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A STUDY OF INVENTORY PROBLEM USING STOCK DEPENDENT DEMAND

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ABSTRACT: This paper presents an inventory model for a single item where the demand rate is stock-dependent. Three fixed costs are considered in the model is purchasing cost, ordering cost and holding cost. A new approach focused on maximizing the return on investment (ROI) is used to determine the optimal policy. It is proved that maximizing profitability is equivalent to minimizing the average inventory cost per item. The optimal policy for minimizing the inventory cost per unit time is also obtained with a zero-order point, but the optimal lot size is different. Both solutions are not equal to the one that provides the maximum profit per unit time. The optimal lot size for the maximum ROI policy does not change if the purchasing cost or the selling price vary. A sensitivity analysis for the optimal values regarding the initial parameters is performed by using partial derivatives. Some useful managerial insights are deduced for decision-makers. Numerical examples are solved to illustrate the obtained results on the Inventory Model with Stock-Dependent Demand Rate and Maximization of the Return on Investment in fuzzy environment.

INDEX TERMS: EOQ models; return on investment maximization; stock-dependent demand rate; minimizing average inventory cost per item, fuzzy trapezoidal numbers.

1.Introduction: Inventory control is also called stock control and it is the process of ensuring the right amount of supply is available in an organization. The company can meet customer demand and delivers financial elasticity with the support of appropriate internal and production controls. Inventory control enables the maximum amount of profit from the least amount of investment in stock without affecting customer satisfaction. Inventory control can help avoid problems, such as out-of-stock (stock out) events.

For example, Walmart estimated it missed out on $3 billion worth of sales in 2014 because its inadequate inventory control procedures led to stock outs. The Successful inventory control requires data from purchases, reorders, shipping, warehousing, storage, receiving, customer satisfaction, loss prevention and turnover. Warehouse management also squarely falls into the arena of stock control. This process includes integrating product coding, reorder points and reports, all product details, inventory lists and counts and methods for selling or storing. Warehouse management then synchronizes sales and purchases to the stock on hand.

Inventory control regulates what is already in the warehouse. Inventory management is broader and regulates everything from what is in the warehouse to how a business gets the product there and the item's final destination.

Stock dependent demand is known as Dependent demand is the demand for component parts, raw materials or sub-assemblies. This demand does not occur until there is demand for a parent item which is typically a product. Dependent demand is usually calculated through a material requirements planning system.

For example, when a manufacturing company is producing electric golf carts, dependent demand consists of the production processes to construct the tires, motor, seats, steering wheel, controls, and frame of on the other hand many golf carts are scheduled for production. Thus, if 100 golf carts are scheduled for production then the associated dependent demand includes 400 tires and 100 motors. In this case, the dependent demand for electric motors is based on a known factor, which is the number of golf carts to be manufactured. This allows the procurement department to reliably place orders with suppliers for 400 tires and 100 motors.

Return on Investment maximization in inventory control refers to the goal of optimizing the allocation of resources in order to achieve the highest possible return on investment within an inventory management. It involves applying mathematical models and techniques to make informed decisions regarding inventory levels, ordering policies and other related factors.

Inventory control is the possible effect of the inventory level on the demand has been recognized and studied by some researchers. As a starting point, Wolfe [**1**] showed empirical evidence that sales of style merchandise are almost proportional to the displayed inventory. In addition, the book by Levin et al. [**2**] mentioned that the presence of inventory has a motivational effect, evidence by the issue that large piles of goods displayed in a supermarket will lead the customers to buy more. Later, Silver and Peterson [**3**] confirmed the results obtained by Wolfe that sales at the retail level tend to be directly proportional to the displayed stock. Larson and DeMarais [**4**] investigated the impact of displayed inventory on sales for four health and beauty items and offered possible explanations for the effect of stock level on demand. They introduced the term "psychic shock" to refer to the reasons for this effect. Achabal et al. [**5**] provided empirical evidence that displayed inventory increases the demand of goods. The adventage of using a stock-dependent demand was highlighted by Balakrishnan et al. [**6**].

