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A Study of Various Parameters, Terminology and Analysis of Deterministic Inventory Control Model

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Abstract

Present-day is the phase of improved globalization, enhanced information technology and production machineries. Low invests, environmental privileges, upgraded transportation and enhanced communication are altogether essential factors that added competition. Furthermore, companies may face growing supplies from customers on buyer related products, consistent lead periods and customer fulfilment. All these growths focus on central competencies generate a necessity for supply chain management, and support on product growth. These days' supply chain & Inventory control management have become crucial problems in the triumph of any business, fulfilling the certain demand of a customer is the important objective in this area. For past some decades, diverse theoretic approaches have been implemented to counter these types of problems. Ultimately, when we discuss money, minimizing the loss or maximizing the profit is aye the task. In the present scenario industrial business becoming more and more competitive, study of supply chain theory needs advanced knowledge.

SCM popularly known as supply chain management is an emerging executive prototype to conform the instantaneous changes of demand of customer inside the emergent world-wide industrial industry. Study about supply chain theory evolve the satisfaction of customer and it consists all direct and indirect stages of customer needs. The theory of supply chain and its management is a summative study of approaches implanted to enhance the entire operation in such a way that products are produced and dispersed at the correct entity, to the correct destination and on time. A key issue in case of supply chain and its

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management is Inventory theory and its control. From raw material to finished goods, inventories are most essential portion of system supply chain.

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1. INTRODUCTION

An Inventory is an amount of goods kept in stocks for future production or sale. In the current scenario of competitive and challenging world, it is much needed to acquire sufficient stocks to run the all sectors of the economy smoothly, maximize the profit and to provide customer satisfaction. An Inventory is a most essential part of all economy or any business, such as agriculture, defence, pharmacy, industry, health sector etc. Goods holds a major capital tied up and periodic and up to date study of material can decrease the risk of failure of any business or economy. Inventory theory plays an essential part of today's scenario due to changing trends in demand, or to learn application of recent developed technology into economy or business, or to remodified the production or sell process, or to revaluate the man force into economy or business.

Any economy is either predictable or unpredictable, for both economies, the existence of Inventory infers the existence of any system, either economy or business that concludes influx, accretion, and outflux. Thus, in this context, Inventory control regarded most essential element.

Existence of Inventory problem occur when we must stock goods for running a system more efficiently and to satisfy the demand of any material on a specified timeframe. Usually, Inventory refers to materials or goods. It can be raw material, finished goods, product in packaging, or any material kept in store to meet the demand of system, market or customer.

Inventory control implies the study of under stoking and overstocking and maintaining a balance among them for efficient and effective run of any operation. Overstocking implies the idle of excess materials and understocking results in improper functioning of any operation, so, in this context, Inventory control plays most significant role.

Inventory control may be widely categorized into two parameters as continuous review control systems and periodic control review systems.

Under continuous review control system: we need knowing Inventory or stocks of goods all the times. It provides the up-to-date availability of Inventory to make it easier to guess when and how much to order.

Under periodic review system: we need knowing Inventory or stocks of goods at specified interval of time. So, inventories are only efficient, reliable and effective, when it could be controlled.

As an essential element in all economy, Inventory serves multiple purposes, such as:

- Assuring the satisfaction of customer
- Assuring the buffer stock in case of uncertain and unpredictable situation
- Decoupling production operations
- Ensuring an undisturbed flow of seasonal goods
- Learning the application and impact of promotional tool and techniques

Inventory control works on the principle of set of decision that state, "how and when to order". Inventory control concludes the objective function to be minimized in case of cost association and to be maximized in case of profit association. Some important questions that adhere to the Inventory control is as follows:

- For future production or sale, what items should be stored?
- When to order and reorder?
- What quantity of amount should be ordered or reordered?

2. BASIC DEFINITIONS AND TERMINOLOGY OF INVENTORY CONTROL

Some important terms associated to Inventory control are as following:

1.2.1 **Inventory Control:** A kind of process or fact of safeguarding that a sufficient amount of Inventory is maintained by any business, so as to be capable of fulfilling the demand of a customer without any delay whereas keeping the holding costs associated with inventories to minimum.

1.2.2 **Inventory Cost:** Any costs which are associated to Inventory are the Inventory cost. It can be characterized into following sub categories-

1.2.3 **Ordering Cost:** Inventory ordering costs related to the cost induce for obtaining Inventory. It comprises the purchase cost and the inward logistics cost. We do use the idea of "EOQ" to least Inventory ordering rate or cost.

