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Analysis of Inventory Management of Agro-based Industries using EOQ and EPQ Model with Profit Maximization

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ABSTRACT

Due to the perishable nature of agricultural product the Inventory management of Agro-based industry is a challenging tax. EOQ model and EPQ model has its importance & role for proper management of this category of Inventory. The success of many industries is related to their ability to provide goods and services at right time and in right place. Different organization adopt different inventory control methods to manage their inventory to avoid stock-out and overstock. This paper analyses possible parameters of existing literature, concentration, description of characteristics and of EOQ inventory control model and EPQ model that have been developed and can solve the Problem in this field & will provide maximum profit with the customer satisfaction.

Keywords : EOQ, EPQ, Inventory management, Holding cost, Ordering cost, production cost

I. INTRODUCTION

Industries that have agricultural produce as raw materials are known as Agro-based Industries. These are consumer-based industries. Food Processing Industries are based on agricultural raw materials as it needs all kind of agricultural raw material for its products. All branches of Agro-based industry are very important because they increase industrial products, provide employment, earn foreign exchange, increase income level and also provide employment to women and provide base for development for backward areas.

The most important factor in organization and the proportion of inventories to total asset is inventory management. Inventory management system has mainly two concerns, one is level of customer service i.e., to have right goods, in right place and at right time and other is cost of ordering and carrying inventories. Inventory management was not proper in this industry which is situated in Odisha. In this paper it is named as AK Industry because the identity of this market complex is protected. This industry is a M.S.M.E. This type of industry was facing many problems when overstock or stock out occurs in the market warehouse. To overcome these problems various methods can be used like JIT (Just in Time), Value stream mapping, EOQ and EPQ etc. In this paper an EOQ and EPQ method is selected for research work.

Bill Roach 2005 [1], explains how the origin of the Economic Order Quantity started 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. He wrote formula of EOQ in 1915, when he was still an undergraduate student. The formula of EOQ is used in business, also in engineering.

India as an agriculture base economy has its requirement for agriculture growth through the establishment & development of Agro-based industry which can be held & possible through successful business of agricultural products whereas success of any business is related to their ability to provide the satisfaction towards the customers and maximum selling of its product, has the required goods and services in the right place & time or proper/effective inventory management. An effective inventory management should maintain sufficient finished goods inventory for smooth sales operation, efficient customer services, minimization of the carrying cost and time, control investment in inventories, keep it at an optimum level, permits a better utilization for available stocks by facilitating interdepartmental transfers with a company. Effective inventory management for manufactured products is with the application of various models whereas Agriculture products with its inventory is big issue today need more attention because, it is difficult task to manage the agriculture products and its inventory due to their unique features such as the perishable nature, limited and unpredictable supply, prices and decision of how much to sell. This is the real case in the Odisha market.

In this case characterization of the optimal inventory (selling) policies has to be developed for variety of cost functions, Here the author has taken the linear cost which may be functioned & if will be relevant in practice, can derive closed form expressions for the optimal policies and the optimal discount profits with the help of EOQ model as a tool for its implementation and effective inventory management. Here the product is Tomato Sauce and Chilli Sauce.

Here the available data is taken for the analysis with the development of calculated cost, estimates to compare business and the recommended EOQ model to the business to implement & increase stocks and reduce reorder. Regardless of all other theory, applying this, EOQ theory to practice, it is possible to make selling decisions judiciously & can significantly make outer form of the prevailing practice of selling. EOQ is an inventory model which is for the fixed order size inventory and is a formula for determining the optimal order size that minimizes the sum of carrying costs and ordering cost which has the requirement of the demand forecasting of the particular region or by taking the usage of a particular product and its past data is available.

Economic Order Quantity (EOQ) and Economic Production Quantity (EPQ) both are widely and successfully used models of inventory management. Economic order quantity is the optimum order size that should be placed with a vendor to minimize blockage of funds and holding and ordering costs. At the same time, it is that adequate quantity of a product or part that will ensure unstopped production or sales activity in an organization. On the other hand, economic production quantity is the optimum lot size that is to be manufactured in a production unit to avoid unnecessary blockage of funds and excess storage costs. This production quantity is adequate to ensure uninterrupted work. Both models aim to minimize costs in an organization by keeping control of inventory. The target is to optimize inventory utilization so that money does not block in excess inventory. Also, the company should not face a shortage of inventory due to which production and

other processes get hampered. An optimum mix of major costs related to inventory like holding cost and ordering cost is worked out to keep costs under control.

Organization's inventory is an important component and its management is vital to the success and cost reduction of the firm's expenditure. In this field of effective inventory management, a number of scholars have done the research and with their suggestions & findings.