In addition, Koschat [**7**] analyzed a real case in the magazine industry, proving that demand can indeed vary with inventory level. Thus, an inventory drop for one brand leads to a decrease of demand for that brand and in an increase of demand for a competing brand. Next, we present a revision of the literature on inventory models with this type of demand.

Baker and Urban [**8**] developed a first deterministic inventory system for a stock-dependent demand rate. Padmanabhan and Vrat [**9**] analyzed an inventory system for deteriorating multi-items with stock-dependent demand. Datta and Pal [**10**] established the optimal inventory policy for a system where the demand rate is constant if the inventory level is less than a given level, and this rate depends on the instantaneous inventory level when it is greater than that given level. Later, Urban [**11**] relaxed the condition of zero-inventory at the end of the inventory cycle considered by Datta and Pal [**10**]. The model of Baker and Urban [**8**] was generalized by Pal et al. [**12**] for items with a constant deterioration rate. Giri et al. [**13**] also extended the inventory model of Urban [**11**] in the same way. Giri and Chaudhuri [**14**] developed the economic order quantity model for stock-dependent demand considering a non-linear holding cost. Datta and Paul [**15**] studied a multi-period inventory system where the demand rate is stock-dependent and sensitive to the selling price. Ouyang [**16**] introduced a model with stock-dependent demand for deteriorating items under conditions of inflation and time-value of money, considering the present value of the total inventory cost as the objective function. Chang [**17**] analyzed an inventory model with non-linear holding cost, where the demand rate depended on the stock level. Later, Pando et al. [**18**,**19**,**20**] considered three models with maximization of the profit per unit time and stock-dependent demand, where the holding cost was non-linear on time, on the stock level or, even more, on both quantities. Yang [**21**] presented an inventory model where the demand rate and the holding cost rate are stock-dependent, and partially backlogged shortages. Annadurai and Uthayakumar [**22**] described a lot-sizing model for deteriorating items with stock-dependent demand, partially backordered shortages and delay in payments. In the same line, Choudhury et al. [**23**] analyzed an inventory system with shortages and time-varying holding costs.

In all the aforesaid works, the objective was either to minimize the total cost related to the administration of the inventory or to maximize the profit or gain obtained with the sale of the items. The comparison between these two alternatives leads to observe that the solution of the minimum inventory cost carries a low profit, while the maximum profit solution carries high inventory costs. In view of this, perhaps the inventory manager may prefer a solution that provides a high profit without greatly increasing the total cost invested in the inventory. Then, the maximization of the ratio between the profit and the total cost of the inventory system, i.e., the return on investment (ROI), could be more interesting. Indeed, if the inventory manager can invest in different products, it would seem reasonable to select the aim that provides a higher return on investment. This is the approach used in this paper.

In the literature on inventory models, there are several papers dedicated to analyzing inventory systems with the maximization of return on investment. Thus, one of the first attempts in adapting the EOQ model to the objective of ROI maximization was made by Raymond [**24**]. Schroeder and Krishnan [**25**] studied an inventory system with the aim of return on investment maximization. They also enumerate the conditions under which ROI is an appropriate criterion and contrast it to the traditional cost minimization and profit maximization criteria. Morse and Scheiner [**26**] analyzed cost minimization, return on investment (ROI) and residual income as alternative criteria and investment measuring for inventory models. Arcelus and Srinivasan [**27**] proposed an economic ordering quantity model for items with price-dependent demand, in which the goal was to find the lot size and the selling price that maximize the return on the funds tied up in inventory. Later, Arcelus and Srinivasan [**28**] developed efficient policies for inventory systems with price-dependent demand under various optimizing criteria. In addition, Giri [**29**] studied a stochastic inventory model with price-dependent demand where the goal is to maximize the expected utility of the net present value of the earnings over an infinite planning horizon. Jordan [**30**] presented a comparative study of the effectiveness of several dynamic lot-sizing methods with respect to return on investment. Rosenberg [**31**] analyzed and compared the criteria profit maximization and return on investment maximization, considering logarithmic demand functions. In addition, Calderón-Rossell [**32**] studied the relationship between the internal rate of return and the return on investment as criteria for evaluating the profitability of an investment.

