DETERMINATION OF INVENTORY TURNOVER RATIOS AND COST SAVINGS BY USING BASIC EOQ MODEL

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Abstract

Inventory plays an important role for an organization for its efficient working. This paper deals with the computation of inventory turnover ratio and optimization of the inventory costs by using basic Economic order Quantity (EOQ) model. The various costs related to inventories have also been computed for ten main items of a manufacturing industry. The turnover ratios of ten items have been computed for the last four years. The total variable costs for managing the inventory by using the EOQ have been computed and compared with the total cost without EOQ model. It is found that there is a 20% reduction in the total variable costs by using EOQ model.

Key words: EOQ model, Total variable costs, turnover ratio, manufacturing industry.

1. INTRODUCTION

Inventories constitute the most significant part of current assets of a company like in India. On an average**,** inventories are approximately 60% of current assets in public Ltd. companies in India. A firm neglecting the management of inventories will be jeopardizing its long run profitability and may fail ultimately. It is possible for a company to reduce its level of inventories to a considerable degree. The reduction in "excessive" inventories carries a favourable impact on a company's profitability. In dictionary meaning of inventory is a "detailed list of goods, furniture etc." Many understand the word inventory, as a stock of goods, but the generally accepted meaning of the word 'goods'. In the accounting language, is the stock of finished goods only. In a manufacturing organisation, however, in addition to the stock of finished goods, there will be stock of partly finished goods, raw materials and stores. The collective name of these entire items is 'inventory'.

The term 'inventory' refers to the stockpile of production a firm is offering for sale and the components that make up the production. The inventory means aggregate of those items of tangible personal property which: (i) held for sale in ordinary course of business. (ii) In-process of production for such sales and (iii) to be currently consumed in production of goods or services to be available for sale. Inventories are expendables physical article whose production held for resale to use in manufacturing a product or for consumption in carrying on business activity such as merchandise, goods purchased by the business which are ready for sale. Inventory is composed of assets that will sell or used in future in the normal course of business operations. The assets, which firms store as inventory in anticipation of need, are raw materials, work in Progress and finished goods.

2. Literature Review

F.W. Harris (1913) was the person who presented the familiar economic order quantity (EOQ) model. Even though Harris's original paper was disseminated widely, it apparently was unnoticed for many years before its rediscovery in 1988. During this period much confusion developed over the origin of the EOQ model. His paper explores the early literature on this model and traces the evolution of the confusion. Harris's original 1913 essay is reprinted following this paper. The model developed by Harris is commonly referred to as the Economic Order Quantity (EOQ) model, and is also known as the lot sized model or Wilson's formula. The objective of the model is to find the right quantity of products to order, given the constant demand rate, the costs associated with ordering and holding inventory, such that the annual operating cost is minimized.

Detailed analysis of continuous and periodic review policies and some extensions can be found in the books by Hadley and Whitin (1963) and Arrow (1958). Pal and Mandal (1997) studied an EOQ economic order quantity model for items deteriorating at some constant rate with demand changing at a known and at a random point of time in the fixed production cycle. Eynan and Kropp (2003) studied a periodic review system under stochastic demand with variable stock-out costs. The optimal values for cycle length and amount of safety stock are difficult to obtain because one of the First Order Conditions does not have a closed form solution. However, by using a Taylor series expansion to approximate part of the cost function, they produce a simple cost function structure which is similar to that of deterministic models. Cheng et al.

(2006) considers the inventory model with random procurement lead time. Using infinitesimal dividing method, the exact (Q, r) inventory cost model of single supplier procurement is presented, which is proved equal to the traditional model. Main properties of the model are analyzed strictly. The convexity of the cost function per unit time is proved. Then the optimal solution can be easily obtained by applying the classical convex optimization methods.

