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An Analysis of Just in Time Manufacturing Technique used in Probabilistic Continuous Economic Order Quantity Review Model

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Abstract. This article explains how a firm manages her inventory to gain minimum production cost and earn business success by using Just in Time (JIT) Manufacturing Technique. It provides a mathematical framework to understand the performance of a firm and argues that inventory cost minimization method is an approach that helps a firm to be competitive and successful. Economic Order Quantity (EOQ) Model is a well established model in which JIT inventory Manufacturing Technique has been connected in the purpose of reducing inventory cost, where small lots may be ordered as and when required.

Keywords: Inventory, probabilistic continuous economic order quantity, setup cost, holding cost, buffer stock, just in time, kanban

AMS Mathematics Subject Classification (2010): 03Cxx

1. Introduction

A project is a specific activity on which money is spent in the expectation of returns. It has a specific objective considering the specific geographic location which would serve a group of population. The objective will be achieved, if the project is managed efficiently. Thereby, project management is planned carefully so as to earn maximum profit by using minimum cost and time. Project management emphasizes the developing a project plan which ultimately contributes to the national economy. In today's turbulent economic world, the firms are striving for ways to achieve competitive advantages. One of the objectives of those firms is to manage the entire production and supply chain to reduce costs. Particularly the main objective in production is to reduce the inventory cost so as to

earn business success. This article explores and investigates how a firm manages her inventory to gain minimum inventory cost. It explains a mathematical framework to understand the efficiency of a firm and argues that inventory cost minimization method is an approach that helps her to be competitive and successful. In economics cost minimization is the process by which a firm determines the price and output level that returns the greatest profit [1].

The article describes inventory, its management and control system as well as inventory model. It justifies the necessities of Just in Time Manufacturing System with the help of mathematical explanations in case of reducing inventory cost. It also establishes that Just in Time manufacturing technique is an approach which works to eliminate inventories rather than optimize them. It focuses on mainly the cost minimization by using the Inventory Model connecting with Just in Time (JIT) Manufacturing Technique.

2. Probabilistic continuous economic order quantity (EOQ) review model

The model [8] is described to find out the optimum cost in which an order is placed that may vary with time depending on the situation under the system of inventory. On the basis of demand of the market, the system is developed and reviews periodically. Thereby it fixes the lead time and re order point. A reorder point is usually specified by the inventory level at which a new order must be placed [6]. The inventory cost is the function of purchasing, set up, holding and shortage costs.

The purchasing cost becomes an important factor when the commodity unit price ‘‘becomes dependent on the size of the order. The setup cost represents the fixed charge incurred when an order is placed. The holding cost, which represents the costs of carrying inventory in stock, normally increases with the level of inventory. Finally, the shortage cost is a penalty incurred when we run out of stock of a needed commodity. This model can give the optimum value from the two important components of inventory cost and those are set up cost and holding cost. Generally, if the set up cost increases the holding cost decreases and if the set up cost decreases the holding cost increases [2].

3. Just in time (JIT) manufacturing technique

JIT Manufacturing Process uses Kanban. The word ‘kanban’ is a Japanese word, which means signboard or visible record. JIT Manufacturing system basically uses containers and cards. A container is used to be filled with the required number of parts which are used at each production stage where it is needed. On the other hand a card is used to authorize the movement of the containers (empty or full) between successive production stages. For example, an empty container itself having appropriate identification could serve as a signal for replenishment. Similarly, a labeled, pallet-sized square painted on the shop floor, if uncovered and visible, could indicate the need to get another pallet of materials from its production centre and move it on top of the empty square at its point of use [5].

4. How JIT manufacturing technique works using kanban

The JIT system is based on the use of containers and cards. These cards in Japan are familiar as kanban [9]. A container is used to be filled with the smallest number of parts which are used at each production stage where it is needed. A card is used to authorize

the movement of containers (empty or full) between successive production stages. The chain of flow of the materials raw or finished is explained in the figure below.

