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Concept of Joint Venture Company is an Easy Approach in Minimizing Inventory Cost in Production Management

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Abstract. Production management discusses how a firm gains maximum profit and ultimately earns business success by minimizing the production cost. Joint venture company in this regard has an important role to play. This paper elaborates this concept mathematically by using few models. The concept has been designed by reducing purchasing, set-up and shortage cost except holding cost. The holding cost little increases as the space required for joint venture company is little more, but the overall inventory cost could be reduced significantly. To get the optimum result Probabilistic Economic Order Quantity Review Model is used in this article mathematically firstly for two separate companies and finally for the joint venture company merging these two.

Keywords: Inventory, Economic Order Quantity (EOQ), Probabilistic Review Model, Iterative Method and Buffer Stock.

1. Introduction

By managing production process and supply chain smoothly a firm can reaches its goal by reducing the cost, especially the inventory cost in a planned way. One of the most important aspects of managing the production process is to have the items in stock at the moment those are needed, which helps the managerial key personnel to minimize the inventory cost. To minimize the inventory cost, Project management needs to plan carefully so as to earn maximum profit by using minimum cost [11]. The paper explores and explains how managements look after their inventories to gain minimum production cost and ultimately earn business success by merging few separate companies into a joint venture company. Concept of Joint Venture Company may open the insight of managerial key personnel in minimizing the inventory cost. If we go for a joint venture company merging few companies together we can very well reduce the total inventory cost which I shall explain mathematically in the paper subsequently.

2. A generalized inventory model

The objective of any inventory model is expressed in terms of optimum order quantity. If the system is based on periodic review at equal time interval, the time for acquiring a new order usually coincides with the beginning of each time interval. On the other hand, if the system is of the continuous review type, a reorder point is usually specified by the inventory level at which a new order must be placed. In this model, the total inventory cost includes the purchasing, setup holding and the shortage cost. The setup cost represents the fixed charge incurred when an order is placed. Thus, to satisfy the demand for a given time period, the (more frequent) ordering of smaller quantities will result in a higher setup cost during the period than if the demand is satisfied by placing larger (and hence less frequent) orders. The holding cost represents the costs of carrying inventory in stock. The shortage cost is a penalty incurred when it runs out of stock of a needed commodity. The purchasing cost is the cost for purchasing raw materials, if the firm produces the items.

3. Probabilistic continuous EOQ review model and its mathematical explanation

In this model the stock is reviewed continuously and an order of size y is placed every time the stock level reaches a certain reorder point R. The aim is to determine the optimum values of y and R that minimize the total expected inventory costs per unit time. Normally in this model, one year represents a unit of time. The model may be explained as below [15]:

Let, f(x) = Demand x, during lead time, $x > 0$.
D = Expected demand per unit time.
H = Holding cost per inventory unit per unit time.
P = Shortage cost per inventory unit (or penalty cost).
K = Setup cost per order.

Applying the EOQ Model, the total annual inventory cost (except purchasing cost),

TAC(y, R) = setup cost + holding cost+ shortage cost.

$$\text{Therefore, TAC (y, R)} = \frac{Dk}{y} + h\left(\frac{y}{2} + R - E\{x\}\right) + p\frac{Ds}{y}.$$

Differentiating the equation and applying the formula of Hadley and Whitin (1963) we get,

$$y^* = \sqrt{\frac{2D(K+ps)}{h}} \text{ and } \int_{R^*}^{\infty} f(x)\,dx = \frac{hy^*}{PD} \tag{1}$$

An explicit general solution for y* and R* is not possible in this case. A convenient numerical iterative method is then used to solve the equations, which ultimately gives,

$$y^* = \hat{y} = \sqrt{\frac{2D(K + pE(x))}{h}} \text{ and } y^* = \bar{y} = \frac{pD}{h} \tag{2}$$

It can be proved[6] that, if $\bar{y} \geq \hat{y}$, the optimal values of y and R exist and are unique. In such a case these values are computed as the first trial value of y* as $y_1 = \sqrt{2DK/h}$. After having the required iterations at this point, we get the values of y (y*)and R (R*) [12].

$$\hat{y} = \sqrt{\left(\frac{2\times 3{,}70{,}000(13{,}000 + 20\times 1{,}500)}{570}\right)} = 7471.584$$

$$\bar{y} = \frac{20\times 3{,}70{,}000}{570} = 12{,}982.456 \tag{3}$$

Since, $\bar{y} \geq \hat{y}$, it has a solution and that is unique.