1.2.4 **Carrying Cost:** Inventory carrying cost associated with the cost of storage the Inventory and its maintenance. It may also comprise the cost of building an infrastructure or building rental to preserve Inventory. The cost associated with carrying cost also depends upon the Inventory management decision maker to manage the Inventory through subcontracted vendors and other service providers.

1.2.5 **Shortage Costs or Stock-Out Costs or Replenishment Costs:** It is cost of Inventory because of unenviability of the Inventory.

1.2.6 Holding Cost: Holding cost of Inventory are those which is associated with storage of Inventory that leftovers unsold. Holding cost are one of the important components of total Inventory cost along with ordering cost and shortage costs. The costs of holding conclude the loss due to damage of goods, storage space cost utilized in storing the Inventory, cost of labour associated and cost of insurance.

1.2.7 Purchase Cost: The cost of purchase is the cost a stockholder pays for any investment, and this cost work as a basis for the calculation of loss or profit.

1.2.8 Shipping Cost: The shipping cost for an Inventory is cost associated with costs of movement of cargo from one path to another path. There are multiple factors that affects shipping costs viz, lot size of Inventory, distance between paths, contracts etc.

1.2.9 Reorder Cost: Reorder cost of an Inventory is the cost that include the repeating the supply of an order, cost associated to preparation of an order, costs of transportation, labour cost and other costs.

1.2.10 Opportunity Cost: The profit/loss from an alternate offer like decision of investment that is inevitable in favour of other. It also concludes the cost due to reduced receptiveness to customers' changing needs, slow down introduction of upgraded items, the Inventory's worth and direct expenditures, since money might be utilized for another purpose.

1.2.11 Salvage Cost: Due to the quantity of Inventory in stock, its demand affected and it incurred an extra cost. Mostly, the cost of salvage is collective with storage costs and not being considered independently.

1.2.12 Replenishment Order Quantity: The replenishment order quantity is a process or an operation that used to making Inventory full again to avoid the situation of stock-out. This order can be placed by a backorder initiated to manufacturer or a supplier, sent through using an "Electronic data interchange" (EDI). In order to upsurge productivity, almost Inventory control systems contrivance rule of replenishment to systematize work in progress to some extent. Replenishment of the Inventory is most commonly engendered when the level of the Inventory touches the reorder level point.

1.2.13 When the reorder point level is touched, a demand equals the "EOQ" is formed by using mathematical modelling. The concept of Min-Max being used in Inventory model, the Inventory Minimum value signifies the reorder point, as well as Maximum represents the required quantity. The quantity of Reorder is Maximum Inventory minus Minimum Inventory. The difficulty of replenishment processes critically depends on ordering agent position inside the supply system. Part of a trading system for stores that relies on integrated warehouses, the refill process or replenishment is characterful, often minor and basically computerized. Certainly, the prototype here at the point of store-grocery supply - characterized the modest orders accepted on a daily basis. Therefore, store managers cannot either complicate a system or demand too much manpower. For warehouses, producers' replenishment is typically larger and has longer cycles (weeks rather than days). Again, this

order by itself is inherently more multipart because lead times can vary a lot (for external manufacturers as next-day delivery for several months for internal manufacturers) and because additional aspects such as wholesale discounts are "economic. Order quantity ".

EPQ: "EPQ" is abbreviation for Economic production quantity, the quantity of a product that must be produced in a lot of single so by way of minimize the overall cost that includes costs of setup for machines and holding costs of Inventory.

1.2.14 EOQ: "EOQ" is an abbreviation for "Economic Order Quantity". The "EOQ" is the optimal measure of the any item which is purchased at once in order to minimalize the collective annual worth of the ordering and carrying the article in Inventory. EOQ is also stated to as the optimum size of lot.

EOQ can be calculated by solving an equation which can be developed using basic mathematical model as follows:

$$EOQ = \sqrt{\frac{2\ D_a\ C_s P_a}{C_h(P_a - D_a)}} \qquad \text{.....(i)}$$

Where, D_a = Annual product demand

P_a = Annual rate of production

C_s = Setup cost fixed to per setup

C_h = Per unit cost of holding Inventory

This equation can be reduced further by using application of differentiation i.e., minima to evaluate the total Inventory cost, which includes cost of setup and holding cost of Inventory. As the lot of production quantity increases, repetition of batches of production in a year decrease resulting in decrement of setup cost but the cost of holding the Inventory increases. At the EPQ price, the total inventory cost of both these costs is at its lowest value.