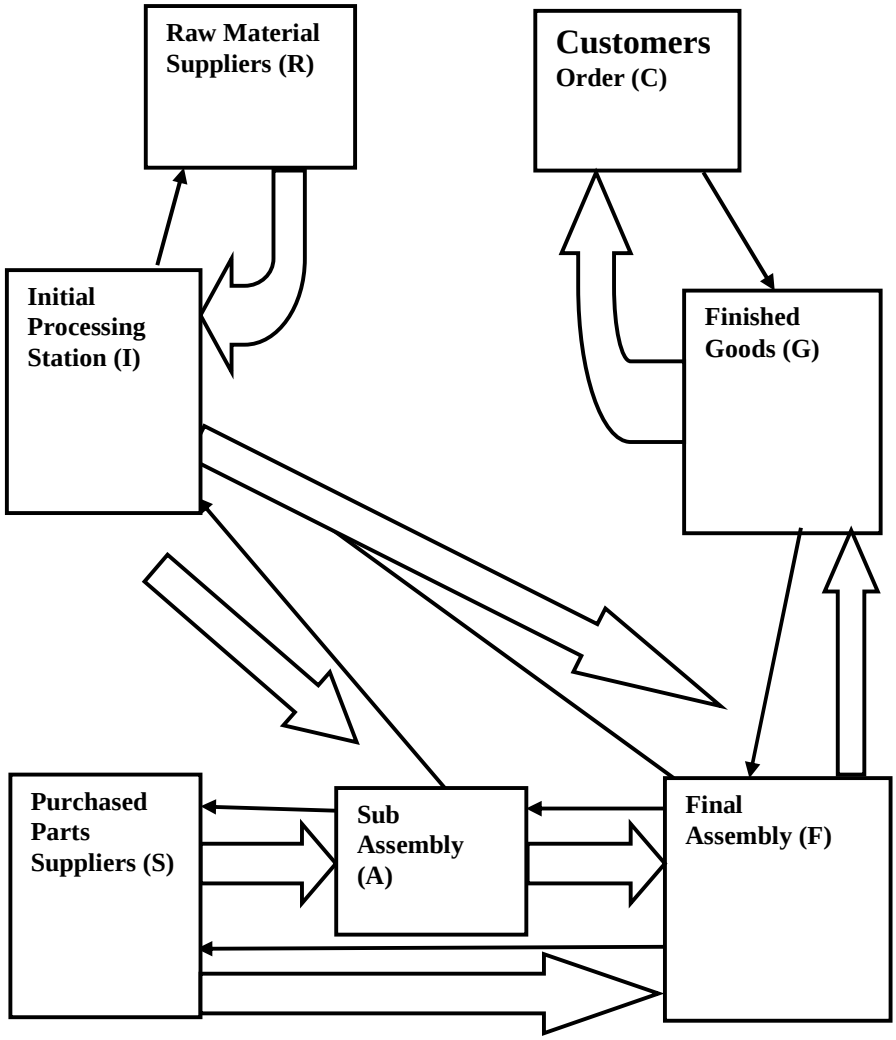

Figure 1:

The single arrows and the double arrows show the movement of Kanban cards and containers respectively. The figure depicts the movement of cards and containers between two consecutive production stages. The raw materials in container R_1 must have a move card m attached with it. Through initial stage it will reach to Sub Assembly, where move card m will be removed. Then all the materials assembled in all sub assembly will move towards Final Assembly with move card m. Here the move card will be removed, which will go back to the previous stages following the Kanban rule. From the final Assembly F, Container F_1 with move card m will move to stage of Finished Goods. At last goods will go to the customers by container G_1. The basic premise of the

JIT system is to reduce both cards and containers to a minimum. For this reason, it is necessary always to seek improvements in product quality, equipment and personnel performance, and procedures to uncover, and hence eliminate, the sources of problems. Such improvements will then result in reducing dependency on in-process inventory. One of the major requirements for a successful implementation of JIT is that the setup cost associated with lot productions (full containers) must be reasonably small. In this model, the total inventory cost minimizes significantly as a whole after using JIT Techniques in a firm [9].

