Economic order quantity – a tool for inventory management – a case study

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Abstract: Inventory refers to the stock of the products, a firm is offering for sale and the stock of sub-components that make up the product. In this research, the economic order quantity method for inventory management is used. In inventory management, economic order quantity (EOQ) is the order quantity that minimises the order quantity, ordering cost, number of orders, total annual cost, carrying cost, order size and average inventory. The purpose of this model is to decide order quantity and reorder point. This research goes throughout the process of analyse the company's current forecasting model and recommends an inventory control model. Order quantity and reorder point was recommended to reduce product inventory. In this work, a case study has been done for optimal inventory control, applied to B. Brown Medical India Pvt. Ltd. The researcher analyses a single product inventory in which cyclic review of inventory control, where separate unsystematic demand may be satisfied. A numerical study is provided to add insight into the results.

Keywords: supply chain management; inventory control; economic order quantity; forecasting; inventory cost.

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1 Introduction and literature review

Inventory is defined as a safeguard between supply and demand, compensating for variations in demand and safeguarding against variations in delivery lead time of raw materials. The resources which firms store as inventory in expectation of need are:

- raw materials
- semi-finished goods
- finished goods.

The raw material inventory contains thing that are purchased by the firm from another and are transformed into finished goods through the manufacturing process. They are vital inputs of the final product. The working process inventory consists of items being used in the production process.

Semi-finished goods are normally that material which is at various stages of production in a multi stage production process.

Finished goods represent final or completed products which are ready for transhipment to customers. The inventory of such goods consists of objects that have been produced but are yet to be sold.

The economic order quantity (EOQ) is the number of units that an organisation should add to inventory with each order to minimise the total costs of inventory such as holding costs, order costs and inventory cost. In inventory management, EOQ is the order quantity that minimises the order quantity, ordering cost, number of orders, total annual cost, carrying cost, order size and average inventory. It is one of the oldest classical production scheduling models.

This work is a case study in optimal inventory control, applied to B. Brown Medical India Pvt. Ltd. This company manufactures IV sets and sutures, right heart catheters and chip products. The company offers surgery, intensive care, plexus anaesthesia and acute and chronic dialysis equipment, including syringe, infusion pumps and FM systems, nerve stimulators and dialysis machines. Its products also include surgical instruments and implants; sutures, surgical specialties and vascular systems; disposables; and clinical nutrition and plasma volume replacement products. The company was founded in 1994 and is based in Mumbai.

In Lukinskiy et al. (2015), this paper is to develop a methodical approach and to come up with a computational approach to assessing the impact of different logistics operations factors on TLC and SL.

Agus and Noor (2006) did measure the insight of managers about the effect of inventory management practices on financial performance of manufacturing firms in

Malaysia. Eneje et al. (2012) did measure effect of efficient inventory management on profitability of breresearcherries in Nigeria.

In Bhunia et al. (2017), they formulate a production-inventory model to investigate the effects of partially integrated production and marketing policy of a manufacturing firm and minimisation problems for production and research and development departments, have been formulated and solved. For solving these optimisation problems, an efficient soft computing algorithm based on particle swarm optimisation-constriction factor (PSO-CO) is proposed.

After reparation process, the repaired products are returned to the buyer store. Considering the time when the lot of repaired products arrives to the buyer store, four cases are identified and studied.

In Cárdenas-Barrón et al. (2014), 41 papers covering an extensive scope of inventory management have been incorporated in this volume from contributing authors from 20 countries located in the USA, Asia, Europe and Africa. This special issue also provides a basis for new directions in inventory management research.

Pacheco-Velázquez et al. (2016) extends the mentioned algebraic approach to the EPQ formula taking shortages into consideration within the case of only one backlog cost per unit and time unit.

Wang et al. (2015), in their paper, an EOQ model for imperfect quality items with partial backordering under screening errors is studied.

Mukhopadhyay and Goswami (2016) formulated the mathematical model and the procedures to derive the optimal solution are discussed. The effectiveness of the proposed model is illustrated with the help of numerical examples. Sensitivity of the optimal order quantity and optimal cost for changes in various parameter values are also examined.