The maximization of the return on investment in an EOQ model was also considered by Trietsch [**33**]. He devised the term ROQ to denote the ROI-maximizing solution and proved that ROQ is bounded from above by the EOQ formula. Otake et al. [**34**] and Otake and Min [**35**] also studied inventory and investment in quality improvement policies to maximize return on investment. Li et al. [**36**] analyzed a return on investment (ROI) maximization model in an inventory with capital investment in setup and quality operations.

However, to the best of our knowledge, stochastic inventory models whose objective is the maximization of the return on investment have not been analyzed in the literature on inventory. Therefore, we have not addressed this issue, and we propose it as a possible research line in the future.

In this work, the optimal inventory policy for a system with stock-dependent demand rate is analyzed, where the aim is the maximization of the return on investment. Taking into account the total cost and the profit (calculated as the difference between revenue and cost) obtained in the inventory, the objective is to determine the optimal inventory policy that maximizes the ratio profit/cost. Even more, the optimal solution which minimizes the inventory cost per unit time for the system is also examined. In such a way, the comparison between both optimal solutions allows us to analyze the likeness and the differences between the maximum return on investment policy and the classical policy of minimum cost per unit time that has been mostly used in the inventory theory.

To illustrate the similarities and differences between the model analyzed in this paper and the cited publications with a bigger link to this work and classification of these papers according to the type of demand, the structure of the holding cost and the studied objective. As in this paper can see, the model analyzed only one with stock-dependent demand rate which compares the problems of maximum ROI and minimum cost per unit time. The two approaches could be interesting. For example, non-profit inventory systems, where the goal is not to make a profit but to provide a service to customers (for example, inventory systems for humanitarian aids items), may prefer to minimize the inventory cost per unit time. On the other hand, if the objective is to obtain a profit with the lowest amount of money, the solution with the maximum return investment will be preferred. The comparison between both policies could get out interesting highlights in the inventory management.

The paper is as follows In **Section1** follows about introduction about an inventory and literature about stock dependent. In **Section 2,** the statement of the model is proposed, after setting the notation and the basic assumptions. The **Section 3** have some properties are discussed and the ROI optimal solution is provided. In addition, the optimal policy that minimizes the inventory cost per unit time is determined and the differences between both solutions are commented. **Section 4** presents Fuzzy Inventory Method Using New Representation Trapezoidal Fuzzy Numbers a sensitivity analysis for the optimal order quantity and the maximum return on investment regarding the input parameters of the system. In **Section 5**, numerical examples are presented to illustrate the theoretical results. Finally, the conclusions are determined and future research lines are addressed in **Section 6**.

2. MODEL STATEMENT

The inventory system considered in this paper is designed for a single item with an infinite planning horizon. A continuous review of inventory is supposed, considering instantaneous replenishment and shortages are not allowed. The unit purchasing cost P and the unit selling price v are fixed parameters. The ordering cost per order K, and the holding cost per unit and per unit time h, are also fixed parameters.

An interesting property of this demand function is that the replenishment of the inventory before the stock is depleted leads to an increase in the demand rate, and therefore an increase in sales revenue. Then, the higher ordering and holding cost could offset and the profit could be improved.

The EOQ(Economic Order Quantity) model is a widely used inventory management technique that helps determine the optimal order quantity to minimize total inventory costs. The methodology of EOQ model involves the following steps:

1. Demand Analysis: It Analyze historical data or forecast future demand to determine the average demand rate for the item in question. This typically involves analyzing sales data, customer orders or market research.
2. Ordering Cost: Identify and quantify the costs associated with placing and order for the item. These costs may include administrative costs, transportation costs, order processing costs, or any other expenses incurred when replenishing inventory.
3. Holding Cost: Determine the costs associated with holding or carrying inventory over a specific period. Holding costs often include costs of storage, insurance, obsolescence and opportunity costs of typing up capital.