1.2.15 Inventory Days: Inventory days is an efficacy ratio that counts the aggregate counting of days the company holds its Inventory before selling it. The fraction measures the total days capitals are secured up in Inventory.

1.2.16 Inventory Models: It is a mathematical model that helps develop all business in evaluation of all types of inventions that must be maintained in a manufacturing process, handling the frequency of collisions, deciding on the quantity of goods or reserving raw materials, Tracking raw resources and stock of goods. To provide continuous service to customers deprived of any delay in delivery.

1.2.17 Demand: Demand is a peculiar principle that refers to a consumer's craving to obtain goods and services and the readiness to pay for a specific good or service. Keeping all aspects constant, an increase in the price of goods or service will decrease the quantity demanded, and vice versa.

1.2.18 Supply: Supply is the commitment and capability of producers to produce or make goods & facilities to take them to market. Supply is completely related to price given that at more prices there is an encouragement to supply more as higher prices may generate increased revenue and profits.

1.2.19 Stockout: A Stockout or out of stock is incident where the product is consumed. It normally refers to Stockouts experienced in retail stores for FMCG products. It implies that the upstream supply chain is commonly not the reason for Stockouts but the replenishment efficacy of a retailer.

1.2.20 Buffer Stock: A buffer stock is a scheme or system which purchases and keeps stocks at times of good harvests to prevent prices dropping below a target value (or price level), and supplies stocks during unhealthy harvests to avoid prices growing above a target value (or price level).

1.2.21 Safety Stock: It is an added quantity of an element held by a company in Inventory to decrease the hazard of an item to being stockout. Safety stock performances as a buffer stock in case the trades of an item are better than strategic and/or the company's dealer is unable to distribute supplementary units at the projected time.

1.2.22 Reorder Level: A router level or reorder point is the inventory point or level at which a company will initiate a new order or restart a manufacturing run. The level of the router depends on an organization's work order lead time and its demand over that time period and whether the business or firm maintains safety stock.

1.2.23 FIFO: "FIFO" stances for first-in, first-out, sense that the oldest Inventory stuffs are recorded as traded first but do not essentially mean that the precise oldest physical item has been surveyed and sold. In another words, the cost interconnected with the given Inventory which was procured first is the expense utilized first.

1.2.24 FILO: Method of Inventory estimation based on the hypo proposed research work that goods are retailed or used in the reverse chronological direction in which they are bought. Hence, the price of goods purchased first (first-in) is the price of goods sold last (last-out). FILO is the same as the last in, first out (LIFO) accounting method.

1.2.25 LIFO: "LIFO" stands for “last-in, first-out”, meaning that the most newly formed items are chronicled as sold first.

1.2.26 Finished Goods: Finished goods are items that might be finalized by the manufacturing procedure, or purchased in a complete form, but which have not so far been sold to customers. Goods that have been purchased in finished form are known as merchandise. The price of finished goods Inventory is measured a short-term benefit, since the expectancy is that these things will be sold in less than one year. The entire quantity of Inventory on hand of finished goods as of the end of a process of any reporting period is commonly accumulated

with unused materials and work-in-process cost, & is described within an only "Inventory" line item on the balance sheet.

1.2.27 Average Inventory: Average Inventory is a process of calculating the value or number of a particular item or item during two or more specified time periods. Average inventory is the average value of an inventory within a given time period, which may differ from the average value of the same data set.

1.2.28 Warehousing: Warehousing is a method of storing goods that will later be sold or circulated. Although a small, home-based business can store products in an empty room, basement, or garage, a large business is usually a building own or rented space specifically designed for storage.

1.2.29 Decoupling Stock: Decomposing inventory involves the separation of inventory within a manufacturing process so that the inventory associated with one phase of a manufacturing process does not slow down other parts of the process. In simple terms, decoupling inventory is a kind of safety stock. Like safety stock, it establishes a buffer between product demand and product supply and is used in work-in-process inventory. Where security stocks are seen as a buffer against increased external demand, decoupling inventory is a buffer against increased internal demand. The decoupling inventory consists of inventory stock that is held to cushion construction assembly against potential issues within the production line. Issues such as equipment interruption or disparity in machine production rates affecting production because one part of the production line is operating at a different speed from the other. If a production line stall and work-in-progress products are incomplete, it causes a reduction in the rate at which inventory stock is renewed. Stock is commonly used in the production of built-to-order.

