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EFFECT ON PROBABILISTIC CONTINUOUS EOQ REVIEW MODEL AFTER APPLYING THIRD PARTY LOGISTICS

By

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Abstract

This article explains how a company manages its business to gain minimum inventory cost and reaches its business success by using Third Party Logistics. Applying Third Party Logistics the company may put its eyes on its production process and marketing smoothly. Thereby, the inventory cost might be reduced substantially. By applying this technique, mainly it can reduce the clerical cost, security staff cost and depreciation cost among the various costs mentioned in the paper subsequently. And to get the optimum level the party uses its few tools like database software. It also expresses a mathematical framework to understand the performance of the company and put the arguments that inventory cost minimization method is an approach that helps it to be competitive and successful in the business arena. To establish a new model in this paper, Probabilistic Continuous Economic Order Quantity (EOQ) Model is used as a baseline.

Keywords and Phrases: *Inventory, Probabilistic Continuous Economic Order Quantity (EOQ) Review Model, fixed cost, variable cost, holding cost, Third Party Logistics.*

1. Introduction.

Inventory, which is an important ingredient of any business and simply a process and place by 'proper and in time' utilization of an enterprise can save a certain amount of production cost. Unless inventories are controlled, they are unreliable, inefficient and less cost effective. The main objective of stock inventory is to

maintain the production chain by supplying the materials from the inventory as required. As such, the project management planned carefully so as to earn maximum profit by using minimum cost and time. The inventory is usually a largest asset of a company, but at some times the company becomes out of stock. One of the important objectives is then to keep the business operational maintaining its stock as required. In economics, cost minimization is the process by which a firm determines the price and output level that returns the greatest profit [1].

The experience and growth of third party or integrated logistics service deployments are laudable and commended by many corporate companies. The key issues with logistics service providers are low network, competency level, IT enablement and unviable cost. Another issue is the level of information technology enablement. Still this has not been an issue with leading logistic supply provider or third party logistic directly. Another major issue faced by the logistic supply provider is the decision making which is mostly controlled by the customers as they may change their demand from to time. Even fighting against all these factors third party logistics are being introduced in many companies [6]. Advantages of applying this third party logistics upon EOQ Inventory Model is described mathematically in this paper with a view to minimizing inventory cost [5].

2. Inventory Management.

Materials - raw, in process, finished, packaging, spares and others - stocked in order to meet an expected demand or distribution in the future is called inventory. Raw materials needed for the finished product cannot be directly fed to the production department from the market. These have to be stored first after procurement – this store is inventory [2]. A good inventory management system provides information to efficiently manage the flow of materials, effectively utilize people and equipment, coordinate internal activities and communicate with customers. Inventory management does not make decisions or manage operations, but provides information to managers who make more accurate and timely decisions to manage their operations [13].

Thus we can say that the inventory management system must be designed to meet the dictates of market place and support the company's strategic plan. To fight against stockless inventory, inventory management system is developed. And ultimately this process transforms raw materials into finish products. It manages its Production planning and controlling as a department and as a joint effort. Every member has some responsibilities for developing the programme and selling it out. Production management manages her production and inventories skillfully by correct scheduling. Finally, it transforms materials into finish products which are known as manufacturing [7].

3. Inventory Models.

Modeling is a wonderful and mysterious art. It underlies much of science and engineering and hence is a basic element of modern life. It is a mode of thinking about and understanding the world and a mode of problem solving. A good model can be beautiful as well as useful [3]. Inventory models are mainly two types which are Inventory models with deterministic demand and Inventory models with probabilistic demand. These models further categorized into various types. Here, I shall discuss the second model.

