Comparative Evaluation of Economic Order Quantity and Modeling Technique for Inventory Control – A Case Study

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Abstract:

Inventory may be a collection of goods and materials, or the company itself keeps those products and materials in storage. It is used collectively for an inventory of the contents of a unit, and a list of the properties of those who died for testamentary purposes. Inventory management is mainly concerned with assessing the scale and position of commodity stockpiles. Inventory management also covers the all inventory costs. The management of inventories is very important for all businesses. Understanding when to repair those products, what is to purchase or make, what is to be paid for as well as when to sell, and at what price it can quickly become difficult choices? Within contemporary global market companies are focusing on development and opportunities to reduce their actual cost and business management needs to increase efficiency, productivity and capacity while not growing their investment. The companies are implementing various inventory management techniques to handle their inventory to prevent over-stock and stock-outs. In this paper an attempt has been made to measured and compare the Economic Order Quantity (EOQ), Safety stock, Reorder point and the inventory cost amongst two models (already used by the company and the proposed model) to optimize overall cost.

Keywords: *Inventory, Inventory Control, Economic order quantity (EOQ), Inventory costs*

1. Introduction

An inventory is the stock of a company's product, and the components that make up the product. An inventory account consists normally of four different categories namely raw material, work in process (WIP), finished product and merchandise as shown in fig 1.

Inventory control has undergone a major change with the technological expansion and accessibility of process [9, 21]. Control of inventory is primarily concerned with determining the dimensions and location of stock with products. Inventory control also covers the fine lines between the renewal cycles, inventory carrying prices, plus management, inventory forecast, inventory valuation, inventory visibility, predictable inventory feature, physical inventory, obtainable inventory space, quality management, renewal, returns, and expected faulty product and demand. Inventory control involves the following points [10, 23]:

i. The effective management system that allows for sales transactions and payment processing.
ii. Processes and system that assess inventory needs, set goals, offer replacement strategies, and report inventory status actual and projected.
iii. Honest basis of comprehension, and therefore the ability to handle financial costs.
iv. Management of inventories that control operating costs.

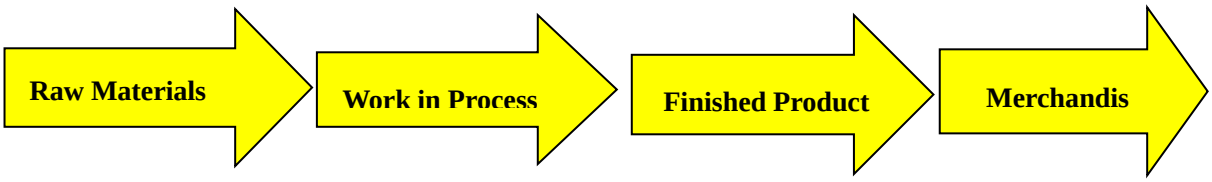

Fig.1: Types of Inventory

Inventory control is the method of utilization for maximizing the profit of a company by keeping minimum inventory. The following are the goals of inventory control [2]:

i. To establish a proper system of inventory management.
ii. Maintain a minimum expenditure to optimize productivity in inventories.
iii. Maintain optimum inventory of finished products to achieve better customer satisfaction level and to minimize stock-out cost or back-orders.
iv. Minimizing the inventory related costs and time of transportation of raw materials and finished products.
v. Maintaining EOQ, Reorder point, and Safety stock.

The various costs are included in the inventory costs, which are discussed in further paragraphs:

a) Holding cost

Inventory holding costs are those expenses that are related to the volume of stock held. The cost of holding inventory is composed of a variety of different factors [20].

b) Storage cost

The cost of renting or buying space required to store inventory, such as renting areas occupied by stock, security stock, maintenance costs, insurance costs, and larceny costs, deposit costs, handling costs, etc.[20].

c) Finance cost

Financing costs on excess inventory may impact It is the consumers who charge business rates. Interest cost payable to spending money [20]. In addition to storage costs, it

means the given rate of returns on inventory investments etc. The carrying value thus covers both the real costs and the potential costs associated with the funds invested in the inventories.

d) Ordering cost

It is the expense of preparing and implementing an order, along with the administrative costs, and dealing with the manufacturer. The average purchasing costs are proportioned reciprocally with the annual inventory of the product [18].

e) Stock out cost

It is the expense associated with the missed opportunity resulting from inventory depletion. Stock depletion may be a product of multiple factors. Cost storage requires an appreciation of a customer's reaction to an out of stock business [18].