4. Lead Time: Determine the lead time required for replenishing the inventory. Lead time is the time interval between placing an order and receiving it.
5. EOQ Calculation: Use the following formula to calculate the Economic Order Quantity(EOQ) is EOQ=sqrt[(2*Annual Demand*Ordering Cost)/Holding Cost]
   The EOQ formula finds the order quantity that minimizes the total costs by balancing the ordering costs and holding costs.
6. Reorder Point: Reorder point is the inventory level at which a new order should be placed to avoid stockouts during the lead time. The reorder point is calculated using the following formula:
   Reorder Point=(Average Demand Per Day)*(Lead Time in Days)
   Here the reorder point ensures that the new order arrives just in time to replenish the inventory before it reaches zero.
7. Safety Stock: Consider adding safety stock to the reorder point to account for uncertainties in demand and lead time. Safety stock acts as a buffer to prevent stockouts during unexpected fluctuations in demand or longer-than-expected lead times.

The EOQ model provides a methodology for determining the optimal order quantity and maintaining efficient inventory levels while minimizing costs. It helps strike a balance between carrying excess inventory and placing frequent small orders.

3. SENSITIVITY ANALYSIS

In this section defined Existing Representation of Trapezoidal Fuzzy Numbers
Different representations of trapezoidal fuzzy numbers are presented. Also average for the representation of trapezoidal fuzzy numbers defined.

3.1 GENERAL REPRESENTATION OF TRAPEZOIDAL FUZZY NUMBERS WITH MEMBERSHIP FUNCTION

A fuzzy number $\tilde{A}=(a,b,c,d)$ where a ≥ b ≥ c ≥ d is said to be a trapezoidal fuzzy number if its membership function is given by

$$\mu_{\tilde{A}}(x)=\begin{cases}0, & \text{if } -\infty < x \le a \\ \dfrac{x-a}{b-a}, & \text{if } a < x \le b \\ 1, & \text{if } b < x \le c \\ \dfrac{d-x}{d-c}, & \text{if } c < x \le d \\ 0, & \text{if } d < x < \infty \end{cases}$$

A trapezoidal fuzzy number $\tilde{A}=(a,b,c,d)$ is said to be zero trapezoidal fuzzy number iff $a=0, b=0, c=0, d=0$. A trapezoidal fuzzy number $\tilde{A}=(a,b,c,d)$ is said to be non-negative trapezoidal fuzzy number iff $a \ge 0$. Two trapezoidal fuzzy numbers $\tilde{A}=(a_1,b_1,c_1,d_1)$ and $\tilde{B}=(a_2,b_2,c_2,d_2)$ are said to be equal i.e., $\tilde{A}=\tilde{B}$ iff $a_1=a_2, b_1=b_2, c_1=c_2, d_1=d_2$.

Example :Let $\tilde{A}=(2,2,5,8)$ be a fuzzy number and its membership function is can be written as

$$\mu_{\tilde{A}}(x)=\begin{cases}0, & \text{if } -\infty < x \le 2 \\ \dfrac{x-2}{2-2}, & \text{if } 2 < x \le 2 \\ 1, & \text{if } 2 < x \le 5 \\ \dfrac{8-x}{8-5}, & \text{if } 5 < x \le 8 \\ 0, & \text{if } 8 < x < \infty \end{cases}$$

3.2 (m,n,α,β) REPRESENTATION OF TRAPEZOIDAL FUZZY NUMBERS WITH MEMBERSHIP FUNCTION

A trapezoidal fuzzy number $\tilde{A}=(a,b,c,d)$, defined in the section 2.2.1, may also be represented as $\tilde{A}=(m,n,\alpha,\beta)$, where $m=b,\ n=c,\ \alpha=b-a,\ \beta=d-c.$

