DETERMINATION OF ECONOMIC ORDER QUANTITY AND REORDER POINT INVENTORY CONTROL MODEL FOR XYZ RETAIL ENTERPRISES

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ABSTRACT

The economic order-quantity model considers the tradeoff between ordering cost and storage cost in choosing the quantity to use in replenishing item inventories. A larger order-quantity reduces ordering frequency and hence ordering cost per month, but requires holding a larger average inventory, which increases storage (holding) cost/month. On the other hand, a smaller order-quantity reduces average inventory but requires more frequent ordering and higher ordering cost/month. The cost minimizing order-quantity is called the Economic Order Quantity (EOQ). Since the retail can be unpredictable and competitive the interest of seeing how forecasting can affect the economic order quantity and the reorder point. To assist company in finding alternative method to solve their forecasting issue. The purpose of this paper is to recommend an alternative way to help to reduce the company's stock by providing more efficient forecasting method along with an economic order quantity and reorder point model. In approach of doing so selling of the product of previous two years or eight quarter has been analyzed. In addition the cost estimation would be calculated to see the significance between both current model and recommended model.

Keywords: Economic Order Quantity, Forecasting, Reorder Point and Inventory Cost.

1.0 ABOUT COMPANY

XYZ Retail Enterprise had a humble beginning in 1981 with a 200 sq. ft. outlet named as ABC Textile. By 2004, the enterprise expanded its outreach with first Retail outlet with exclusive Sarees and Salwar Kameez store. The business grew multi-fold with 250000 sq. ft. showroom in 2006 at C.G., 27000 sq. ft. showroom in M.P. in 2009 & 25000 sq. ft. in M.H in 2010.

XYX Retail Enterprise is the first ISO 9001-2008 store in C.G. in retail, it was awarded the title of best retail store of Chhattisgarh by the Honorable Chief Minister of Chhattisgarh.

1.1 Problem Identification

The present forecasting model used in XYZ Retail Enterprise has brought problems due to ineffective forecasting that has resulted in product stocks out and loss of sale. The forecasting method used is rolling average method which takes previous demand and calculates the average for the next forecasting period by doing this method variability is not taken into account due to historical demand which can cause inaccurate forecasting results. Essentially the purpose of the paper was to recommend alternative way to help to reduce company's stock out by providing a more effective forecasting method along with economic order quantity and reorder point.

2. LITERATURE REVIEW

Every manufacturer is confronted with the problem of finding the most economical quantity to manufacture in putting through an order. This is a general problem and admits of

a general solution, and however much it may be advisable to exercise judgment in a particular case, such exercise of judgment will be assisted by knowledge of the general solution. The writer has seen the practical workings of a first-class stock system and does not wish to be understood as claiming that any mere mathematical formula should be depended upon entirely for determining the amount of stock that should be carried or put through on an order. This is a matter that calls, in each case, for a trained judgment, for which there is no substitute. There are many other factors of even more importance than those given in this discussion. But in deciding on the best size of order, the man responsible should consider all the factors that are mentioned. While it is perfectly possible to estimate closely enough what affect these factors will have, the chances are many mistakes costing money will be made. Hence, using the formula as a check is at least warranted. Given the theoretically correct result, it is easy to apply such correction factors as may be deemed necessary. In determining the economical size of lot, the following factors are involved:

2.1 Inventory Control

Inventory Control is defined as scientific method of finding how much stock should be maintained in order to meet product demand and able to provide right type of material at right time in right quantity at right price.

2.2 Economic Order Quantity

Economic order quantity is also known as reorder quantity. Economic order quantity (EOQ) is a level of inventory where the total cost of holding inventory is at minimum. Economic order quantity is the level of quantity at which the cost of ordering will be equal with the storage cost of materials. In other words, the quantity of materials which is economical to be ordered at one time is known as economic order quantity. The total costs of materials consist of the ordering cost and carrying cost. While determining the economic order quantity, the ordering cost and carrying cost should be considered.