Economic order quantity (EOQ) is one of the oldest resource management methods. This was first put-up in 1913 by Ford W. Harris. EOQ has been one of the most important and robust formulae in inventory management [19]. Economic Order Quantity (EOQ) is an inventory management system that demonstrates the amount of an item to cut the total cost of every product handling (Handling Cost) and ordering process (Ordering Cost) process.

Two categories of costs are protected by the EOQ model: Ordering costs and Holding costs. To minimize the overall cost of both: ordering costs and holding costs, it is important for a company to find a trade-off point of ordering quantity. In this sense, the quantity to be ordered is known as the Economic Order Quantity to minimize the overall cost of both the Ordering and holding costs (fig. 2).

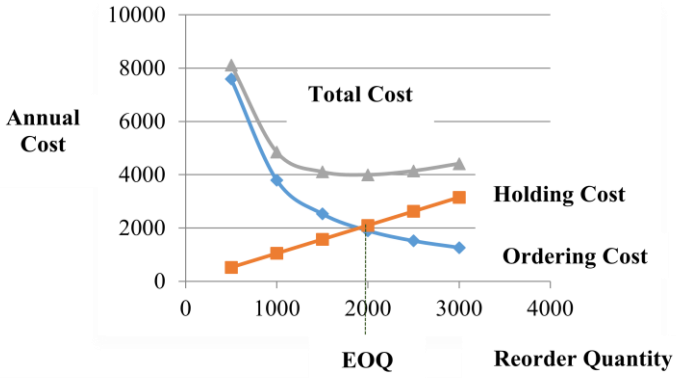

Fig. 2: Costs v/s Reorder Quantity (Proposed Model during 2014-15

The Economic Order Quantity (EOQ) model is an extremely useful inventory management system. It is used to measure the optimum quantity that can be purchased for cost optimization [12].

A case study has been done in a company that manufacturers molded plastic parts for automobile companies, by using injection molding process. Research work has been done to minimize inventory of raw materials by implementing EOQ proposed model and company model.

2. Literature Survey

Inventory may be a list of products and materials, or company keeps certain products and materials itself available in stock. In this study reviews both theoretical and empirical works of EOQ and also literature review on different types of inventory management under different conditions.

Ray and Chaudhuri[17]analyzed an EOQ model with stock dependent demand, shortage, inflation, and time discounting. There are two types of inflation rates are considered: internal (company) inflation, and external (general economy) inflation. A sensitivity of the optimal solution is conducted with respect to input variables. Roach [19] clarified how the Economic Order Quantity emerged clarified that the quantity of the economic order (EOQ) was a notable equation that determines the optimum quantity of the economic order.

Fantazyet al. [6] discussed new supply chain strategies in the manufacturing field, and also presented the empirical testing of the supply chain strategies hypothesis. Babazadeh and Jafar[3]represented a robust stochastic programming approach for agile and responsive logistics under operational and disruption risks. Authors also developed agile supply chain network design for a new market opportunity. Aggarwal and Muninarayanaappa [1] used inventory management to balance customer care, product quality, and inventory cost. There are varieties of factors that influence the decision making of inventories. Only two are considered in their research: the cost factor and the uncertainty factor which includes uncertainty about demand and uncertainty about lead-time.