A fuzzy number $\tilde{A}=(m,n,\alpha,\beta)$ is said to be a trapezoidal fuzzy number if its membership function is given by

$$\mu_{\tilde{A}}(x)=\begin{cases}0, & \text{if } -\infty<x\le m-\alpha\\ 1+\dfrac{m-x}{\alpha}, & \text{if } m-\alpha<x\le m\\ 1, & \text{if } m<x\le n\\ \dfrac{n-x}{\beta}+1, & \text{if } n<x\le n+\beta\\ 0, & \text{if } n+\beta<x<\infty.\end{cases} \qquad \text{where} \quad \alpha,\beta\ge 0.$$

A trapezoidal fuzzy number $\tilde{A}=(m,n,\alpha,\beta)$ is said to be zero trapezoidal fuzzy number iff $m=0, n=0, \alpha=0, \beta=0.$

A trapezoidal fuzzy number $\tilde{A}=(m,n,\alpha,\beta)$ is said to be non-negative trapezoidal fuzzy number iff $m-\alpha\ge 0.$

Two trapezoidal fuzzy numbers $\tilde{A}=(m_1,n_1,\alpha_1,\beta_1)$ and $\tilde{B}=(m_2,n_2,\alpha_2,\beta_2)$ are said to be equal i.e., $\tilde{A}=\tilde{B}$ iff $m_1=m_2, n_1=n_2, \alpha_1=\alpha_2, \beta_1=\beta_2.$

Example: Let $\tilde{A}$ =(2,5,0,3) be a fuzzy number of (m,n,α,β) type and its membership function can be written as

$$\mu_{\tilde{A}}(x)=\begin{cases}0, & \text{if } -\infty<x\le 2\\ 1+\dfrac{2-x}{0}, & \text{if } 2<x\le 2\\ 1, & \text{if } 2<x\le 5\\ \dfrac{5-x}{3}+1, & \text{if } 5<x\le 8\\ 0, & \text{if } 8<x<\infty.\end{cases}$$

Let two trapezoidal fuzzy numbers be $\tilde{A}$ =(1,1,2,2) and $\tilde{B}$ =(1,1,2,2)

Here, both $\tilde{A}$ and $\tilde{B}$ are equal trapezoidal fuzzy numbers.

3.3 AVERAGE AND RANKING FUNCTION FOR TRAPEZOIDAL FUZZY NUMBERS

Average and Ranking Function is the most important to compare the fuzzy numbers to our approach.
$\Re$:F(R)→R, where F(R) is a set of fuzzy numbers defined on set of real numbers, which maps each fuzzy number into the real line, where a natural order exists.

Let (a,b,c,d) be a trapezoidal fuzzy number then Avg $(a,b,c,d)=\dfrac{a+b+c+d}{4}$.

Let (m,n,α,β) be a trapezoidal fuzzy number then $\Re(m,n,\alpha,\beta)=\dfrac{m+n}{2}+\dfrac{\beta-\alpha}{4}$.

Example:

Let $\tilde{A}$ =(2,2,5,8) be a trapezoidal fuzzy number then A($\tilde{A}$) = A $(a,b,c,d)=\dfrac{a+b+c+d}{4}$

$\therefore\Re(\tilde{A})=\dfrac{17}{4}=4.25$

Let $\tilde{A}$ =(2,5,0,3) be a trapezoidal fuzzy number then $\Re(\tilde{A})=\Re(m,n,\alpha,\beta)=\dfrac{m+n}{2}+\dfrac{\beta-\alpha}{4}$.

$\therefore\Re(\tilde{A})=\dfrac{7}{2}+\dfrac{3}{4}$=3.5+0.75=4.25

4. FUZZY INVENTORY METHOD USING NEW REPRESENTATION TRAPEZOIDAL FUZZY NUMBERS

In this section, a new method is proposed to find the fuzzy optimal solution of Fuzzy Inventory method problems. The steps of the method are as follows

Step 1: Represent all the parameters of Fuzzy Inventory model problems by a particular type of trapezoidal fuzzy number and formulate the given problem, as proposed in the section 3;
Step 2: Convert the fuzzy objective function into the crisp objective function form by using appropriate average and ranking formula.
Step 3: Convert all the fuzzy constraints and restrictions into the crisp constraints and restrictions by using the arithmetic operation.
Step 4: Find the optimal solution of obtained crisp inventory model problem by using Excel software.
Step 5: Use the crisp optimal solution in Step4 and find the fuzzy optimal solution.
Step 6: Find the fuzzy inventory model and corresponding maximum total completion fuzzy time using the fuzzy optimal solution from Step5.