Wongmongkolrit (2007) studied the constraints of EOQ model with discrete demand or slow moving items. According to this study, the modification of EOQ model is originally studied by based on spare parts discrete demand. This is the study of forming the extension of EOQ model conforming to discrete demand. Porras and Dekker (2008) performed an optimization of the inventory system of spare parts. They compare different re-order point methods for effective spare parts inventory control, motivated by a case study at a large oil refinery. Different demand modeling techniques and inventory policies are evaluated using real data. They presented a methodology for the empirical test of different inventory models with actual data for spare parts, using two different approaches, namely an ex-post and an ex-ante approach. Daeschel (2012) studied and create an effective inventory management system for the GFR team. A database of the fasteners used by the team was created and includes information such as annual demand, inventory value, and lead times. This information was used, along with the appropriate formulas, to calculate the economic order quantity (EOQ), the total material cost (TMC) and the order point (OP) for each part. A comparison of two major vendors was also included, and the vendor with lowest TMC was recommended. Face to face communication methods to convey this new idea were recommended. Lean manufacturing techniques to help implement this new system were researched including 5S tools and a pokayoke. Study of this gives exactly when to economically order a part, how many to order, and who to order from. This will save money, as well as increase productivity and professionalism. Saha and Basu (2013) studied that how much discount on selling price may be given during deterioration to maximize the profit per unit time and whether a pre-deterioration discount affects the unit profit or not. A mathematical model is developed incorporating both pre- and post deterioration discounts on unit selling price, where analytical results reveal some important characteristics of discount structure.

Nathan et al. (2014) studied the process of analyzing the company's current forecasting model and recommended an inventory control model to help them solve their current issue. As a result, an Economic Order Quantity (EOQ) and a Reorder Point was recommended to help them reduce their product stock outs. The shortage of raw material for production always makes the process discontinuous and reduces the productivity. The ABC analysis technique for the inventory control system is first used to identify the most important multiple products and then the economic order quantity (EOQ) of each product is developed to find their inventory model equation individually. Guajardo et al. (2014) addressed the problem of how to determine control parameters for the inventory of spare parts of an energy company. The prevailing policy is based on an (s, S) system subject to a fill rate constraint. The parameters are decided based mainly on the expert judgment of the planners at different plants. They tested seven demand models using real-world data for about 21000 items. They found that significant differences in cost and service level may appear from using one or another model.

1. Products and Industry

The industry 'X' was founded in March 1972, and it is the leading manufacturers and suppliers of high tensile fasteners such as Bolts, Screws, Nuts and similar parts for automobile and other industrial sectors. It is also catering the needs of various sectors such as Wind Energy, Oil & Gas, Locomotives, Automobiles, Agriculture Equipments (Tractors), Machine Building and different industrial and its sub-con items. The endeavor of the company is to provide high level customer satisfaction. This industry is located in northern part of the India and four units of this industry are spread over an area of 1, 00,000 square meters and have a total production capacity of 25,000 metric tons (MT) per annum. The core competency of this Group lies in its ability to resource quality material and manufacture complete custom design solution. The Global vision and providing fastener solutions for more than three decades has now made The Company one of the Global leaders for manufacturing high tensile precision fasteners and cold forged components.

The industry is one of the largest exporters of fasteners in India. Whereas 35% of the total sales is contributed from the products exported to various countries such as The United States of America (USA), Australia, Canada, Denmark, Dubai, France, Germany, Hong-Kong, Indonesia, Japan, Malaysia, Singapore, South Africa, Switzerland, Sweden etc. The Company is a partner of the Global Fastener Alliance (GFA).

4. Implementation of Economic Order Quantity (EOQ) model

The basic EOQ model is most populated and most widely used in the industries. The purpose of using the EOQ model in this research is to find out the particular quantity, which minimize total inventory costs that are the total ordering and carrying costs. Following assumptions are considered for implementing this model.

(i) The cost of the ordering remains constant.
(ii) The demand rate for the year is known and evenly spread throughout the year.
(iii)The lead time is constant (lead time is the latency time it takes a process to initiate and complete the procurement).
(iv) Prices of materials are fixed and no quantity discounts are allowed.
(v) The optimal plan is calculated for only one product.
(vi) There is no delay in the replenishment of the stock, and the order is delivered in the quantity that was demanded, i.e. in whole batch.
(vii) The procurement is instantaneous.