Sahari et al. (2012) empirically examined the relationship between inventory management and firm performance along with capital concentration. For the purpose, they took a sample of 82 construction firms in Malaysia for the period 2006–2010. Using the regression and correlation analysis methods, they assumed that inventory management is positively correlated with firm performance. In addition, the results indicate that there is a positive link between inventory management and capital intensity.

Anichebe and Agu (2013) observed the effect of inventory management on organisational effectiveness in selected organisations in Enugu, Nigeria. Using an expressive research and a sample size of 248 defendants, they established that there is significant relationship between good inventory management and organisational effectiveness. Inventory management was found to have an important effect on organisational productivity. There was a high positive connection between good inventory management and organisational profitability. They concluded that inventory management is very vital to the success and growth of organisations. The entire profitability of an organisation is tied to the volume of products sold which has a direct relationship with the quality of the product.

Roach (2005) explains that the EOQ has been a well-known formula that analyses the optimal EOQ. Roach describes how the origin of the EOQ started in his article, 'Origin of the economic order quantity formula; transcription or transformation?', published in 2005.

In the article, 'Optimizing economic order quantity', issued by Piasecki in 2001, focused on the EOQ. Piasecki (2001) indications that in today's leading technology, many companies are not taking advantage of the fundamental inventory models. There

are various software packages in aiding companies with inventory control, but if the data entered are inaccurate, it may lead to poor results (Piasecki, 2001).

2 Methodology adopted

The EOQ model considers the exchange between ordering cost and storage cost in choosing the quantity to use in restores item inventories. This model can also be defined as the cost minimising order quantity.

This model is the easiest way for calculating inventory. EOQ may be calculated as:

- Economic order quantity = √2 ∗ total units required ∗ cost per order / ordering cost

$$EOQ = \sqrt{2AO_c} \big/ C_o \tag{1}$$

- Ordering cost = cost per order ∗ no. of orders

$$C_o = O_c * N \tag{2}$$

- Number of orders for the year = total units required / economic order quantity

$$N = A / EOQ \tag{3}$$

- Total annual cost = carrying cost + ordering cost

$$T_c = C_c + C_o \tag{4}$$

- Carrying cost = order size ∗ average inventory

$$C_c = S * I_A \tag{5}$$

- Order size = total units required / no. of orders

$$S = A / N \tag{6}$$

- Average inventory = order size / 2

$$I_A = S / 2 \tag{7}$$

Equations (1), (2), (3), (4), (5), (6) and (7) have been implemented for calculating the EOQ, ordering cost, number of orders, total annual cost, carrying cost, order size and average inventory, respectively where:

A total units required

I_{max} max. inventory

Q_t in-transit inventory

Q_b surplus inventory

EOQ economic order quantity

T_c total annual cost

C_c carrying cost

C_o ordering cost

O_c cost per order

S order size

N number of orders for the year

I_A average inventory.

B. Braun Medical India Pvt. Ltd. uses its inventory model to calculate final products inventory and the data collected for three consecutive years is represented in Table 1.

Table 1 Data collected from company

Year / *Data*	*2016*	*2015*	*2014*
EOQ	3,600	3,805.4	1,885
Ordering cost	77,500	78,000	35,580
Number of order	34	39	20
Total annual cost	5,737,635	7,344,567	1,600k
Carrying cost	6,348,443	7,552,467	1,666k
Order size	3,400	3,700	1,850
Average inventory	1,800	1,800	1,200

Note: ISO standard.

The collected data has been implemented in the proposed model and the results obtained are discussed in Section 3.

3 Results and discussions

As a matter of fact, the inventory management techniques are a part of production management, but a familiarity with them is of great help to the financial managers in planning and budgeting inventory. The purpose of EOQ models is to decide how much to order and when to order. This research goes throughout the process of analyse the company's current forecasting model and suggest an inventory control model. A case study for inventory control has been done on B. Brown Medical India Pvt. Ltd. The company offers surgery, intensive care, plexus anaesthesia and acute and chronic dialysis equipment, including syringe, infusion pumps and FM systems, nerve stimulators and dialysis machines.