Kasisomayajula[11] examined an analytical study on "inventory management in the commercial vehicle industry in India." There is a major relationship between Inventory and Sales. Study reveals inventory review of all units in the Indian commercial vehicle industry. Proper resource management is important for sustaining and enhancing the quality of the company. Effective inventory control would increase the company's productivity. Wisner et al.[22] evaluated that the overall inventory management system of the organization is satisfactory; the company makes use of suitable approaches using inventory management approaches, ABC (Always Better Control) analysis and EOQ (Economic Order Quantity). The goal is to find ways to control the inventory better so that the profits and revenues of the business can have a minimal effect.

Mangal and Gupta [14, 15] presented management of demand uncertainty in supply chain cost planning. The author's approach in this paper is deterministic planning and scheduling models combining safety stock rates as a way of addressing demand problems in routine service. Guga and Musa [8] examined a case study of Inventory Management through the EOQ model. In this study, costs are calculated to compare the two models, the one used by this company and the proposed one.

Kumar [12] discussed the Economic Order Quantity (EOQ) model that is a very helpful method for managing inventories. It is used to measure the optimum quantity that can be purchased to optimize the costs in such a way as to maintain an even output flow while preventing unnecessary inventory expenditure. Parate and Agarwal[16] concluded that, in most scenarios, the best inventory strategy will be to optimize holding costs, stock of raw materials, or finished goods. Deterministic model and probabilistic model of inventory management has been implemented by them.

Sunhal and Mangal [21] analyzed the inventory management techniques in a Supply Chain by using Economic Order Quantity (EOQ) Model. Inventory cost, order cost and the gross operating costs were also reduced. The order size and the total inventory were optimized. Riza et al. [18] covered that the implementation of Economic Order Quantity for reducing inventory cost in automotive industry. EOQ mathematical model was developed to determine optimum inventory levels within the framework of operations management. In fact, the cost per unit of procurement of goods varies with time and lead time.

Dhull et al. [5] investigated the optimization of supply chain management inventory control using novel regression techniques in an organization. The EOQ is a commonly used tool for estimating the parameters of inventory management, and the different regression methods predicted the same parameters. There is a comparison between standard EOQ model and predicted values with different regression techniques. Gokhale and Kaloji[7] introduced a study on Inventory Management and its impact on profitability in the industry. This paper consists of different parts where the inventory management concepts are discussed and also introduces inventory costs. In this paper they could properly implement and monitor the norms and method of Inventory Management, they can maximize the profit with minimize the cost.

Senthilnathan[20] explained that Economic Order Quantity is an important method for the control of inventories. EOQ relationship to Economic Number of Order (ENO), inventory period duration, and quantity reorder point is also analyzed. Mallieswari et al. [13] analyzed forecasting of Reorder Point using Economic Order Quantity for leading food Industry. Within this paper Reorder Point and costs are calculated to compare two models, one is used by this company and other is used by proposed model. Proposed model is reduce their total cost enhance quality and efficiency without increasing their investment. Baber [4] analyzed a modified framework for a smart system using the EOQ model for demand variations. This model will help to reduce all costs incurred in ordering and storing inventories when implemented at each point of demand transition.

Vast literature survey identified that a lot of work has been done in the inventory regarding consumer, regarding production system, how to improve production but very limited work has been done on inventory related cost like ordering cost, holding cost, total cost, reorder level, maximum stock level, minimum stock level and average stock level. Also

it has been found that very limited work has been done on how to calculate ordering cost, holding cost, total cost, reorder level, maximum stock level, minimum stock level, average stock level? So, in this paper an attempt has been made to calculate the above said items.

3. Methodology

The EOQ model was used to optimize inventory and find optimum order quantity with the goal of reducing the overall cost associated with one product. Ordering cost (O), number of orders (N), total annual cost (T), holding cost (H), ordering quantity (Q), annual demand (A), and holding cost per unit (C) have been used to calculate EOQ and annual stock levels and re-order level have also been calculated.

Case Study

Keeping the research prospective in view, a case study on plastic manufacturing auto components industry in India has been done and the data collected from the company has been shown in table-1.

Assumptions:

Following assumptions have been used in the proposed inventory management model:

i. The lead time for the order being obtained is constant.
ii. Transshipment cost is neglected.
iii. Unit cost is constant.
iv. Demand and total cost is variable.