4.1 Formulae

The economic order quantity (EOQ) can be calculated from the Mahapatra (2010):

$$EOQ = \sqrt{\frac{Annual\ consumption\ in\ units \times cost\ per\ order}{price\ per\ unit \times carrying\ cost\ expressed\ as\ a\ percentage\ of\ total\ investment}}$$

Total Holding cost= C (Q/2)
No. of order = D /Q

Total Ordering cost = F (D/Q)
Where, C= carrying cost, D = Annual demand and F= Ordering cost per order

4.2 Methodology

Research methodology represents the strategies involves in collecting and analyzing data in order to have meaningful interpretations of the research findings. This sub-section deals with the data collection and how these data were analyzed and the research design. The data related to the inventories have been collected form the reliable source of the concerned industry.

4.3 Inventory Turnover Ratios

Ratios are basically used for analysis of short-term financial position or test of the stock level. The short term obligations of a firm can be met in time only when it is having sufficient current assets. So to win the firm & the efficient use of current assets (inventory) position must be strong. But a very high degree of inventory level is not good for a firm being tied up in the current assets.

4.4 Calculation of Inventory Turnover Ratios

The inventory turnover ratio establishes the relationship between costs of goods sold and average inventory. This ratio indicates the efficiency of the firm in producing and selling its products. It is calculated by dividing the cost of goods sold by the average inventory; as given below:

$$Inventory\ turnover\ ratio = \frac{cost\ of\ goods\ sales}{Average\ inventory}$$

Average inventory = Total inventory/2

$$Holding\ period\ of\ Inventory = \frac{365}{Inventory\ turnover\ ratio}$$

4.4.1 Raw materials turnover ratios

With the help of raw material turnover ratio, it can be ascertained that how many times the stock of raw material converted into sales during the year. The data of raw materials for industry 'X' are collected for last four financial years.

$$Raw\ material\ turnover\ ratio = \frac{Cost\ of\ goods\ sold}{Average\ stock\ of\ raw\ materials}$$

Table 1 shows the calculation of Turn over ratio for raw materials.

Table 1 Calculation of Turn over ratio for raw materials

YEAR	2010-11	2011-12	2012-13	2013-14
Opening stock (in units)	47926633	337147297	235913157	151363869
Closing stock (in units)	337147297	235913157	151363869	192334134
Total (in units)	385073930	573060454	387277026	343698003
Average Inventory (in units)	192536965	286530227	193638513	171849002
Cost of good sold (in rupees)	3104226861	3434858655	3195927096	3513633752
Inventory turn over ratio	16.12	11.98	16.50	20.45
Holding period (in days)	22.64	30.45	22.12	17.85

4.4.2 Work in-progress inventory turnover ratios

The Work in-progress inventory turnover ratio ascertains that how many times the stock of work in progress material converted into sales during the year. The Work in-progress inventory turnover ratio may be computed as:

$$Work\ in\ progress\ turnover\ ratio = \frac{Cost\ of\ goods\ sold}{Average\ stock\ of\ work\ in\ process\ inventories}$$

Table 2 shows the calculation of Turn over ratio for work in-progress inventory.

Table 2 Calculation of turn over ratios for work in-progress inventory

YEAR	2010-11	2011-12	2012-13	2013-14
Opening stock (in units)	207930537	376343190	496518246	734907883
Closing stock (in units)	376343190	496518246	734907883	779932987
Total (in units)	584273727	872861436	1231426129	1514840870
Average Inventory (in units)	292136864	436430718	615713065	757420435
Cost of good sold (in rupees)	3104226861	3434858655	3195927096	3513633752
Inventory turn over ratio	10.62	7.87	5.19	4.63
Holding period (in days)	34.34	46.37	70.31	78.68

4.4.3 Finished goods inventory turnover ratios

The finished goods inventory turnover ratio ascertains that how many times the stock of finished good material converted into sales during the year. The finished goods turnover ratios may be computed as:

$$Finished\ goods\ \ turnover\ ratio = \frac{Cost\ of\ goods\ sold}{Average\ stock\ of\ \ finished\ goods}$$

Table 3 shows the calculation of Turn over ratio for finish goods inventory.