4. First company (separately)

A company has a demand of 1,20,000 T Shirts per year where, holding cost per unit per year is 400 Taka, set up cost per order is 6,000 taka and shortage cost per unit per year is 15 taka. Demand at lead time varies over (0, 1000), from previous historical data buffer stock is maintained as of 500 pieces and purchasing cost for raw material is @ 18 taka per shirt piece. We are going to calculate the total inventory cost of the company. Here we get, Expected total demand D = 1,20,000 pieces, Set up cost per order K= 6,000 taka, Shortage cost per unit P = 15 taka, Holding cost per unit per year h = 400 taka, Demand at lead time varies over (0, 1000). Therefore f(x) = 1/1000, Buffer stock E(x) = 500 pieces, Hence, the Purchasing Cost (@ 18 taka per shirt piece raw material) PC = 1,20,000x 18 taka = 21,60,000 taka. Now from the equation (1), (2) and (3) we get,

$$\hat{y} = \sqrt{\left(\frac{2\times 1{,}20{,}000(6{,}000+15\times 500)}{400}\right)} = 2{,}509.98$$

$$\bar{y} = \frac{PD}{h} = \frac{15\times 1{,}20{,}000}{400} = 4500$$

Since, $\bar{y} \geq \hat{y}$, it has a solution and that is unique [14].

Now from the three equations we get,

$$\int_{R^{**}}^{\infty} f(x)\, dx = \frac{hy^*}{PD} \quad \text{which gives us} \quad \int_{R^*}^{1000} \frac{1}{1000}\, dx = \frac{400\times y^*}{15\times 1{,}20{,}000}$$

Therefore, $R^* = 2000 - \dfrac{y^*}{4.464}$

After the successive uses of the iterations we have, $R^* \cong 522.491$ and $Y^* \cong 2150.828$.

Now, we get all other components as set up cost $\dfrac{DK}{Y}$ = 3,34,754.801 taka, holding cost $h\left(\dfrac{Y}{2}+R-E\{x\}\right)$ = 4,39,162 taka, shortage cost $\dfrac{PDS}{Y}$ = 95,410.978 taka.

Therefore the total inventory cost,

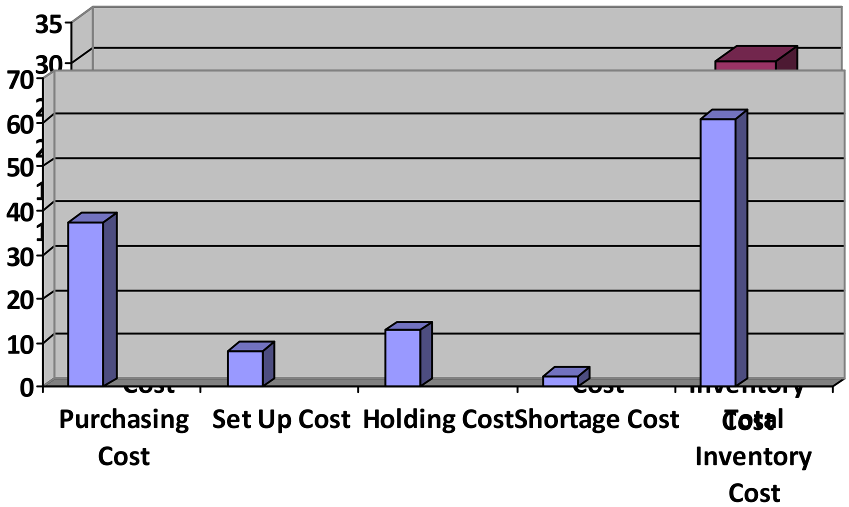
TAC (y, R) = purchasing cost + Set up cost + Holding cost + Shortage cost.

$$= PC + \frac{DK}{Y} + h\left(\frac{Y}{2}+R-E\{x\}\right) + \frac{PDS}{Y}$$

= (21,60,000+ 3,34,754.801+ 4,39,162+ 95,410.978)taka = 30,29,327.779 taka.

In the figure below, the vertical axis indicates in lac (1 lac = 0.1 milion) taka (i.e, 1 unit = 0.1 milion taka) and the horizontal axis indicate the type of costs.