Following formulae have been used to calculate inventory related costs:

1. Number of kg of plastic material purchased
(Company) Q = Cost of the plastic material / Unit cost
of the material
2. Number of orders (Company) = A/Q
Where, A = Annual Demand
3. Calculation of Economic Order Quantity (EOQ):-
EOQ = √ ((2×Annual Consumption × Ordering Cost)/
Storage (Holding) Cost per unit)
EOQ=√ (2AO/C)
Where,
O = Ordering cost
C = Holding cost per unit = Carrying rate × unit cost
4. Number of orders for the year (N) = A/EOQ
5. Total annual cost (T) = Ordering Cost + Holding Cost
Ordering cost (O) = Cost per order × number of orders

Holding cost (H) = [(Q/2) × C]

6. Reorder level = Safety stock + Lead time × Average usage

Where,

Safety stock =Usage × Period of safety stock/ total working days in a year

Average usage = Usage/Total working days during a year

7. Minimum stock level=Re-order level – (Average lead time × Average usage) (Company)

8. Minimum stock level = Re-order level – (Max. lead time × Min. usage)

9. Maximum stock level = Re-order-level + Re-ordering Quantity-(Minimum lead time × Minimum usage)

10. Average stock level = ½(Maximum stock level + Minimum stock level)

The data collected from industry and used in the proposed model has been shown in table-1.

Table 1: Actual Input Data (From Company)

Particulars	2014-15	2015-16	2016-17
Demand for plastic	3400kg/month	3600kg/month	3800kg/month
Total cost	260, 000	280, 000	300, 000
Ordering cost	10% of the total	10% of the total	10% of the total
working days/ year	365 days	365 days	365 days
Period of safety stock	30 days	30 days	30 days
Carrying rate	0.03/unit/year	0.03/unit/year	0.03/unit/year
One unit cost (C)	Rs. 70/kg	Rs. 70/kg	Rs. 70/kg
Lead time	6-8 days	6-8 days	6-8 days

4. Results and Discussions

In this research work, Economic Order Quantity (EOQ), Safety stock, Reorder point and the inventory cost are measured to compare amongst two models (used by the company and the proposed model) has been done to optimize overall cost. Calculations based on the proposed model have been done by using collected data from company and the outcomes have been represented in table 2. Calculated costs associated with inventory for the years 2014-15.

2015-16, 2016-17 have been shown in table 3, 4 and 5 respectively and fig 3, 4 & 5.

Table 2: Data output (2014-17)

		2014-15		2015-16		2016-17	
SN	**Terms**	**Proposed EOQ Model**	**Company's Model**	**Proposed EOQ Model**	**Company's Model**	**Proposed EOQ Model**	**Company's Model**
	Annual demand (kg)	40800	40800	43200	43200	45600	45600
	Order qty (kg)	1901	3343	1956	3600	2010	3857
	Number of order	21	12	22	12	23	12

Table 3: Inventory associated Costs (2014-15)

2014-15			
S.N.	**Terms**	**oposed EOQ Model**	**Company's Model**
1.	Holding cost (Rs.)	1996	3510
2.	Ordering cost (Rs.)	1953	1116
3.	Total cost (Rs.)	3949	4626
4.	Reorder level (kg)	4137	4137
5.	Minimum stock level (kg)	3257	3353
6.	Maximum stock level (kg)	5366	6808
7.	Average stock level (kg)	4312	5081