Table 3 Turn over ratios for finished goods inventories

Opening stock (in units)	**2010-11**	**2011-12**	**2012-13**	**2013-14**
Closing stock (in units)	419095398	369275612	454478159	500687534
Total (in units)	369275612	454478159	500687534	488770642
Average Inventory (in units)	788371010	823753771	955165693	989458176
Cost of good sold (in rupees)	394185505	411876886	477582847	494729088
Inventory turn over ratio	3104226861	3434858655	3195927096	3513633752
Holding period (in days)	7.87	8.33	6.69	7.10
Opening stock (in units)	46.34	43.76	54.54	51.39

4.5 EOQ Analysis of various products

Ten products have been considered for cost comparisons by using existing and EOQ methods. Table 4 shows the cost comparison for product Nos. 1, 2 and 3.

Table 4 Cost comparison for product Nos. 1, 2 and 3 by existing and EOQ methods

Parameters	**Product 1**		**Product 2**		**Product 3**	
Costs (in Rupees)	Analysis of various cost by existing method	Analysis of various cost by EOQ method	Analysis of various cost by existing method	Analysis of various cost by EOQ method	Analysis of various cost by existing method	Analysis of various cost by EOQ method
Holding cost	23.10	6.64	21.1	21.01	21.01	21.01
Ordering/setup cost	458.75	352.73	445.28	445.28	445.28	445.28
No. of order in a quarter	3	8	3	8	3	8
Ordering cost quarterly	1376.25	3670.0	1335.84	3562.24	1162.89	2325.78
Holding cost quarterly	24255.92	14,485.55	22059.43	13664.68	12,658.74	9521.60
Total quarterly cost	25632.17	18155.55	23395.27	17226.92	13,821.63	11,847.38
Saving (in Rs.)	7476.62		6168.35		1974.25	

Percentage	29%	26%	14%

Table 5 shows the cost comparisons for product Nos. 4, 5 and 6.

Table 5 Cost comparison for product Nos. 4, 5 and 6 by existing and EOQ methods

Parameters	Product 4		Product 5		Product 6	
Costs (in Rupees)	Analysis of various cost by existing method	Analysis of various cost by EOQ method	Analysis of various cost by existing method	Analysis of various cost by EOQ method	Analysis of various cost by existing method	Analysis of various cost by EOQ method
Holding cost	12.68	12.68	9.90	9.90	5.40	5.40
Ordering/setup cost	12.68	12.68	9.90	9.90	5.40	5.40
No. of order in a quarter	391.63	391.63	373.75	373.75	344.78	344.78
Ordering cost quarterly	3	6	3	4	3	3
Holding cost quarterly	1174.89	2349.78	1121.25	1495.00	1034.34	1034.34
Total quarterly cost	13311.00	9661.12	10395.39	6379.88	5671.40	4526.03
Saving (in Rs.)	14485.89	12010.9	11516.64	7874.88	6705.74	5560.37
Percentage	17%		32%		17%	

Table 6 shows the cost comparison for product Nos. 7, 8 and 9.

Table 6 Cost comparison for product Nos. 7, 8 and 9 by existing and EOQ methods

Parameters	Product 7		Product 8		Product 9	
Cost (In Rupees)	Analysis of various cost by existing method	Analysis of various cost by EOQ method	Analysis of various cost by existing method	Analysis of various cost by EOQ method	Analysis of various cost by existing method	Analysis of various cost by EOQ method
Holding cost	8.15	8.15	8.15	8.15	8.74	8.74

Ordering/setup cost	362.5	362.5	362.5	362.5	366.25	366.25
No. of order in a quarter	3	4	3	4	3	5
Ordering cost quarterly	1087.5	1450.00	1087.5	1450.00	1098.75	1831.25
Holding cost quarterly	8560.91	6246.06	8560.91	6246.06	9172.41	7999.28
Total quarterly cost	9648.41	7696.06	9648.41	7696.06	10271.16	9830.53
Saving	1952.35		1952.35		440.63	
Percentage	20%		20%		4%	

Table 7 shows the cost comparison for product No. 10.

