$$\text{Total cost is minimized: } S^* = \sqrt{\frac{2aK}{h}} \sqrt{\frac{p}{p+h}} \quad Q^* = \sqrt{\frac{2aK}{h}} \sqrt{\frac{p+h}{p}}$$

$$\text{Optimum period length: } \frac{Q^*}{a} = \sqrt{\frac{2K}{ah}} \sqrt{\frac{p+h}{p}}$$

$$\text{Maximum shortage: } Q^* - S^* = \frac{h}{p} S^* = \sqrt{\frac{2aK}{p}} \sqrt{\frac{h}{p+h}}$$

CHAPTER 5

5.1 Application

- ❖ To part of the purchases of almost every organization
- ❖ Eliminate burden of calculation and also enables the use more complex formulas
- ❖ Useful for materials that have
 1. Reasonably steady and predictable usage
 2. Relatively low cost
 3. Short lead time

CHAPTER 6

6.1 CONCLUSION:

In this project, we developed optimum inventory quantity model with constant demand. In General inventory control is a major element of an efficient operation for any business that buys and resells goods. In this motive we developed Mathematical inventory model with varying holding cost, shortage cost and fixed transportation cost. We obtained buyer economic order quantity and minimum total inventory cost. And also, this project we focused on the manufacturer - buyer inventory cost, which makes more profit. This model shows that determination of saving percentage when holding cost and shortage cost increased, which gave more benefit compare with manufacture. Graphical representation illustrated this model.

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