Comparison of collected data and the data received from the opted model has been shown in Table 2.

After implementing the EOQ model as discussed above, it has been observed that the number of orders, ordering cost, total annual cost, carrying cost, order size, average inventory and order quantity has been reduced to a great extent and graphical results are shown from Figures 1 to 7.

Figure 1 Comparison of inventory cost (see online version for colours)

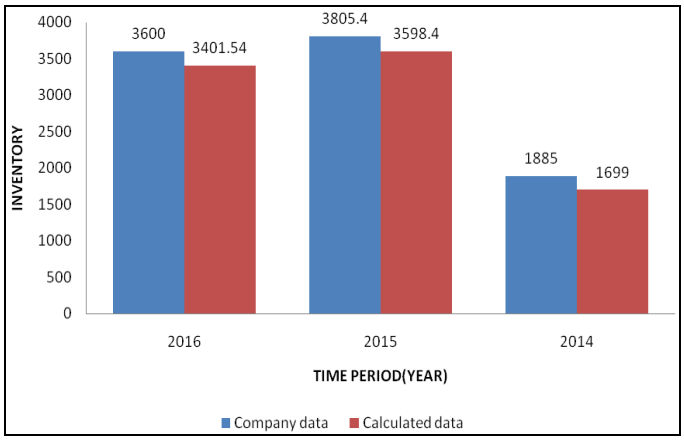

Figure 2 Comparison of ordering cost (see online version for colours)

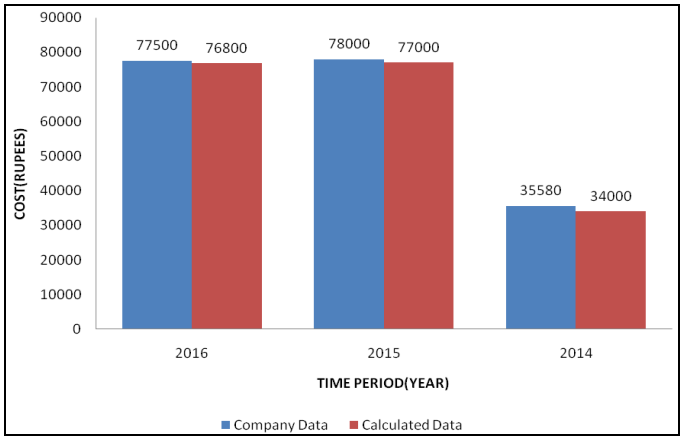

Figure 3 Comparison of number of orders (see online version for colours)

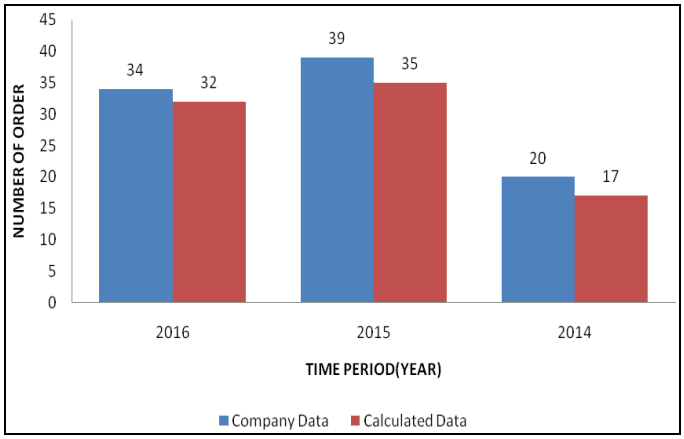

Figure 4 Comparison of total annual cost (see online version for colours)