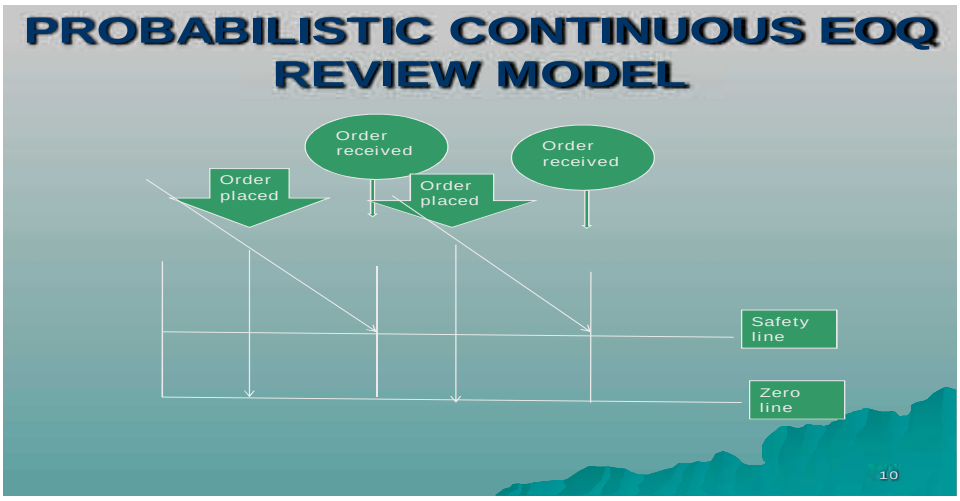
4. Probabilistic Continuous EOQ Review Model.

A probabilistic EOQ (Economic Order Quantity) model is such a model in which the stock is reviewed continuously and an order of size q is placed at each time u, when the stock level reaches a certain reorder point. The objective is to determine the optimum values of q and u that minimize the total expected inventory cost [3]. And in this model total inventory cost is the function of fixed cost, variable cost, purchasing cost and holding cost. The costs are explained below:

a. Fixed Cost (K): This cost includes shipping cost and receiving or clerical cost. The shipping cost again has two components as the rent of trucks and labour cost.

b. the Variable Cost (C): This is the addition of purchasing cost of raw materials and cost related to purchase. This is, in fact, the cost of purchasing raw materials, which occupies almost 70% of its total costs.

c. Holding cost (h): This cost is the function of direct cost related to inventory and financial cost. This cost has various components like warehouse rent, insurance cost, refrigeration cost, labour cost, clerical/ store staffs cost, overhead cost, security staffs cost, maintenance cost, obsolence cost etc.



Picture – Economic Order Quantity (EOQ) Model

5. First Model.

Let us discuss briefly few of the traditional models before I propose a new Model to minimize the inventory cost. Placing the order monthly and using the Generalized EOQ Review Model [8] [11], we now find various costs. Consider, the company puts its order monthly. It fills up the demand also monthly. Hence, demand (λ)= order quantity (q). Let us consider, a firm's eexpected demand/month λ = 10,00,000 pieces which is carried by trucks. Capacity/truck = 8,000 pieces and rent/truck = 15,000 tk. The firm expends 125 tk to buy the raw materials of each piece and other cost related to purchase is 15 tk. Depreciation rate of the company is 8.5 % and the interest rate is 15%.

Thereby, the transportation required (i.e. expected demand is transported by),

= (10,00,000 ÷ 8,000) trucks = 125 trucks/month.

We put, Demand λ in 1 cycle (i.e. in unit time). Then, demand q is put in q/λ cycle. i.e. at q/λ time, 1 order is placed (as demand q = 1 order).

Then at unit time, 1/(q/λ) order is placed. i.e. at unit time, λ/q order is placed. This λ/q is called the order frequency (OF).

Mathematically, $OF = \lim_{t \to \infty} \{1/t\} = \lambda/q$

During a cycle, inventory decreases from q to 0. So its average inventory, i = ½(q+0) = q/2

Let us consider, holding cost per unit = h.

Therefore, the total average inventory holding cost = average inventory x holding cost per unit = hi = ½hq

Fixed cost per order = K and variable cost per unit = C.

Hence, the total variable cost per order = total demand x variable cost per unit = Cq

So, total average cost per order = Fixed cost per order + total variable cost per order = K + Cq.