1.2.30 Lead Time: The period of time that elapses from the beginning of a process to its completion. All enterprises and companies check the deadlines for the execution of orders at the stages of pre-processing, processing and subsequent processing in the industry, the organization of the supply chain and project management. By comparing grades with well-known standards, they can determine what inefficiency is; reducing lead time can simplify operations, increase productivity, and increase revenue. On the contrary, longer lead times adversely affect sales and production processes.

1.2.31 Inflation: Inflation is a situation of rising prices in the economy. A more accurate definition of inflation is a constant increase in the general price level in the economy. Inflation means an increase in the total cost of living as prices for goods and services rise. The inflation rate measures the annual percentage change in the overall price level.

1.2.32 Just in Time Delivery: It is symbolically represented in the form of JIT and is an inventory management strategy that helps to expedite the execution of orders thanks to specific applications in orders for raw materials and production. Thus, the production procedure

begins only when the customer orders any order, then the stock in the warehouse is delivered only as necessary.

1.2.33 Fixed Order Quantity: "A fixed order quantity is an inventory management system in which the maximum and minimum inventory levels are fixed, and the maximum and fixed inventory quantities can be replenished at a time when the inventory level touches an automatically set recording point or the smallest inventory level".

1.2.34 Deterministic Inventory Control: The method is grounded on the hypo proposed research work that altogether parameters and variables linked with the Inventory are identified or can be estimated with certainty, and that the replenishment lead time is constant and independent of demand.

1.2.35 Highest-In, First Out: Highest Entry, First Exit, abbreviated as HIFO, is a method of allocation and inventory accounting in which inventory with the highest purchase costs is first used or removed from stock.

1.2.36 The Finite Time Horizon is the end time period during which the inventory level will be monitored.

1.2.37 Trade Credit: A trading loan is a loan provided by one trader to another trader for the purchase of goods and services. the possibility of buying a trade loan without immediate payment. Trade credit is usually used as a source of short-term financing by commercial organizations. it is available to customers with reasonable financial standing and goodwill.

1.2.38 Echelon Inventory: Echelon Inventory is certainly on the Inventory list among the ranks in the supply chain, and the customer is done. When we use this help to determine safe stocks at a certain stage in the supply chain, as this will not depend on the local stock, but will depend on the stock available in the previous stages and stages. It will also help minimize inventory. safety inventory for specific steps. If we consider a retailer who takes an Inventory from a supplier and sells it to customers, a Security Inventory will depend on an assessment of customer demand and supply uncertainty. Here, supply uncertainty depends on the safety inventory maintained by the supplier. Therefore, if a supplier improves inventory security, a retailer can reduce inventory security. Thus, one can find the best value for both. Therefore, it is important that the steps in the supply chain interact with each other in terms of their inventory levels and take into account the echelon inventory rather than the local inventory. Sales orders have not yet been processed. The difference between aggregate production and aggregate demand is greater than and usually equal to x, where the lag is negative when we encounter small fractions of overdue debt. When we encounter a lag in the future, it gets a complete lag. The partial debt ratio is appropriately determined to reflect the share of the customer who wishes to accept that repayment is reduced and the waiting time for the next replacement.

1.2.39 Deterioration: Degradation is defined as decomposition, evaporation, moral aging, decreased utility or marginal value of goods with a utility deficit from the initial state. This may be due to the following reasons. Objects can have a fixed lifespan and can be useless when stored after the expiration of their lifespan, for example, drugs, films, light bulbs, etc. Decomposition can occur due to poor, poor or insufficient storage conditions, for example, dairy products. A malfunction can also lead to mistreatment in the store, for example, fruits and vegetables, dishes. Some important factors in an inventory deterioration study:

- **Demand Rate**: Demand level is a very important key factor in the study of inventory deterioration. It acts as the driving force of the entire inventory system. Demand indicators can be constant, linear, quadratic, cubic, linear, etc. And they are functions of time.
- **Constant Demand:** If the demand for a product follows a constant function of time, then demand is called constant demand, and it can be expressed by the following equation $D\ (t) = a$, where a is a positive constant, and also a denotes the initial level of demand.
- **Linear Demand:** If the demand for a product follows a linear function of time, then demand is called linear demand and can be expressed by the following linear equation $D\ (t) = a + bt$, where a and b are positive constants, as well as positions for the initial demand level and' b 'means an increase in demand over time.
- **Quadratic Demand:** If the demand for a product corresponds to a quadratic function of time, then demand is called quadratic demand and can be expressed by the following quadratic equation $(t) = a + bt + ct^2$, where a, b and c are positive constants. and "a" stands for the initial rate of demand, "b" stands for an increase in the demand rate over time, and c stands for a change in the rate of demand over time.
- **Cubic Demand**: If the demand for a product corresponds to the cubic nature of time, then demand is called cubic demand and can be expressed by the following cubic equation $D\ (t) = a + bt + ct^2 + dt^3$, where a, b, c and positive are positive constants, and also a denotes initial level of demand, "b" means an increase in demand over time, "c" means a change in demand over time, and "d" means an acceleration in demand over time. If the coefficient t =0 in d in cubic demand, then cubic demand becomes quadratic demand. Similarly, if the coefficients t =0 in d and t = 0 in c in cubic demand, then cubic demand becomes linear demand, and the coefficients t =0 in d, t =0 in c and t =0 in b in cubic demand, then cubic demand becomes constant demand. As an illustration, we can consider the real situation: during the summer season, the demand for cold

drinks gradually increases from April to June. Demand for cold drinks is considered linear in April, quadratic in May and cubic in June. Otherwise, it can be considered as constants for the remaining seasons.

- **Ramp Type Demand:** If the demand for the product corresponds to the ramp time function, then demand is called demand of the ramp type and can be expressed by the following equation $(t) = \{at, t < \mu a\mu, t \geq \mu$ at any time $t \geq$, $a>0$, where "a" denotes the initial norm demand, and "μ" stands for a fixed point in time. The characteristic of the demand rate of the ramp type is that demand increases over time to a certain time, and then remains stable or constant for the remainder of the period.

Example. If a new mobile phone brand has appeared on the mobile phone market, the demand for this mobile phone increases with time at the beginning, up to a certain time (i.e., from the moment another new mobile phone brand appears), and then remains stable or constant for the remaining period.

3. INVENTORY ANALYSIS

Inventory analysis is the process of understanding the assortment of business products while understanding the demand for certain products. When conducting business for managers, it is important to have improved inventory control in order to practice periodic analysis.

1.3.1 ABC Analysis: The ABC method states that when considering an Inventory, a company should evaluate items from A to C based on the following rules:

- A-items are items with the highest annual consumption value. The top 70–80% of the company's annual consumer value, as a rule, is only 10–20% of the total inventory.
- B-items are interclassed items through a moderate consumption value. 15-25% of annual consumer value is 30% of the total inventory position.
- C-items, in contrast, are items with the lowest consumer value. Low 5% of the annual cost of consumption is 50% of the total inventory.
  The annual cost of consumption is calculated by the formula: (annual demand) x (unit cost of production).

Using this classification, the procurement manager can identify inventory hotspots and distinguish them from other products, especially from numerous but profitable ones.

1.3.2 FSN Analysis: This analysis classifies inventory based on quantity, rate of consumption, and frequency of problems and uses. Here is a basic description of the FSN analysis: F stands for fast moving, S for slow moving, and N for stationary objects.

- Fast moving - items that are often issued / used. It is represented by the symbol "F".

- Slow moving - items that are used / released less during a certain period. It is represented by the symbol "S".
- Non-moving - items that are not used / released for a certain period of time. It is represented as "N".

1.3.3 VED Analysis: This is an analysis, the classification of which depends on user experience and perception. This analysis classifies inventions according to the relative importance of certain objects, such as those found in spare parts. In the VED analysis, subjects are classified into three categories, which:

- Vital - inventory that must be constantly kept in stock.
- Necessary - it is enough to have a minimum supply of this inventory.
- Desirable - the operation can be performed as desired or without

1.3.4 HML Analysis: HML analysis classifies the list based on product value / unit price. The classification is as follows:

- High cost - indicated by the letter "H". High unit cost item.
- Average cost - indicated by the letter "F". Medium Value Item.
- Low cost - indicated by the letter "L". Low unit cost item.