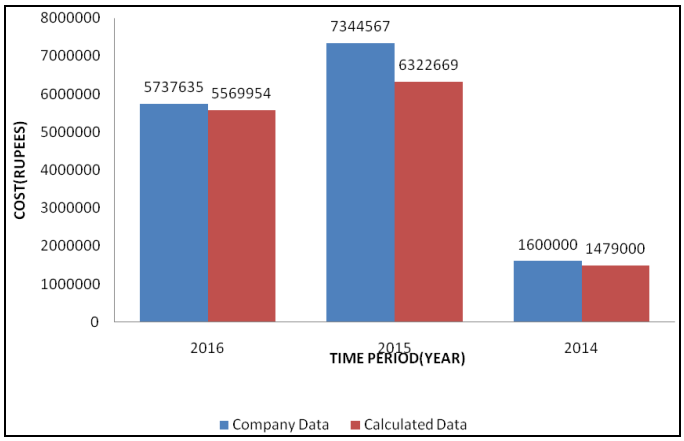

Figure 5 Comparison of carrying cost (see online version for colours)

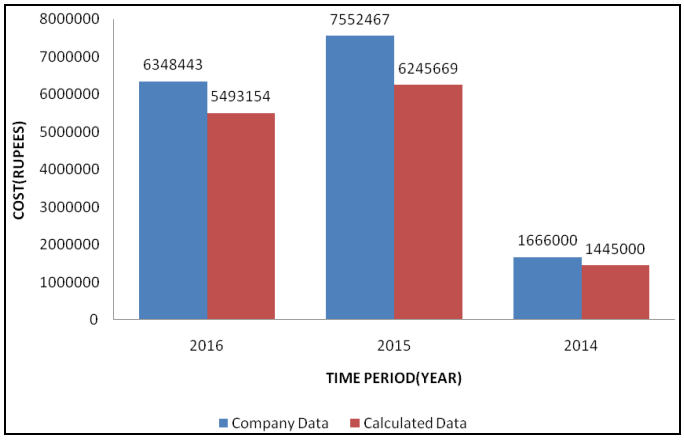

Figure 6 Comparison of order size (see online version for colours)

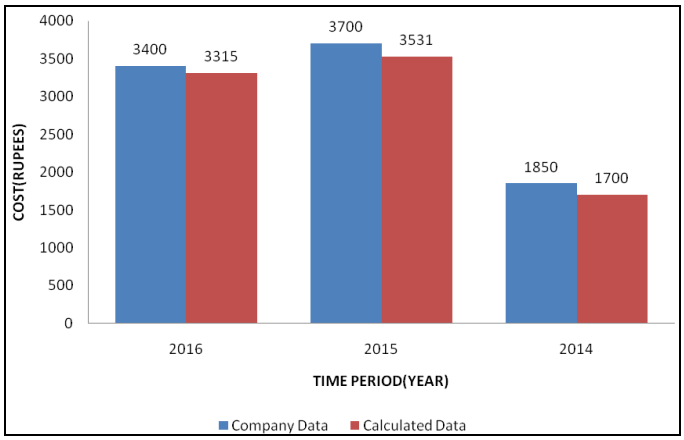

Figure 7 Comparison of average inventory (see online version for colours)