5. NUMERICAL EXAMPLE AND COMPUTATIONAL RESULTS

In this section, numerical examples are used to illustrate the proposed model and the solution methodology. In addition, the changes of the optimal solution regarding the parameters of the model are analyzed.

A small camera maker sells imported electronic flash gun with camera, as an optional camera accessory. Last 6 month's records indicate that the average demand for the flash guns was about (90,100,100,110) units per month, the actual demand varying generally between (60, 70, 70, 80) and (130,140,140,150) units per month. Only thrice had the demand exceeded (130,140,140,150) and was (140,150,150,160), (150,160,160,170) and (170,180,180,190) per month. The camera man, by an agreement with a reliable overseas suppliers, receives (90,100,100,110) guns respectively each month. Calculate the must economic buffer stock the supplier should hold. Assume inventory carrying charges of 20% and the rounded cost of gun as Rs.(190,200,200,210) respectively per unit. In case of excess demand, camera maker purchases extra units from other importers at a premium of Rs.(40,50,50,60) per unit.

5.1: REPRESENTATION OF (A,B,C,D) TYPE AND AVERAGE(a,b,c,d)=(a+b+c+d)/4

To show the advantages of trapezoidal representation over existing representation of fuzzy numbers, the real stock application is solved by using all two representations of fuzzy numbers. The problem is to find the fuzzy inventory models converted into crisp and estimated the buffer stock, maximum stock, inventory carrying cost, stock-out cost and total inventory cost in fuzzy time of the real application in which the fuzzy values (units and cost) are represented by the following (a, b, c, d) type trapezoidal fuzzy numbers.

Using the section 3 and calculated average and ranking values for demand and cost respectively.
D=Avg(90,100,100,110)=100unit, C1(cost of guns)=Avg(190,200,200,210)=Rs.200 and C2(other importer premium cost)= Avg(40,50,50,60)=Rs.50

According to real application problem D= 100 units per month,
C1=Rs.200*20%= Rs 200*0.20 and C2 (cost of shortage)= Rs. 50 per unit

Suppose the camera man decide to keep a buffer stock of Avg(65,75,75,85)=75 units then,
Average inventory level =buffer stock+0.5 Q=75+0.5*100=125 units.

Total average cost for 3 months =Rs.(125*200*0.20)*3=Rs.15,000=Avg(14k,15k,15k,16k)where k=Rs.1000 which is the carrying cost.

Obviously that with a starting stock of 175 units, only once in 3 months would there be a shortage(stock-out) of 5=Avg(0,5,5,10) units (when consumption rate is 180=Avg(170,180,180,190) units per month) and the same is purchased at premium of Rs.50=Rs.Avg(40,50,50,60)
Stock-out cost = 5*Rs.50=Rs.250= Rs.Avg(240,250,250,260)
Total inventory cost = Carrying cost + Stock-out cost
= Rs.15,000+Rs.250
=Rs. 15,250.
=Rs.Avg(14,250,15,250,15,250,16,250)
The total inventory cost for 3 months for different levels of buffer stock is caluculted and which shown in the following table into crisp values and converted the values again into the trapezoidal fuzzy values.

Buffter stock(units)	Maximum stock(BS+Q)	Inventory carrying cost(Rs.)	Stock-out cost(Rs.)	Total inventory cost(Rs.)
75	175	15,000	250	15,250
65	165	13,800	750	14,550
60	160	13,200	1,000	14,200
50	150	12,000	1,500	**13,500**

In the above calculations, observed that the minimum total inventory cost for 3 months is highlighted in table Rs.13,500=Rs.Avg(12,500,13,500,13,500,14,500) and the corresponding the most economic(optimum)buffer stock is around 50 units=Avg(40,50,50,60) units respectively.