Second company (separately)



Another company has a demand of 2,50,000 pieces of T Shirts per year where, holding cost per unit per year is 700 Taka, set up cost per order is 10,000 Taka and shortage cost per unit per year is 25 Taka. Demand at lead time varies over (0, 2000), from previous historical data buffer stock is maintained as of 1000 no and purchasing cost for raw material is @ 15 taka per shirt piece. We are going to calculate the total inventory cost of the company. Here we get, the Purchasing Cost (@ 15 taka per shirt piece raw material) PC = 2,50,000x 15 taka = 37,50,000 taka. Considering all other data as stated we get, $R^* \cong 1320.536$ and $Y^* \cong 3033.127$, which ultimately gives as set up cost $\frac{DK}{Y}$ = 8,24,231.890 taka, holding cost $h\left(\frac{Y}{2}+R-E\{x\}\right)$ = 12,85,969.65 taka, shortage cost $\frac{PDS}{Y}$ = 2,37,362.300 taka. Therefore the total inventory cost, TAC (y, R) = PC $+\frac{DK}{Y}+h\left(\frac{Y}{2}+R-E\{x\}\right)+\frac{PDS}{Y}$ = 60,97,563.84 taka.

In the figure below, the vertical axis indicates in lac (1 lac = 0.1 milion) taka (i.e. 1 unit = 1 lac taka) and the horizontal axis indicate the type of costs. Hence, the total inventory cost for these two separate companies together is = (30,29,327.779 taka + 60,97,563.840 taka) = 91,26,891.619 taka.

5. Joint venture company (combining the two companies)

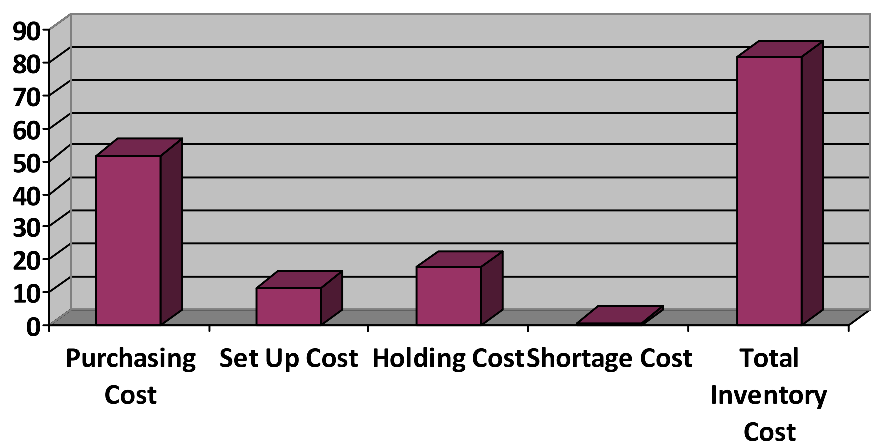
If we go for a joint venture company merging few companies together we can very well reduce the total inventory cost which is explained in this paper. Expected total demand of the joint venture company may then become summation of that of the companies, since demand remains same in the market and which does not affect the joint venture company. Set up cost will be little lesser than the summation of that of those two companies, but little more than that of the big (second) company, since set up cost of one company will support the other mutually. Shortage cost and holding cost will be amidst of the same cost of the two companies respectively, because of mutual support to each other. Demand at lead time will be lesser than any of the two companies; buffer stock may be maintained between that of big company and the summation of that of the two companies. Here as per above discussion we get, expected total demand D = 1,20,000+2,50,000 = 3,70,000 pieces, set up cost per order K= 13, 000 taka, shortage cost per unit P = 20 taka, holding cost per unit per year h = 570 taka, demand at lead time varies over (0, 3000), Therefore, f(x) = 1/3000, buffer stock E(x) = 1500 no and purchasing Cost (@ 14 taka per shirt piece raw material) PC = 3,70,000x 14 taka = 51,80,000 taka. Applying the formula as stated above we get, $R^* \cong$ 2,511.059 and $Y^* \cong$ 4,232.230 and set up Cost $\frac{DK}{Y}$ = 11,36,516.683 taka, holding cost $h\left(\frac{Y}{2}+R-E\{x\}\right)$ = 17,82,489.18 taka and shortage cost $\frac{PDS}{Y}$ = 69,668.473 taka. Now the total inventory cost,

TAC (y, R) = purchasing cost + Set up cost + Holding cost + Shortage cost.

$$= \text{PC} + \frac{DK}{Y} + h\left(\frac{Y}{2}+R-E\{x\}\right) + \frac{PDS}{Y}$$

= (51,80,00+ 11,36,516.68 +17,82,489.18 + 69,668.47)taka = 81,68,674.34 taka.