1.3.5 SDE Analysis: This analysis classifies the inventory according to how easily the product is available, or by the time during which the item is missing. The list is classified as follows:

- Scarce (S) - it takes a long time for imported goods.
- Complex (D) - items that should be available for more than two weeks, but less than 6 months.
- Easily accessible (E) - items that are easily accessible

1.4 BENEFITS OF INVENTORY ANALYSIS

- Creating the right warehouse scheme
- Reducing the time required to receive items sold
- Implement appropriate authorization
- Suitable product classification for better cost management
- Proper management of inactive inventory items
- Improved company capital consumption and the best and constructive cash flow
- Future identification of possible odds or losses

4. VARIABLES IN INVENTORY PROBLEMS

Variables associated with Inventory problems are classified into two Categories:

The Controlled Variables: The variables that may be controlled, separately or in combination are the following.

- Frequency or time of acquisition: The variables associated with the Inventory may depend on the decision maker, monitoring how often or when the list needs to be updated. Problems fall into two categories:
- Stage of completion of complete goods: the decision-maker can control the state in which incomplete objects are stored. There is no delay in supplying customers.
- Amount received: the decision maker can control the level of procurement or production.

The Uncontrolled Variables: Stocks that cannot be processed in the Stocks task are divided into cost variables and others.

5. CONSTRAINTS IN INVENTORY MODEL

Limitations in inventory systems are associated with various properties that in some way impose restrictions on the components discussed in this section. These limitations must be taken into account when creating models of inventory systems and when solving them. We consider replenishment constraints, demand constraints and cost constraints.

Replenishment Constraints: Some replenishment restrictions are as follows:

- Space restrictions: in some systems the amount of space for storing inventory is limited, so the volume in the Inventory at any time cannot exceed a certain amount.
- Planning and verification of restrictions: we have already mentioned that planning and inspection periods may be prescribed in some systems. Such recipes should be considered as limitations.
- Inventory levels: on some systems, management may place specific specifications at the inventory levels. In this system, inventory levels at the beginning of any planning period should be many times higher than the average demand for this period, and they are such that there can be no shortage.
- Inventory policy: management may prescribe an inventory policy. The researcher may need to find the optimal solutions for this policy, even if for other policies expensive solutions with losses exist. Thus, a policy (t, s) can sometimes be prescribed, even if a policy (s, s) can be shown as the best policy.

Demand Constraints: Some demand constraints are as follows:

- Negative demand: when customer returns are allowed and when they exceed shipments for a period, the overall effect is the same as negative demand. For many systems, negative demand does not affect the analysis. Sometimes, however, the analysis is really influenced if we admit the possibility of negative requirements.

Example: marketing any idea or person that people don't like and is willing to pay to save them. Dental work is an example. Negative goods are things you have to pay someone to pick up such rubbish, damaged tires, an unwanted car, etc.

- Dependent demand structures: demand for any period may depend on demand in the previous period. The analysis of a system with such dependent demand structures is rather complicated. This also applies to systems in which demand forecasting is an integral part of the inventory system.
- Replenishment of the deficit. In some systems, any deficit accumulated during a period can be replenished immediately after a replenishment occurs at the end of the period. In other systems, for example, when sales are lost, the deficit cannot be filled. This demand property has a significant impact on the cost of shortages and, therefore, on the decision of inventory systems.

Cost Constraints: Several cost restrictions have already been mentioned. Some systems do not allow a flaw, while others do not make any inventions. When planning periods are set, replenishment baskets may be limited and not subject to control. The fact that one replenishment cost can only be used for one product is another important artificial limitation. In some systems, the probability of a deficit may be below a certain value, say, 0.05. In other systems, the inventory problem can be formulated as a given total SC per unit of time, what should be done to minimize the deficit? "

6. RATIONALE OF THE STUDY

- Inventory ensures the smooth operation of the production process, ensuring an adequate supply of raw materials, components and industrial goods for production lines.
- Inventories serve as a buffer against uncertain and unstable use and reduce scarcity situations, thereby avoiding production delays and loss of customer goodwill.
- Inventory control theory helps us to find satisfactory answers to,

What stocks should be acquired and maintained?

From what sources should they be obtained?

How much stock should be acquired when replenishment is needed?

When should you replenish stocks?