Hence, long run average order cost = total average cost/order x order frequency = (K + Cq) x λ/q

And holding cost, $h = \hat{h} + \alpha C$, [where, $\hat{h}$ = direct cost related to inventory & αC = financial cost]

Now, the total average inventory cost,

C(q) = average order cost + average inventory holding cost

⇨ C(q) = (K + Cq) x λ/q + ½hq

⇨ C(q) = C λ + K λ/q + ½ hq, which is the EOQ equation.

Hence, The rent of truck = 15,000 x 125 = 18,75,000 tk

Labour cost = (200 x 6) x 125 = 1,50,000 tk, (as each track employs 6 labours each of whom is paid 200 tk per truck and total trucks required 125 for each order.)

And the receiving or clerical cost = 10,000 x 5 tk = 50, 000 tk (as 5 clerks are employed each of whom is paid 10,000 tk per month).

Thereby, Fixed Cost (K) = Rent of Trucks + Labour Cost + Receiving Cost

= 18,75,000 tk + 1,50,000 tk + 50,000 x tk = 20,75,000 tk

Variable Cost (C) = purchasing cost of raw materials + cost related to purchase

= 125 tk + 15 tk = 140 tk

Holding Cost = direct cost related to inventory + financial cost

⇨ $h = \hat{h} + \alpha c$, (where $\hat{h}$ = direct cost related to inventory, α = interest rate and αc = financial cost)

Now we find out the direct cost, $\hat{h}$. $\hat{h}$ includes various costs which are already mentioned before. We consider the components of this cost as below:

$\hat{h}$ = ware house rent (a_1) + insurance cost (a_2) + refrigeration cost (a_3) + labour cost (a_4) + clerical or store staff cost (a_5) + overhead cost (a_6) + security staff cost (a_7) + maintenance cost (a_8) + obsolescence or depreciation cost (a_9).

Finding each cost separately we get,

a. Ware house rent (a_1): Ware house can contain 5,00,000 pieces and its rent per month = 2,50,000 tk. i.e. rent spent for 1 piece = (2,50,000 ÷ 10,00,000) tk = .25 tk.

b. Insurance cost (a_2): Monthly insurance cost = 50,000 tk. i.e. cost for 10,00,000 piece = 50,000 tk. Cost for 1 piece = (50,000 ÷ 10,00,000) tk. = 0.05 tk.

c. Refrigeration cost (a_3): Monthly refrigeration cost = 2,50,000 tk. i.e. cost for 10,00,000 piece =2, 50,000 tk. Cost for 1 piece = (2,50,000 ÷ 10,00,000) tk. = 0.30 tk

d. Labour cost (a_4): Number of total labour = 30. Labour cost per head per day = 500 tk. Total labour cost per month = 500 x 30 x 30 tk. = 4,50,000 tk. i.e. cost for 10,00,000 pieces = 4,50,000 tk. Cost for 1 piece = (4,50,000 ÷ 10,00,000) tk. = 0.45 tk

e. Clerical or store staff cost (a_5): Number of total clerks = 35. Salary for the clerks per head per month = 15,000 tk. Total clerical cost per month = 15,000 x 35 = 5,25,000 tk. i.e. cost of 10,00,000 pieces =5,25,000 tk. Cost for 1 piece per month =(5,25,000 ÷ 10,00,000) = 0.525 tk.

f. Overhead cost (a_6): Overhead cost per month = 4,00,000 tk. i.e. cost of 10,00,000 pieces = 4,00,000 tk. Cost of 1 piece per month = (4,00,000 ÷ 5,00,000) = 0.40 tk.

g. Security staff cost (a_7): Number of total guards = 9. Salary for the staffs per head per month =10,000 tk. Total salary per month = (10,000 x 9) = 90,000 tk. i.e. salary cost for 10,00,000 pieces = 90,000 tk. Salary cost for 1 piece per month = (90,000 ÷ 10,00,000) = 0.09 tk.

h. Maintenance cost (a_8): Maintenance cost per month = 5,00,000 tk. i.e. cost for 10,00,000 pieces = 5,00,000 tk. Cost for 1 piece = (5,00,000 ÷ 10,00,000) = 0.50 tk.

j. Obsolescence or depreciation cost (a_9): Depreciation rate of the company is 8.5 %. i.e. 100 tk cost = 8.5 tk. Therefore 140 tk (cost of 1 piece) costs = (8.5 x 140) ÷100 tk = 11.90 tk.