L. Bournee & D.H.T Walker (1977) Company performance depend upon many variables, either depends on sales marketing good human resource or the less production cost. Wee H M. (1999) Domestic and international research shows that the agricultural products are perishable products, and their inventory model is based on the study of perishable products. And the core elements in the perishable products are: 1) demand, 2) freshness, 3) loss rate J. W Toomy (2000), The role of inventory management is to maintain a desired stock level for every specific product item, where the systems that plan and control inventory must be based in the product, customer and the process of product that available in the inventory.

Prasad & TATA (2000) Batching of inventory helps NGOS to save on their transport cost which will eventually save on their total supply chain with total cost Wild (2002) recommends, proper warehousing of inventory so that when goods are ordered, they are held at the warehouse or the least item possible minimizing holding cost of inventory Kavalya (2004). Total cost model needs to be balanced by ensuring purchase costs, ordering cost and holding costs are minimized so that the firm can reap good profits and maintains its budgetary allocation for nongovernmental organization. Beamon and Kotleba (2006) explain that reorder level (ROL) is critical for human terrain organizations to achieve optimal efficiency and to be effective. They need to have two reorder levels one that is normal where as a second one that is for emergency cases in case of disaster. This improves performance and customer satisfaction. Lai & Chang (2009) it was found out that keeping moderate inventory is good and it enables an organization operate minimal expenses of holding and setup costs; eliminate unwanted lead time produce goods as per customer order. This enables and organization achieve total quality control as efficient and effective supply chain management are implemented in a firm's value chain. T. Lwiki & P. B Ojera (2013), Inventory management is a crucial part of a firm because mismanagement of inventory threatens a firm's viability such as too much inventory consumes physical space, creates financial burden and increases the possibilities of damage, spoilage, and loss. A. Swain, D. Samal, A. Kalam (2018), explain the inventory of potato in Odisha market to prevent the loss and farmer's suicide. D. Samal, A. Kalam (2021), explain the inventory of Ghee in RKL market to prevent the loss and customer satisfaction. Anantadjaya, S. P., Nawangwulan, I. M., Irhamsyah, M., & Carmelita, P. W. (2021). discussed about Supply Chain management, inventory management & financial performance: evidence from manufacturing firms.

II. ASSUMPTIONS & NOTATION

Constant Demand and Easy Restocking

Both models assume the demand to be constant over the year. The EOQ model assumes that the product is easily available in the open market. Its replenishment will happen as soon as it reaches the minimum threshold level. Similarly, the EPQ model assumes that the production capacity aligns with the requirements. And the product can happen as the stock goes down below a minimum level. It will ensure no stock-out situation. And, also successfully took care of all demand.

Constant Price

Both models assume the price of the product to be constant all through the year. While making a

purchase under EOQ or producing the product under EPQ, the price does not vary. Also, no discounts are on offer on quantity or value.

Constant Quality

Both models assume that the quality of the products purchased or produced remains the same all year-round. There is no variation in it due to which the demand also does not change.

1) Holding and Ordering Costs remain Unchanged.

Holding the cost of inventory is the cost of stocking and maintaining inventory. It can be in the form of rentals for the storage area, salaries of personnel looking after the inventory, electricity bills, repairs, maintenance, etc. Ordering costs are the costs at the time of placing an order for the inventory. These can be in the form of freight, packing and forwarding charges, etc.

Both models have the assumption that these costs will remain unchanged throughout the year. Besides, the EPQ model assumes that the set-up costs of production also remain constant throughout the year. And this set-up cost will not change with the production length.

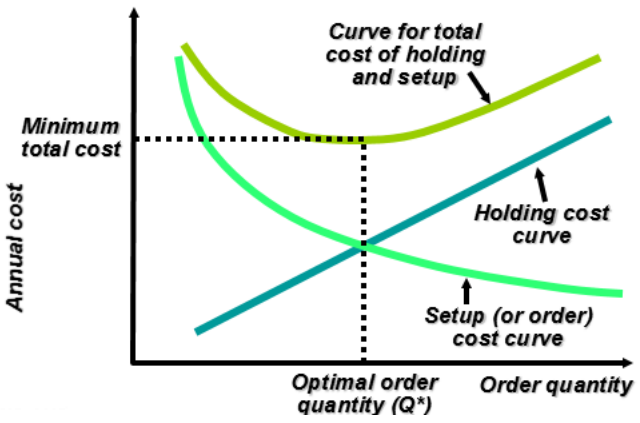

Figure 1: EOQ Model

$$EOQ = \sqrt{\frac{2D.O}{H}}$$

Q= The EOQ order quantity. this is the variable we want to optimize. All the other variables are fixed quantities.