7. REFERENCES/BIBLIOGRAPHY

1. Banerjee, A., (1986). A joint economic-lot-size model for purchaser and vendor. *Decision sciences,* 1986, 292-311.
2. Bose, S., Goswami, A. and Chaudhuri, K. S., (1995). An EOQ model for deteriorating items with linear time dependent demand rate and shortages under inflation and time discounting. *Journal of the Operational Research Society,* 46 (6), 771 – 782.
3. Bringham, E. F. (1995): Fundamentals of financial Management. *The Dryden Press, Florida*
4. Buzacott, J. A., (1975). Economic order quantities with inflation. *Operational Research Quarterly,* 26 (3), 553 – 558.
5. Chandra, M. J. and Bahner, M. L., (1985). The effects of inflation and time value of money on some inventory systems. *International Journal of Production Research,* 23 (4), 723 – 729.
6. Chang, H. J., Teng, J. T., Ouyang, L. Y. and Dye, C. Y. (2006): Retailer's optimal pricing and lot-sizing policies for deteriorating items with partial backlogging. *European Journal of Operational Research,* 168, 51 – 64.
7. Chakravarty, A.K., Martin, G.E., (1988). An optimal joint buyer-seller discount pricing model. *Computers and Operations Research,* 15, 271-281.
8. Chung, K.J. and Huang, Y.F., (2003). The optimal cycle time for EPQ inventory model under permissible delay in payments. *International Journal of Production Economics,* 84(3), 30-318.
9. Datta, T. K. and Pal, A. K., (1991). Effects of inflation and time value of money on an inventory model with linear time dependent demand rate and shortages. *European Journal of Operational Research,* 52 (2), 326 –333.
10. Dave, U. and Patel, L. K., (1981). (T, Si) – policy inventory model for deteriorating items with time proportional demand. *Journal of the Operational Research Society,* 32, 137 – 142.
11. Dave, U. (1985): On Economic order quantity under conditions of permissible delay in payments, *Journal of the Operational Research Society,* 36, 1069.
12. Donaldson, W. A., (1977). Inventory replenishment policy for a linear trend in demand – an analytical solution. *Operational Research Quarterly,* 28, 663 – 670.
13. Goyal, S. K. (1985): Economic order quantity under conditions of permissible delay in payments. *Journal of the Operational Research Society,* 36, 335 – 338.
14. Goyal, S. K., (1988). A heuristic for replenishment of trended inventories considering shortages. *Journal of the Operational Research Society,* 39, 885 –887.

15. Goyal, S.K., Gupta, Y.P., (1989). Integrated inventory and models: the buyer vendor coordination, *European Journal of Operational Research,* 41, 261-269.

16. Goyal, S. K. and Giri, B. C., (2001). Recent trends in modelling of deteriorating inventory. *European Journal of Operational Research,* 134, 1 – 16.

17. Hollier, R. H. and Mak, K.L., 1983. Inventory replenishment policies for deteriorating items in declining market. *International Journal of Production research,* 21, 813-826.

18. Hwang, H. and Shinn, S. W. (1997): Retailer's pricing and lot-sizing policy for exponentially deteriorating products under the condition of permissible delay in payments. *Computers and Operation research,* 24, 539-547.

19. Jaggi, C. K. and Aggarwal, S.P., (1995). Ordering policy of deteriorating items under permissible delay in payments. *Journal of the operational Research Society,* 46, 658-662.

20. Jamal, A. M. M., Sarker, B. R, Wang, S. (1997): An ordering policy for deteriorating items with allowable shortages and permissible delay in payment. *Journal of the Operational Research Society;* 48, 826 – 833.

21. Jamal, A. M. M., Sarker, B. R, Wang, S. (2000): Optimal payment time for a retailer under permitted delay of payment by the wholesaler. *International Journal of Production Economics,* 66, 59-66.

22. Kim, K.H., Hwang, H., (1988). An incremental discount-pricing schedule with multiple customers and single price break. *European Journal of Operational Research,* 35, 71-79.

23. Kim, (1997) Lal, P., Staelin, R., (1984). An approach for developing an optimal discount pricing policy. *Management Science,* 30, 1524-1539.

24. Lee, L. E., Resenblatt, M. J., (1986). A generalized quantity discount-pricing model to increase supplier's profits. *Management Science,* 32, 1177-1185.