Now we find the financial cost (αc):

k. Interest rate α = 15 %. i.e. cost for 100 tk per year = 15 tk. Cost for 1 tk per month = 15 ÷ (100 x 12) tk = 0.0125 tk.

l. Variable cost C = 140 tk. Therefore, the financial cost (αc) = (0.0125 x 140) tk = 1.75 tk

Putting all these values the equation $h = \hat{h} + \alpha c$ gives us as below:

⇨ h = (0.25+ 0.05+ 0.25+ 0.45+ 0.525+ 0.40+ 0.09+ 0.50+ 11.90) tk+ 1.75 tk

⇨ h = (14.415 + 1.75) tk = 16.165 tk

Now, the total average inventory cost C(q),

$C(q) = C\lambda + k\lambda/q + \frac{1}{2}hq$

= (140x 10,00,000 +20,75,400 + ½x16.165x 10,00,000) tk, {Considering λ = q, so kλ/q = k as the company puts its order monthly and also monthly demand is calculated}

= 15,01,57,900.00 tk

6. Second Model.

This is the Moderate EOQ Model. In this model, differentiating the equation of previous EOQ Model $C(q) = C\lambda + K\lambda/q + \frac{1}{2}hq$, w.r.t. q and considering C, K & λ as constant we get,

$\acute{C}(q) = -K\lambda/q^2 + \frac{1}{2}h = 0$

Which gives the unique solution of Economic Order Quantity q* & Economic Order Interval u* with the help of theorem of Hadley and Whitin (1963) [12] and those are,

Economic Order Quantity, $q^* = \sqrt{(2k\lambda/h)} = \sqrt{\{(2x\ 20,75,000x\ 10,00,000)/16.165\}}$ = 5,06,683 unit.

Economic Order Interval, $u^* = \sqrt{(2k/\lambda h)} = \sqrt{\{(2x\ 20,75,000)/(10,00,000x\ 16.165)\}}$

= 0.0.5067 months = 15.20 days ≈ 15 days.

Hence, the total average inventory cost, $C^* = C\lambda + \sqrt{(2K\lambda h)}$

= 140x 10,00,000 tk + √(2x20,75,000x 10,00,000x 16.165) tk

= 14,81,90,528.00 tk

which is less than the First Model.

This cost is further reduced by applying the proposed Model with the help of Third Party Logistics.

7. Third Model (Proposed Model).

We are applying Third Party Logistics [9] in this model to reduce the inventory cost. If the company manages its few complicated administrative components by applying a

Third Party Logistics, it may focus on its production process and marketing smoothly. Thereby, the inventory cost might be reduced substantially. By applying Third Party Logistics, mainly we can reduce the clerical cost, security staff cost and depreciation cost among the costs mentioned in the first model. In this model, Third Party uses database software:

a. Clerical Cost. The party will be paid 1,20,000.00 tk per month. i.e. cost of 10,00,000 pieces per month = 1,20,000.00 tk. Clerical cost of 1 piece per month = 0.12 tk. In the EOQ Model this cost was = 0.525 tk.

b. Security Staffs Cost. Third Party will utilize the same guards for few adjacent companies. i.e. the party utilizes 9 (this 9 was calculated in EOQ Model as well) guards for 5 adjacent warehouses. Salary of 1 guard = 10,000.00 tk. Salary of 9 guards = 90,000.00 tk. Thereby, Security Staff Cost of 10,00,000 pieces for 5 companies = 90,000.00 tk. The Security Staff Cost per piece in the company = 90,000.00 ÷ (10,00,000x 5) tk. = 0.018 tk. In the EOQ Model this cost was = 0.09 tk.

c. Depreciation Cost. Third Party will refuse the rejected ones right after checking the goods on the spot before loading onto the trucks. Third Party utilizes its own tools to reduce the depreciation cost which are as follows:

i. Checking by using labour on the spot while loading.