D = the annual demand of product in quantity /unit time.

O = the product order cost. This is the flat fee charged for making any order is independent of Q.

C= Unit cost

H = Holding cost/unit

A = Demand for the year

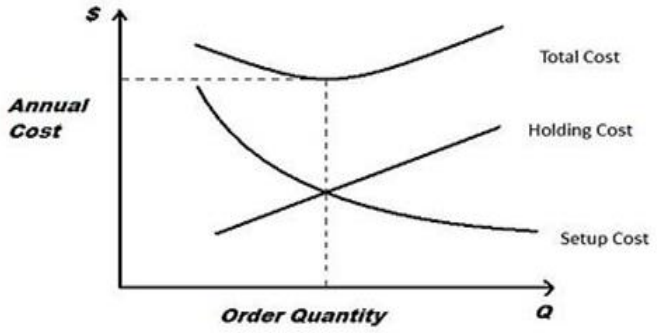

Figure 2: EPQ Model

$$EPQ = \sqrt{\frac{2D.O}{H(1-x)}}$$

Here, x= D/ P where P= Production rate.

Limitations of EOQ and EPQ Model:

Unrealistic Assumptions:

The most significant limitation of both models is that the assumptions are unrealistic.

- Both models assume the holding cost, ordering cost, demand, price, quality, etc. of the product or part to be constant throughout the year. It is not realistic in the real world.
- Holding and ordering costs may vary due to change in rentals, salaries of personnel, and other overhead expenses.
- Constant demand, as well as the price of a product, can hardly be constant. They fluctuate a lot in the real world.
- Consumer income, tastes, and preferences, prices of inputs and raw materials, seasonal variation in demand, etc. are key factors that will affect demand as well as price.

Similarly, the assumption of the constant quality of the product is not realistic, especially under the EPQ model. The quality of the product generally changes with every production batch. The production process also does not remain constant because of factors like an interruption in power supply, breakages, and repairs in plant and machinery, overheating, change in the quality of inputs and raw materials, etc. Also, the model does not consider wastages or damages in the production process due to which the product quality may go wrong, directly impacting the demand for the product.

Differentiation Table

Both models aim to minimize costs in an organization by keeping control of inventory. The target is to optimize inventory utilization so that money does not block in excess inventory. Also, the company should not face a shortage of inventory due to which production and other processes get hampered. An optimum mix of major costs related to inventory like holding cost and ordering cost is worked out to keep costs under control.

Basis	EOQ	EPQ
Meaning	Economic order quantity is the optimum order size that should be placed with a vendor to minimize blockage of funds and holding and ordering costs	Economic production quantity is the optimum lot size that is to be manufactured in a production unit to avoid unnecessary blockage of funds and excess storage costs
Formula	$EOQ = \sqrt{\frac{2D.O}{H}}$	$EPQ = \sqrt{\frac{2D.O}{H(1-x)}}$
Production	The company itself is not producing the item under consideration	The company is the producer itself of the part under consideration
Lead Time	The presence of constant lead time is assumed	There is no such assumption

III. CALCULATION OF EOQ

It determines the optimal amount of those cost that affected both by the amount of inventories held and the number of orders made. Ordering in bulk at the same time will increase the costs of maintaining a small business, because that will increase the number of stocks in the warehouse, while ordering costs will be lowered. Increasing the number of orders reduces holding costs but increases the costs of ordering. EOQ model minimizes the amount of these costs, which found a formula that shows the connections between the costs of maintaining and ordering and annual demand for the material. Here the authors have taken the data of AK industry who produce Tomato and Chilli Sauce and sell. Significant costs affecting the determination of the optimal inventory levels are holding costs and ordering costs. Significant holding costs are only those that differ with respect to inventory levels. This includes the opportunity cost of the holding funds, invested in stocks, which is reflected by the cost of wanted return from investing in stocks compared with any other investment alternative. For the firm the required return is 25%. In other holding costs, it is included storage and security and electricity and the cost of electricity goes to 12000 for 12 months. In ordering costs there are included costs for transportation which relate to the number of units ordered. Society makes a supply once in every week and the charge is 10000.

Economic order Quantity (EOQ) can be determined by reflecting the total costs for different amounts of orders through the formula. For the EOQ'S determination, we need the annual demand data, the cost of ordering and cost of holding. In this paper for

experiment we supposed to calculate EOQ for the Tomato Sauce and Chilli Sauce which is sold.