5. Justification of using proposed JIT manufacturing technique (model) in comparison with traditional EOQ model to reduce the inventory cost

To justify the use of JIT Manufacturing Model we shall put an example. Say, a firm is given the responsibility to supply 100 boxes of itemes per week in an office. Firm's purchasing cost per box is $23,000.00, shipping cost regardless of size and labour cost are $2,50,000.00 and $60,000.00 per month respectively. The firm spent 15% of its total cost as financial cost. It also expends $250.00 per week to arrange each box. Here we shall justify that the proposed JIT Manufacturing Technique gives better performance than the traditional EOQ Model to find out the inventory cost of the firm [3]. To solve the problem first, we use the probabilistic EOQ **(**Economic Order Quantity**)** Model in which the stock is reviewed continuously and an order of size y is placed every time the stock level reaches a certain reorder point R. With the help of Hadley and Whitin [7], a convenient numerical method is then used to determine the optimum values of y and R. Using the formula of Hadley and Whitin we get,

The purchasing cost per month (1 month = 4.29 weeks) is $C\lambda$ = $23,000.00 X 100.00 x 4.29 = $98,67,000.00 as the variable cost C includes the purchasing and its related cost and λ is the demand rate per week. The expected holding cost, h = □ + αC, where □ is the box arranging cost for per box per week and α = financial cost per year. And we get holding cost per month h = ($250.00 + 0.15/52 x $23,000.00) x 4.29 = $1,357.00. Fixed cost K = $(2,50,000.00 + 60,000.00) = $3,10,000.00.

Now from the Probabilistic EOQ Model we get the total inventory cost C(q) as below [7]:

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

= $(98,67,000.00 + 3,10,000.00 + 2,91,076.00)

= $1,04,68,076.00

Now applying Just in Time Manufacturing Technique, we put the demand or order as and when we require, then we get:

Economic Order Quantity/month [7],

$q = \sqrt{\{(2 \times k \times \lambda)/h\}}$ [as per the formula of the model]

$= 76.78 \cong 77$

Order Interval $u = \sqrt{\{(2 \times k)/(\lambda \times h)\}}$ [as per the formula of the model]

= 0.77 week

$$\text{No of order/month} = \frac{\text{Expected total demand / month}}{\text{Order Quantity / order}} = \frac{429}{76.78} = 5.59 \cong 6$$

Hence, the number of order = 6, total quantity needed per month 429. The firm uses other cost as much as $2,000.00 per order. Now calculating in details (considering as transportation cost per truck = $8,000.00, labour and clerical cost per month = $20,000.00) we get, Shipping cost = $8,000.00 x 6 = $48,000.00, Clerical cost = $20,000.00 x 6 = $1,20,000.00, Other cost = $2,000.00 x 6 = $12,000.00. Adding all the above costs we get the Set up cost = $1,80,000.00. The firm spends $20,000.00 for space rent, $5,000.00 for overheads, tax, insurance and depreciation cost as $15,000.00. Thereby its total Holding cost becomes $40,000.00. The firm may also has few shortage cost as $50,000.00 basing on its previous experience. Its Purchasing cost = $23,000.00 x 429 = $98,67,000.00.

Hence, the total inventory cost by using JIT, = $(1,80,000.00 + 40,000.00 + 50,000.00 + 98,67,000.00) = $1,01,37,000.00.

6. Comparison

Here, we can see that using general EOQ model, total Inventory Cost becomes $1,04,68,076.00 whereas, after applying the Just in Time technique this cost becomes $1,01,37,000.00 which is less than the previous one. The comparison is given below:

Cost	EOQ Model	Proposed JIT Manufacturing Model
Inventory Cost	$1,04,68,076.00	$1,01,37,000.00

7. Conclusion

The firm should take the approach to cost reduction through consideration of its entire people as well as organizations. The firm must consider other components as well to reduce the inventory cost further, which this paper explained taking adequate care of Just in Time manufacturing technique. In this paper it is showed that applying Just in Time Manufacturing Technique, the inventory cost reduced than that of traditional EOQ Model.

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