25. Li, S.X., Hung, Z. and Ashley, A. (1996). Inventory channel coordination and bargaining in a manufacturer- retailer system. *Annal of operational Research* ,68, 47-60.

26. Liao, H. C., Tsai, C. H. and Su, C.T. (2000): An inventory model with deteriorating items under inflation when a delay in payments is permissible. *International Journal of Production Economics,* 63, 207-214.

27. Misra, R. B., (1979 – a). A study of inflation effects on inventory system. *Logistic Spectrum,* 9 (3), 260 –268.

28. Misra, R. B., (1979 – b). A note on optimal inventory management under inflation. *Naval Research Logistics,* 26 (1), 161 – 165.

29. Mitra, A., Cox, J. F. and Jesse, R. R., (1984). A note on determining order quantities with a linear trend in demand. *Journal of the Operational Research Society,* 39, 687 – 692.

30. Monahan, J.P., (1984). A quantity discount-pricing model to increase vendor profits. *Management Sciences,* 30, 720-726.

31. Nahmias (1982) Ouyang, L. Y., Teng, J. T. and Chen, L. H. (2006): Optimal ordering policy for deteriorating items with partial backlogging under permissible delay in payments. *Journal of Global Optimization,* 34, 245 – 271.

32. Ouyang, L. Y., Teng, J. T., Goyal, S. K. and Yang, C. T. (2009): An economic order quantity model for deteriorating items with partially permissible delay in payments linked to order quantity. *European Journal of Operational Research,* 194, 418 – 431.

33. Ritchie, E., (1980). Practical inventory replenishment policies for a linear trend in demand followed by a period of steady demand. *Journal of the Operational Research Society,* 31, 605 – 613.

34. Ritchie, E., (1984). The EOQ for linear increasing demand: A simple optimal solution. *Journal of the Operational Research Society,* 35, 949 – 952.

35. Ritchie, E., (1985). Stock replenishment quantities for unbounded linear increasing demand: An interesting consequence of the optimal policy. *Journal of the Operational Research Society,* 36, 737 – 739.

36. Raafat, F., (1991). Survey of literature on continuously deteriorating inventory models. *Journal of the Operational Research Society,* 40, 27 – 37.

37. Sachan, R. S., (1984). On (T, Si) – policy inventory model for determining items with time proportional demand. *Journal of the Operational Research Society,* 35, 1013 – 1019.

38. Sarker, B. R. and Pan, H., (1994). Effects of inflation and time value of money on order quantity and allowable shortage. *International Journal of Production Economics,* 34 (1), 65 – 72.

39. Sarker, B. R., Jamal, A. M. M. and Wang, S., (2000). Supply chain model for perishable products under inflation and permissible delay in payment. *Computers and Operations Research,* 27, 59 – 75.

40. Sarmah, S.P., Acharya, D'Aguilar, S.K., (2006). Buyer vendor coordination models in supply chain management. *European Journal of Operational Research* 175,1–15.

41. Shah, Nita H. (1993a). A lot - size model for exponentially decaying inventory when delay in payments is permissible. *CERO,* 35 (1-2), 1 – 9.

42. Shah, Nita H. (1993b). A probabilistic order level system when delay in payments is permissible. *Journal of the Korean Operations Research and Management Science;* 18 (2), 175 – 183.

43. Shah, Nita H. (1993c). Probabilistic time scheduling model for exponentially decaying inventory when delay in payments is permissible. *International Journal of Production Economics;* 32, 77 – 82.

44. Shah, Nita H. and Shah, Y. K., (2000). Literature survey on inventory models for deteriorating items. *Economic Annals,* 44, 221 – 237.

45. Shah, Nita H., Shah, B. J. and Shah, Y. K., (2003). Present value formulation of economic lot-size model for inventory system with variable deteriorating rate of items. *Modelling, Measurement and Control*, 24 (2), 17-28.

46. Shah, Nita H., Shah, B. J. and Shah, Y. K., (2004). An order-level lot-size model with stock dependent demand for time dependent rate of deterioration of items under permissible delay in payments. *Far East Journal of Theoretical Statistics,* 12 (2), 201 – 220.

47. Shah, N. H., Gor, A. S. and Wee, H. M., (2008). Optimal strategy for an integrated vendor-buyer inventory system for deteriorating items with salvage value. Proceedings of 14th Computing. *The Australian Theory of Symposium (CATS),* 77, 63-68.