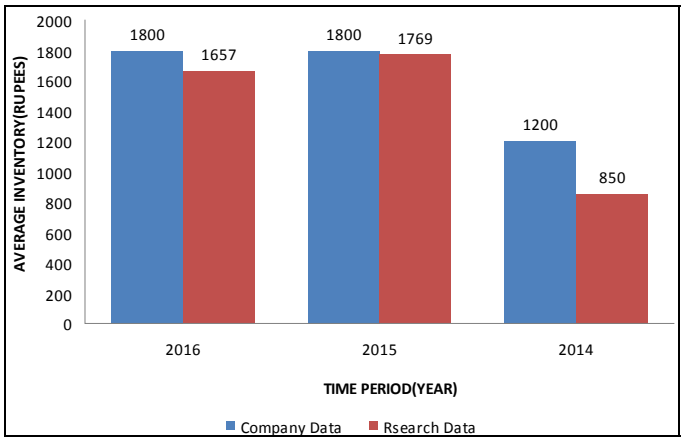

Table 2 Comparison of company data and research data at different years

Year / *Data*	*2016*		*2015*		*2014*	
	Company data	*Research data*	*Company data*	*Research data*	*Company data*	*Research data*
EOQ (Rs.)	3,600	3,401.54	3,805.4	3,598.4	1,885	1,699
Ordering cost (Rs.)	77,500	76,800	78,000	77,000	35,580	34,000
Number of order	34	32	39	35	20	17
Total annual cost (Rs.)	5,737,635	5,569,954	7,344,567	6,322,669	1,600k	1,479k
Carrying cost (Rs.)	6,348,443	5,493,154	7,552,467	6,245,669	1,666k	1,445k
Order size	3,400	3,315	3,700	3,531	1,850	1,700
Average inventory (Rs.)	1,800	1,657	1,800	1,769	1,200	850

Note: ISO standard.

Results indicate that the inventory cost for the year 2016 has been reduced up to 5.83%, for the year 2015 up to 5.75% and reduction up to 10.71% for the year 2014. The ordering cost has been reduced up to 0.91%, 1.29% and 4.64% for the year 2016, 2015 and 2014, respectively. Similarly, it has been found that the number of order for the year 2016 has been reduced up to 6.25%, for the year 2015 has been reduced up to 11.42% and for the year 2014 has been reduced up to 17.64%. The total annual cost has also been decreased up to 3.01% for the year 2016, up to 16.16% for the year 2015 and up to 8.18% for the year 2014. The carrying cost for the year 2016 has been reduced up to 15.57%, for the year 2015 has been reduced up to 20.92% and for the year 2014 has been reduced up to 15.29%. The order size has been reduced up to 2.56% for the year 2016, has been reduced up to 4.78% for the year 2015 and has been reduced up to 8.82% for the year 2014. The average inventory for the year 2016 has been reduced up to 8.63%, for the year 2015 has been reduced up to 1.75% and for the year 2014 has been reduced up to 41.17%.

4 Conclusions

Inventories can be said as stock of raw materials, components and work in process, spare parts and finished product. Inventory management has to keep accurate records of finished goods that are ready for shipment. Accurately maintaining figures on the finished supplies inventory makes it possible to quickly express information to sales workers as to what is presented and ready for shipment at any given time. Inventory management is vital for keeping costs down, while meeting regulation. EOQ was recommended to help decrease product inventory. The purpose of this model is to decide how much to order. Inventory management is essential for keeping costs low, while meeting guidelines. Supply and demand is a delicate balance and inventory management hope to guarantee that the balance is uninterrupted. Inventory management will be seen in the forms of increased income and profits, positive employee atmosphere and on overall increase of customer satisfaction. In this work, it has been concluded that by opting EOQ model the number of orders, ordering cost, total annual cost, carrying cost, order size, average inventory and EOQ has been reduced to a great extent. Results indicate that the inventory cost for the year 2016 has been reduced up to 5.83%, for the year 2015 up to 5.75% and reduction up to 10.71% for the year 2014. The ordering cost has been reduced up to 0.91%, 1.29% and 4.64% for the year 2016, 2015 and 2014, respectively. Similarly, it has been found that the number of order for the year 2016 has been reduced up to 6.25%, for the year 2015 has been reduced up to 11.42% and for the year 2014 has been reduced up to 17.64%. The total annual cost has also been decreased up to 3.01% for the year 2016, up to 16.16% for the year 2015 and up to 8.18% for the year 2014. The carrying cost for the year 2016 has been reduced up to 15.57%, for 2015 the year has been reduced up to 20.92% and for the year 2014 has been reduced up to 15.29%. The order size has been reduced up to 2.56% for the year 2016, has been reduced up to 4.78% for the year 2015 and has been reduced up to 8.82% for the year 2014. The average inventory for the year 2016 has been reduced up to 8.63%, for the year 2015 has been reduced up to 1.75% and for the year 2014 has been reduced up to 41.17%.

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