5.2 : REPRESENTATION OF (m,n,α,β) TYPE AND RANK(m,n,α,β)=(m+n)/2+(β-α)/4

To show the advantages of trapezoidal representation over existing representation of fuzzy numbers, the real stock application is solved by using all two representations of fuzzy numbers. The problem is to find the fuzzy inventory models converted into crisp and estimated the buffer stock, maximum stock , inventory carrying cost , stock-out cost and total inventory cost in fuzzy time of the real application in which the fuzzy values (units and cost) are represented by the following **(m,n,α,β)** type trapezoidal fuzzy numbers.

Using the section 3 and calculated average and ranking values for demand and cost respectively.
D=Rank(100,100,10,10)=100unit, C1(cost of guns)=Rank(200,200,10,10)=Rs.200 and C2(other importer premium cost)= Rank(50,50,10,10)=Rs.50

According to real application problem D= 100 units per month,
C1=Rs.200*20%= Rs 200*0.20 and C2 (cost of shortage) = Rs.50 per unit

Suppose the camera man decide to keep a buffer stock of Rank (65, 75, 75, 85) =75 units then,
Average inventory level =buffer stock+0.5 Q=75+0.5*105=125units.

Total average cost for 3 months =Rs.(125*200*0.20)*3=Rs.15,000 and Rank(15k,15k,1k,1k)=15,000 where k=Rs.1000 which is the carrying cost.

Obviously that with a starting stock of 175 units, only once in 3 months would there be a shortage(stock-out) of 5=Rank(5,5,5,5) units (when consumption rate is 180=Rank(180,180,10,10) units per month) and the same is purchased at premium of Rs.50=Rs.Rank(50,50,10,10)

Stock-out cost = 5*Rs.50=Rs.250= Rs. Rank(250,250,10,10)
Total inventory cost = Carrying cost + Stock-out cost
= Rs.15,000+Rs.250
=Rs. 15,250.
=Rs. Rank(15250,15250,1000,1000

The total inventory cost for 3 months for different levels of buffer stock is calculated and which shown in the following table into crisp values and converted the values again into the trapezoidal fuzzy values.

TABLE: CALCULATION MAXIMUM,INVENTORT,STOCK-OUT,TOTAL INVENTORY

Buffer stock(units)	Maximum stock(BS+Q)	Inventory carrying cost(Rs.)	Stock-out cost(Rs.)	Total inventory cost(Rs.)
75	175	15,000	250	15,250
65	165	13,800	750	14,550
60	160	13,200	1,000	14,200
50	150	12,000	1,500	**13,500**

In the above calculations, observed that the minimum total inventory cost for 3 months is highlighted in table Rs.13,500=Rs. Rank(13500,13500,1000,1000) and the corresponding the most economic(optimum)buffer stock is around 50 units=Rank(50,50,10,10) units respectively.

6. **CONCLUSION**: In the real application is showing the result as when the buffer stock maintained is very low, the inventory holding cost would be low but shortages will occur very frequently and the cost of shortages would be very high. Conversely, the buffer maintained is rather large, shortages would be rather rare, resulting into low shortage costs but the inventory cost would be high. It conclude that i.e. it becomes necessary to strike balance between the cost of shortages and cost of inventory holding to appear at an optimum buffer stock which is reserve stock.

The trapezoidal representation (a,b,c,d) type with average and (m,n,α,β) type with rank formula exist are same result. It can be useful for further research models of inventory stock level with different companies assumptions or control systems models etc.

This work is partially supported by the literature and basic concepts of inventory of stock dependent model with trapezoidal fuzzy number converted as a crisp number using ranking function and calculated the lead time with cost analysis and conclusion by data disclosure for the calculated example.

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