2.2.1 History of Economics Order Quantity

Bill Roach explains how the origin of the Economic Order Quantity began in his article, "Origin of the Economic Order Quantity formula; transcription or transformation?" published in 2005. Roach explains that the Economic Order Quantity (EOQ) has been a well-known formula that calculates the optimal economic order quantity. He also mentions how Ford W. Harris contribution to the EOQ formula was significant. Harris was always a self-taught individual that only received formal schooling that extended throughout high school. He managed to write and publish the economic order quantity formula in 1915 as an undergraduate student. (Roach 2005)

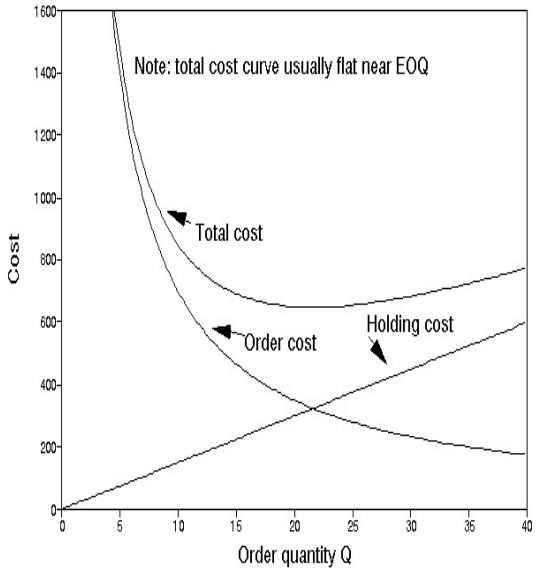
The Economic Order Quantity (EOQ) formula has been used in both engineering and business disciplines. Engineers study the EOQ formula in engineering economics and industrial engineering courses. On the other hand, business disciplines study the EOQ in both operational and financial courses. In both disciplines, EOQ formulas have practical and specific applications in illustrating concepts of cost tradeoffs; as well as specific application in inventory (Roach 2005).

2.2.2 Optimizing Economic Order Quantity

In the article, "Optimizing Economic Order Quantity," published by Dave Piasecki in 2001, focused on the economic order quantity. Piasecki mentions 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 inputted are inaccurate, it may lead to poor results. (Piasecki 2001) In order to have suitable results for any inventory model, accurate product costs, activity costs, forecasts, history, and lead times need to be in place. (Piasecki 2001) As a result of bad data, companies have had bad experience with some inventory models, and that is one of the reasons they do not take advantage of the EOQ model.

Piasecki also explains that another reason why a company does not take advantage of the EOQ model is because management does not know how it works. (Piasecki 2001) Even if a company has implemented a leading software package to help them, if they do not know how the system works it could cost

more harm than good. Many times the users do not understand how the data is calculated and how the system is set up. They simply rely on the system built- in default software calculations, which in most cases, the system is "out of whack". (Piasecki 2001) In order to prevent the system from going "out of whack," management as well as the user, need to obtain proper knowledge of the EOQ concepts and how they are derived. The software is only design to aid and not replace the traditional way of running a business.



2.2.3 A Technique for Applying EOQ Models to Retail Cycle Stock Inventories

The focus of this article was to apply the EOQ model to small business in order to calculate the order quantity in dollar amount for each vendor. William Bassin illustrated how the EOQ model minimized the total cost of ordering and carrying stock in small businesses. Bassin calculates the order quantities based on existing data in an easy to use Microsoft Excel spreadsheet. As a result for using an EOQ system, small businesses could:

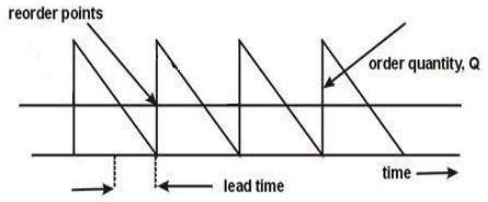
1. Yield cost savings by reducing inventory investments
2. Not requiring measurement of or assumption about ordering and carrying cost.
3. Keying the technique to the current mode of doing business.

2.3 Reorder Point and Safety Stock

Another important technique used along with the Economic Order Quantity is the Reorder Point (ROP) and Safety Stock. According to Fangruo Chen, the ROP quantity reflects the level of inventory that triggers the placement of an order for additional units**.** Whereas, the quantity associated with safety stock protects the company from stock outs or backorders. Safety stock is also known as a "buffer". In Figure 2, the graph illustrates how the reorder point is connected with the lead time and the order quantity as a function of time.

In determining the reorder point the following three factors need to be at hand:

1. Demand – Quantity of inventory used or sold each day
2. Lead time- Time it takes for an order to arrive when an order is placed.
3. Safety Stock- The quantity of inventory kept on hand in case there is a unpredictable event like delays in lead time or unexpected demand.



2.4 Forecasting

Forecasting is the activity of estimating the quantity of a product or service that consumers will purchase. There are different forecasting methods that can assist in predicting the quantity of a product a consumer will purchase. Choosing what forecasting method to use from a Company's historical sales data can be quite challenging.