Table 7 Cost comparisons for product No. 10 by existing and EOQ methods

Costs (in Rupees)	Analysis of various cost by existing method	Analysis of various cost by EOQ method
Holding cost	6.64	6.64
Ordering/setup cost	352.73	352.73
no. of order in a quarter	3	4
ordering cost quarterly	1058.19	1410.92
holding cost quarterly	6967.77	5845.88
total quarterly cost	8025.96	7256.80
Saving	769.16	
Percentage	10%	

Table 8 shows the overall cost comparison and cost saving for all the ten products.

Table 8 Overall cost comparison and saving of all the products

Overall cost Comparisons						
Product Nos.	Previous Method			Recommended Method		
	Ordering Cost (in Rupees)	Holding Cost(in Rupees)	Total Cost (in Rs.)	Ordering Cost (in Rs.)	Holding cost (in Rs.)	Total cost (in Rs.)
1	1376.25	24255.92	25632.17	14485.55	3670.00	18155.55

2	1335.84	22059.43	23395.27	13664.68	3562.24	17226.92
3	1162.89	12658.74	13821.63	9521.60	2325.78	11847.38
4	1174.89	13311.00	14485.89	9661.12	2349.78	12010.90
5	1121.25	10395.39	11516.64	6379.88	1495.00	7874.88
6	1034.34	5671.40	6705.74	4526.03	1034.34	5560.37
7	1087.50	8560.91	9648.41	6246.06	1450.00	7696.06
8	1098.75	9172.41	10271.16	7999.28	1831.25	9830.53
9	1050.24	6535.65	7585.89	5523.28	1400.32	6923.60
10	1058.19	6967.77	8075.96	5845.88	1410.92	7256.80
Total cost	11500.14	119588.61	131088.75	83853.37	20529.63	104383.00

Total cost savings for ten products = Rs. 26,705.05

Total cost savings for ten products in percentage= 20%

5. Results and discussion

The results obtained from this case study are summarized as follows:

(i) The economic order quantity, inventory turnover ratio and holding period for various products have been found out in the presented case study.

(ii) By providing and recommending the EOQ inventory control model, the results have shown improvements in cost reduction. So, if the industry follows and implements the recommended inventory model, it can reduce the total cost by approximately 20%.

(iii) The holding period (in days) for raw material inventory is increasing gradually from year to year. The holding period for raw material inventory in 2010-11 was 22.63 days which increases to 30.44 in the year 2013-14.

(iv) The holding period of raw material inventory increased due to decrease in demand of fasteners in international market. In the year 2013-14, the holding period decrease up to 17.85 days due to the increases in demand of fasteners. Inventory turnover ratio decrease in the financial year 2010-11 to 2011-12 from 16.11 to 12.98 which shows the decrease in the sale of fasteners. In next two years inventory turnover ratio increase gradually from 16.5 to 20.44 which shows the increase in the sales of firm.

(v) For the work in-progress inventory, the turnover ratio is continuously decreasing from year to year and holding period increases from 2010-11 to 2013-14, which shows that company manages a large amount of work in progress inventory to meet the demand of variety of products.

6. Conclusions

There are many medium and small scale industries which are still using their conventional methods of procurement without considering the EOQ models of inventory management. By using the EOQ models, these industries can save a lot of money in procurement of raw materials; semi finished and finished components; procured from other sources. Because, a balance is required between inventory carrying cost and ordering costs. This paper shows the calculation of turnover ratios and holding periods for raw materials, in-process inventory and finished goods inventories. The cost savings of Rs. 26,705 have been obtained by using the EOQ model on only ten products and this amount of saving can be increased for many other products with EOQ models.

The limitations of this study is that basic EOQ model was implemented only in some products of the industry; while it can be applied for all the products to minimize the total cost and increase the profit of industry. Another limitation is that; only basic model is applied in this case study but other suitable inventory control models may be used in the same or other industries.

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