Therefore, the total inventory cost for Joint Venture Company is 81,68,674.34 taka. The costs of Joint Venture Company are shown in the figure below, where the figure in the vertical axis indicates in lac (1 lac = 0.1 milion) taka (i.e. 1 unit = 1 lac taka) and the horizontal axis indicates the type of costs. Analyzing all the costs related to inventory from the above companies we observe that in the case of Joint Venture Company the cost reduces considerably, which is explained below:



Here we also observe that only holding cost is little increased because of order quantity. Order quantity is little more in the joint venture company in relation with separate company, which takes more space in the premises and that ultimately increases rent, clerical, overheads, labor cost etc.

6. Result analysis

Analyzing the results, we observe that purchasing cost is reduced by 7,30,000 taka, setup cost is reduced by 22,470.01 taka, holding cost is increased by 57,357.53 taka and shortage cost is reduced by 2,63,104.81 taka in the joint venture company than the separate company.

7. Conclusion

By mathematical process of finding the minimum value of function and using iterative method the paper could easily find the solution quickly, which in turns proved that a joint venture company reduced its inventory cost significantly in the probabilistic continuous EOQ review model. To get its optimum level the paper also considered that "how much to order" and "when to order" correctly. Where the separate companies spend huge amount of inventory costs, the joint venture company saves this cost considerably as much as 10% of total cost.

REFERENCES

8. S.I.Ukil, M.M.Ahmed, S.Sultana and M.S.Uddin, Effect on probabilistic continuous EOQ review model after applying third party logistics, *J. of Mech. of Cont and Math Sci*, 9(2) (2015) 1385-1395.
9. S.I.Ukil, M.M.Ahmed, M.S.A.Jaglul, N.Sultana and M.S.Uddin, An analysis of just in time manufacturing technique used in probabilistic continuous economic order quantity review model, A*nnals of Pure and Applied Mathematics,* 9(2) (2015) 145-150.
10. S.Chakrabortty, M.Pal and P.K.Nayak, Intuitionist fuzzy optimization technique for pare to optimal solution of manufacturing inventory models with shortages, *European Journal of Operational Research*, 228 (2013) 381-387.
11. B.Sarkar, S.S.Sana and K.Chaudhuri, An inventory model with finite replenishment rate, trade credit policy and price-discount offer, *Journal of Industrial Engineering*, (2013) 18 pages.
12. S.Chakraborty, M.Pal and P.K.Nayak, Solution of interval-valued manufacturing inventory models with shortages, *Int. Journal of Engineering and Physical Sciences*, 4(2) (2010) 96-101.
13. S.Chakraborty, M.Pal and P.K.Nayak, Multisession technique to solve interval-valued purchasing inventory models without shortages, *J. of Information and Computing Science*, 5(3) (2010) 173-182.
14. L.Cheng, C.S.Tsou, M.C.Lee, L.H.Huang, D.Song, and W.S.Teng, Tradeoff analysis for optimal multi objective inventory model, *Journal of Applied Mathematics,* (2013), 8 pages.
15. S.Chakraborty, M.Pal and P.K.Nayak, Intuitionist fuzzy optimization technique for the solution of an EOQ model, *Fifteenth Int. Conf. on IFSs*, Burgas, 11-12 May 2011, *Notes on Intuitionist Fuzzy Sets,* 17(2) (2011) 52-64.

16. S.Chakraborty, M.Pal and P.K.Nayak, An algorithm for solution of an interval valued EOQ model, *Int. J. Optimization and Control: Theories & Applications*, 3(1) (2013) 55-64.
17. Y.F.Huang, C.S.Lai and M.L.Shyu, Retailer's EOQ model with limited storage space under partially permissible delay in payments, *J. for Mathematical Probs. in Engineering,* (2007), 18 pages.
18. F.F.El Dabee and R.A.Hokoma, Just-in-time for reducing inventory costs throughout a supply chafin: a case study, *Journal for World Academy of Science, Engineering and Technology*, 6 (2012).
19. K.E.Stecke, Using Mathematics to Solve Some Problems in Industry, *INFORMS Transactions on Education*, 5(2) (2005).
20. K.K.Ahuja, Production Management, New Delhi, (2006).
21. P.H.Zipkin, Foundations of Inventory Management, International Edition, (2000).
22. P.K.Gupta and D.S.Hira, Introduction to Operations Research, (1995).
23. G.Hadley and T.Whitin, Analysis of Inventory Systems, Prentice Hall, Engle-wood Cliffs, (1963).
24. H.A.Taha, Operations Research: An Introduction, Fifth Edition.