The article, "Using Composite Moving Averages to Forecast Sales" by DJ Rob and EA Silver, states that the demand average of two periods can provide a better forecast than that of a single moving averages. (Rob, Silver 2002) This method is known as the simplest forecasting method. A more detailed explanation of this simple method will be explained during the execution of this project.

Extensive topic research was conducted to gain knowledge of the concepts used to complete the project. The authors researched have done an excellent job conveying their material and how each variable can affect different scenarios due to demand variability. The essential material used was the forecasting techniques along with the economic order quantity methods. The methods used ensured that appropriate steps were taken to fully understand the concept in order to build an inventory control model for XYZ Enterprises,

2.5 Design

Although the EOQ system has been around for many years and it is a quite simple formula to understand, companies seem to be fading away from this method. New alternatives have been introduced like Material Requirement Planning (MRP), which deals more with manufacturing process, but can also be used in retail. MRP has an important forecasting method that deals with forecasting conditions which were essential in order to calculate the products seasonal trends. Therefore, in order to recommend an EOQ analysis model for Company showroom, several MRP methods were incorporated in the calculations.

2.6 Collecting Data

Sales of Jeans pants, T-Shirt, Girl's Tops are chosen from Company outlet database that is considered to be high revenue level items. Two years worth of historical data is obtained in order to see the products sales behavior due to its demand to help with establishing a forecasting trend for each product. Along with the products historical data, the products ordering cost, purchasing cost and unit cost is collected to calculate the products total annual cost. The data also is used to establish the economic order quantity and the reorder point of each product. Once the data is collected, analyzing it is the first initial step.

2.7 Analyzing the data

In the analysis portion of the project, there were several methods used in conjunction with the EOQ and ROP model. One method, as mention earlier in the report, was demand forecasting which included seasonal and annual trends. These techniques used to calculate the annual trends involved moving averages and exponential smoothing. Furthermore, the annual trend was used in the EOQ model as the annual demand in order to manipulate the fix order cost or the holding cost of each product. Moving averages consist of two simple techniques that involve simple moving average and weighted moving averages. For both moving averages, if the periods increase then the forecast becomes more stable in the calculations.

3. DATA COLLECTION AND ANALYSIS

3.1. Methodology

Once the design was established, it was used as the projects guideline to ensure proper steps were taken to complete the project. In this portion, the processes of each method used as well as assumptions taken are explained in order to show how the results were obtained.

3.2 Data

The data collected was provided by the XYX which included the products sales, holding cost, ordering cost and unit price for their previous two years. Only two years worth of data was provided because the company's database only retains that amount. The first step taken was to sort out the problem and insert their historical demand into an excel spreadsheet to see the products behavior.

3.3 Forecasting Method

A forecasting method was used to aid the company reduce stock outs as well as to help them understand alternative ways for forecasting due products behaviors. For this particular reason, plotting the demand in excel was essential to see the forecasting trends. The products were sorted into two categories, seasonal index and moving averages due to the products demand behavior which was shown in the excel graphs. By separating each product in two categories, it would ensure we use the correct method of forecasting to get the most accurate result. This process was extremely important because it would be the use as the constant demand when calculating the economic order quantity as well as the reorder point for the recommended analysis.

3.3.1 Simple Moving Average

There is one product i.e. Jeans pant where we use simple moving average. These products

had constant demand from quarter to quarter, but there was still some noise (unexpected demand) in some quarters. Moving average is used for the product since they have the least variability, which would give a more accurate forecasting result. As mention earlier in the design process, moving average is the average value of previous periods calculated over the periods length. The data obtain was in months, but since there was a lot of variability from month to month in each product, picking quarter demand is more useful in the calculation. As a result of choosing quarters as the time period, the variability is reduced. The next step was to forecast for the next quarter using different time periods. So, forecasting is done using 2-8 periods and looked at how each forecasting period varied due to the amount of periods used. Ideally, using more periods would give you the best results since you have more historical data, but it's not always true. In moving average, one of the most important factors to take into consideration is calculating the mean average deviation (MAD) of the demand. So, if you don't calculate the MAD value for each period used, then the forecasting would have more variability. The MAD value provides the least variability in each period, so the lower the MAD value, the more accurate the forecasting.

An example of a product forecast is shown in table 1.1 to illustrate the difference in forecasting and the difference in the MAD value. In table 1.1, the highlighted portion indicates how many periods gave the best forecasting result with least
Variability.

3.3.2 Seasonal Index

There are two products that fit the seasonal index category. In this method the demand is not considered to be constant from quarter to quarter.

Due this unpredictable demand, seasonal index is used to make any seasonal adjustments throughout the year. This behavior is when the product goes through a demand cycle that imitates or is similar to a sinusoidal trend.