1 truck (capacity of 1 truck is 8,00 pieces) might be checked by 2 labours (cost per labour per track is 500.00 tk). So the labour cost for 1 truck = 1,000.00 tk. So the labour cost for 125 trucks = 125x 1,000.00 tk.= 1,25,000.00 tk.

ii. The Party will be paid extra for their efforts taking.

And that is by 25 % out of the cost they expended. i.e. 25 % of 1,25,000.00 tk = 31,250.00 tk. And, the depreciation cost per month = 1,25,000.00 tk + 31,250.00 tk. = 1,56,250.00 tk. i.e. Cost for 10,00,000

pieces per month = 1,56,250.00 tk. Cost for 1 piece per month = 0.156 tk. In the EOQ Model this cost was = 11.90 tk.

Putting these values in the equation $\acute{h} = \hat{h} + \alpha c$, finally we get the holding cost as below:

$\acute{h}$ = (0.25+ 0.05+ 0.25+ 0.45+ 0.12+ 0.40+ 0.018+ 0.50+ 0.156) tk+ 1.75 tk = 3.944 tk

Hence, the Total Average Inventory Cost, $C^* = C\lambda + \sqrt{(2K\lambda \acute{h})}$

= 140x 10,00,000 tk + √(2x20,75,000x 10,00,000x 3.944) tk

= 14,40,45,689.00 tk

Now seeing the comparison very well we can find out the effect on probabilistic continuous EOQ review model after applying Third Party Logistics. It reduces the holding cost substantially. The comparison is shown as below:

SER	MODELS	COST COMPONENTS (IN TK)			TOTAL INVENTORY COST (IN TK)
		Variable Cost per Piece	Holding Cost per Piece	Fixed Cost per Month	
1	Generalized EOQ	140	16.165	20,75,000.00	15,01,57,900.00
2	Moderate EOQ	140	16.165	20,75,000.00	14,81,90,528.00
3	Proposed Model	140	3.944	20,75,000.00	14,40,45,689.00

8. Summary.

For EOQ model, inventory cost is reduced by taka 19,67,372.00. For proposed model, inventory cost is reduced further by taka 41,44,839.00. Here we also observe that variable cost is 140 taka per piece which costs 3,50,000 taka in total for all the models (140.00 x 10,00,000 = 14,00,00,000 taka).Variable cost is the price of the raw materials and the cost related to purchasing. If this cost is manageable further, maybe by purchasing materials in an opportune moment; this cost might be minimized substantially.

9. Conclusion.

In any industry, inventory is the largest investment which has a significant role to play for minimizing inventory cost. If the third party is used for various logistics, the company may put her eyes on the inventory management smoothly. Ultimately, the enterprise reaches to its goal reducing its inventory cost.

Study of inventories will be incomplete without a study of logistics. Business starts with the customer and again ends with the customer. And the relation between a firm and a customer depends on the logistics provided. Logistics is concerned with the movement of goods. Logistics is responsible for both incoming goods and the distribution of goods to the next member of the supply chain as well as the end customer himself.

Logistics professionals design and manage the firm's distribution system consisting of warehouse, distribution points and freight carriers. By giving the responsibilities of logistics professionals to the third party, the firm can easily concentrate its inventory control smoothly and thereby reducing inventory cost, business success gets easier without any extra hassle and burden. This paper clearly justified how much inventory cost is possible to reduce by using third party logistics instead of its own integrated logistics. This is not that only inventory cost could be reduced by using logistics of third party, the other costs of the firm may also be reduced by using this technique.

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