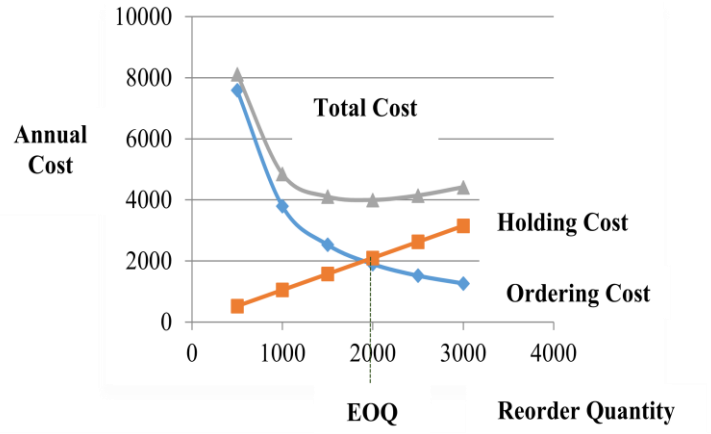

Fig. 3: Costs v/s Reorder Quantity (Proposed Model during 2014-15

Table 4: Inventory associated Costs (2015-16)

2015-16			
S.N.	**Terms**	**Proposed EOQ Model**	**Company's Model**
1.	Holding cost (Rs.)	2054	3780
2.	Ordering cost (Rs.)	2046	1116
3.	Total cost (Rs.)	4100	4896
4.	Reorder level (kg)	4377	4377
5.	Minimum stock level (kg)	3433	3551
6.	Maximum stock level (kg)	5628	7269
7.	Average stock level (kg)	4529	5410

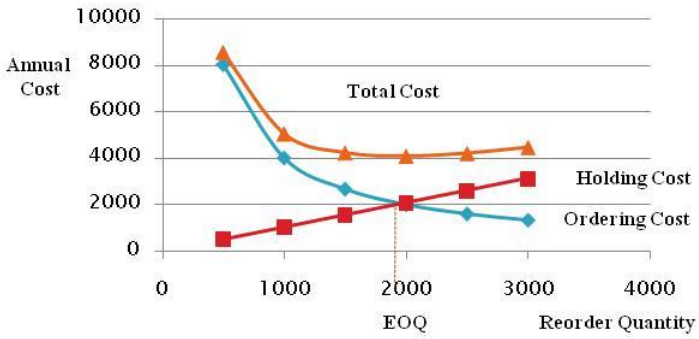

Fig. 4: Cost v/s Reorder Quantity (Proposed model during 2015-16)

Table 5: Inventory associated Costs (2016-17)

2016-17			
S.N.	**Terms**	**Proposed EOQ Model**	**Company's Model**
1.	Holding cost (Rs.)	2111	4050
2.	Ordering cost (Rs.)	2139	1116
3.	Total cost (Rs.)	4250	5166
4.	Reorder level (kg)	4623	4623
5.	Minimum stock level (kg)	3623	3748
6.	Maximum stock level (kg)	5823	7730
7.	Average stock level (kg)	4753	5739

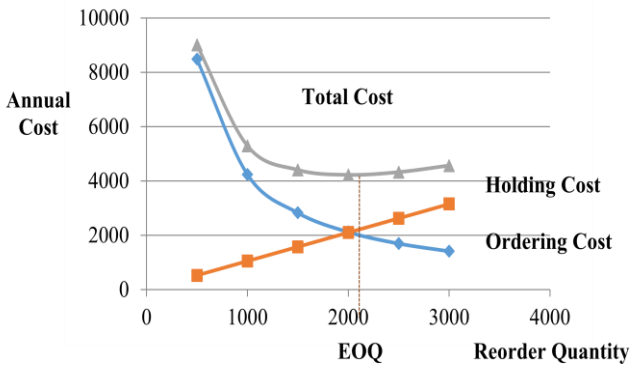

Fig. 5: Cost v/s Reorder Quantity (Proposed model during 2016-17

5. Conclusions

In this work, two models (one is used by company and other is the proposed model) have been compared to evaluate EOQ, Safety stock, Reorder point and the inventory associated costs. It has been observed that Economic Order Quantity has been reduced from 43.13% to 47.89% as compared to collected data, similarly holding cost and total cost have been reduced by 43.13% to 47.88%, and 14.63 to 17.73% respectively as compared to company data. It has also been observed that Minimum stock level, maximum stock level and average stock level are decreased by 2.86% to 3.34%, 21.18% to 24.67% and 15.13 to 17.18% respectively as compared to collected data from the company.

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