3.4 Economic Order Quantity

Most of the data was provided by the company to calculate the economic order quantity for each product. In the data gathered, as mention in our literature review, an EOQ is used to minimize stock outs and find the optimal order quantity while minimize total cost associated with each product. The holding cost and order cost are equal when the optimal order quantity is obtained. As mention in the literature review, all the variables needed in order to calculate the optimal order quantity are given. For their current method, to calculate the ordering cost for each product additional data was collected. The additional data collected was the number of orders placed per year, quarter and monthly. Only the orders placed per quarter were useful since all the calculations were done in based on quarter demand. With this data, the holding cost and the ordering cost was determined in order to compare the cost estimates from their current method and the recommended method. This portion of the project was the most challenging to complete because there was some reverse engineering involved to get the total cost for each product.

3.5 Reorder Point

Along with the economic order quantity, a reorder point was provided. The reorder point took in consideration the annual demand and the lead time. The lead time is the number of days it takes to receive the product when an order is placed. The reorder point states that an order needs to be placed once the product falls below a certain amount of units as indicated in the tables. Furthermore, the reorder point maintains enough stock to satisfy the demand between orders.

4. Result and Discussion

4.1 Demand and Cost Estimate:

Once the total cost was produced for all the three products for both, the company current method and the recommended EOQ, the cost estimates is calculated. There are two parts in the total quarter cost that was looked at closely in the calculations which are the holding cost and order cost. As shown in table 3.1, both current and the recommended methods show that both holding cost and order cost are associated to the thirteen products analyzed. The results looked reasonable, for instance, in their current method their holding cost is low compared to the recommended results. This illustrates that in the recommended method, the company would have to store more inventory

in their warehouse which would increase their holding cost. But when the order cost associated with the three products was compared, there was a significant difference in cost. This is because the company would order more frequently since they would have low inventory levels which created a high order cost. In the recommended method, both the holding cost and the order cost were equal due to the economic order quantity calculations. As mention earlier, the EOQ would give the optimal order quantity when both the holding cost and order cost are minimized.

4.2 Conclusion

The current forecasting model used in XYZ, Bilaspur (C.G) has brought problems due to ineffective forecasting and results in piling of stocks and loss of sales. In order to help them to reduce their stock outs a forecasting model was provided along with economic order quantity and reorder point. The recommended model provides two different forecasting techniques that allow a more accurate forecasting result for different products behavior. Finally the economic order quantity and the reorder point optimized the order quantity for each product when an order is placed. In previous method the company was ordering the number of products on the basis of mean of demand in respective quarters, thus total overall cost was Rs.31700.7. But in current method, forecasting of demand is done on the basis of moving average for Product-1 and seasonal index method for Product-2 and Product-3.On the basis of recommended forecast demand economic order quantity is determined, thus total overall cost is Rs.13981.1, which plays a key role in increasing profit. Reducing the company stock out problem by providing and recommending the inventory control model, the result have shown improvements in forecasting as well as cost reduction. So, if the company follows through and implements the recommended inventory model they would be able to reduce the cost of inventory by approximately **55.89%** per quarter and the total saving is **Rs.17719.4** per quarter.

4.3 Future Scope

The proposed project directs that the recommended concept of economic order quantity and reorder point level may be very advantageous for small enterprises to big industry which will not only make profit to the company but also it will boost the overall economic growth of the nation. As MRP has an important forecasting method that deals with forecasting conditions which were essential in order to calculate the products seasonal trends when both EOQ and MRP methods are incorporated together then the result would be more satisfactory.

REFERENCES

1. Cargal, James M. "The EOQ Inventory Formula."Http://www.cargalmathbooks.com.

2. Carter, Joseph, Bruce Ferrin, and Craig Carter. "On Extending Russell and Krajewski's Algorithm for Economic Purchase Order Quantities." *Decision Sciences*, 26.6 (1995): 819.

3. Hillier, Frederick S., and Gerald J. Lieberman. *Introduction to Operations Research and Revised CD-ROM 8*. 8th ed. New York: McGraw-Hill Science/Engineering/Math, 2005. Print.

4. Lee Won. "Optimal Order Quantities and Prices with Storage Space and Inventory Investment Limitations." *Computers & Industrial Engineering*, 26.3 (1994): 481.

5. Putra. "How EOQ, EPR, Re-Order Point, Safety Stock Determin." 7 Dec. 2008.

6. Sudipta "An EOQ model with progressive payment scheme under DCF approach with price and credit sensitivity demand" International Journal of Advanced Engineering Research and Studies E-ISSN2249–8974(2013)