Monthly Demand (Raw Materials)

Material	Amount
Type-I	12 quintal
Type-II	7.5 quintal
Type-III	3 quintal

The AK industry calculates demand for Tomato Sauce and Chilli Sauce based on average monthly turnover. It works 365 days a year. So the annual demand for the Tomato Sauce and Chilli Sauce are

D1= 12 quintals/one month ×12 = 144 quintals.

holding cost=0.3 per unit per year

The purchase price for 1 k.g. is Rs 30/- i.e, C1=Rs 30/- per k.g.

D2= 7.5 quintals/one month ×12 = 90 quintals.

holding cost=0.3 per unit per year

The purchase price for 1 k.g. is Rs 20/- i.e, C2=Rs 20/- per k.g.

D3= 3 quintals/one month ×12 = 36 quintals.

holding cost=0.3 per unit per year

The purchase price for 1 k.g. is Rs 50/- i.e, C3=Rs 50/- per k.g.

C=(C1+C2+C3)/3=100/3

H=h*C

$D=D_1+D_2+D_3$

According to the data, they order one time in a month and the total charge is Rs. 66000/-Ordering cost It includes the cost of transportation cost, it orders once in a month a truck of raw materials charge Rs 6000.

So, the price excluding transportation cost is

66000-6000=60000

Therefore, raw material purchased $\frac{60000}{(100/3)} = 1800\,k.g$

Ordering cost per k.g.= $\frac{6000\times12}{1800} = 40$

So EOQ= $\sqrt{\frac{2\times21600\times40}{0.3\times(100/3)}} = 415.69k.g$

So, the economic order for the raw materials is approximately 4.15 quintals per order to minimize the cost.

D_1= 45 quintals/one month ×12 = 540 quintals.

Holding cost=0.03 per unit per year

The Selling price for 1 k.g. is Rs 70/- i.e, C=Rs 70/- per k.g.

D_2= 63 quintals/one month ×12 =756 quintals.

$D=D_1+D_2$

Holding cost=0.3 per unit per year

The Selling price for 1 k.g. is Rs 60/- i.e, C=Rs 60/- per k.g.

Therefore, total order for 10800

Ordering cost per k.g.= $\frac{58500\times12}{10800} = 65$ Average

$$EPQ = \sqrt{\frac{2D.O}{H(1-x)}}$$

Here, x= D/ P, where P= Production rate

EPQ= $\sqrt{\frac{2\times10800\times65}{0.3\times(0.1)}} = 6841.05k.g.$

So, the economic production quantity is approximately 68.41 quintals per order to minimize the cost.

IV. RESULT ANALYSIS

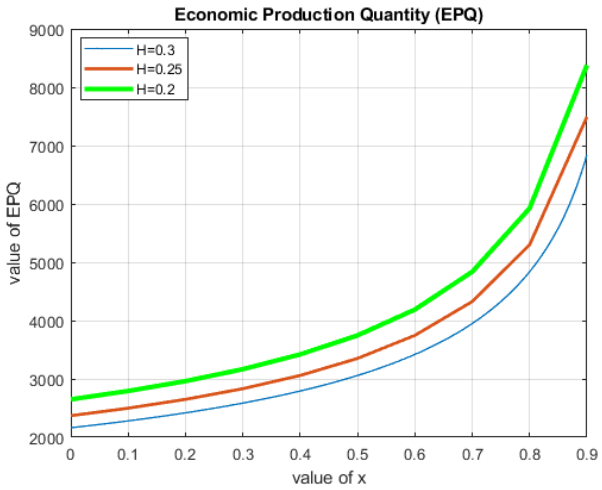

Figure 3

From the Figure 3, it reveals that EOQ is directly proportional to ordering cost and inversely proportional to holding cost.

Similarly, from the Figure 4 and 5, we got the result that EPQ is directly proportional to ordering cost and directly proportional to the demand and production ratio.

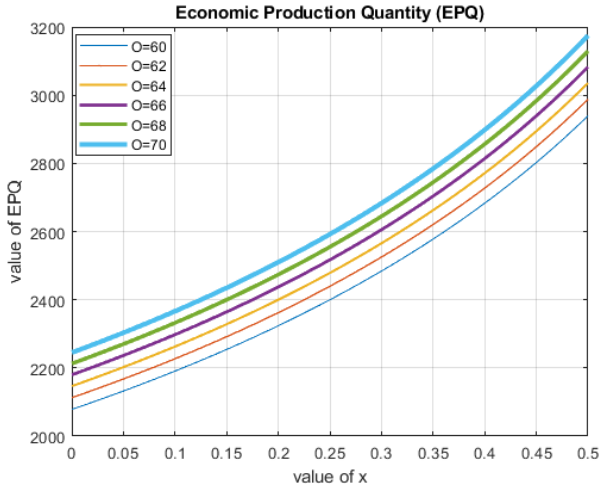

Figure 4

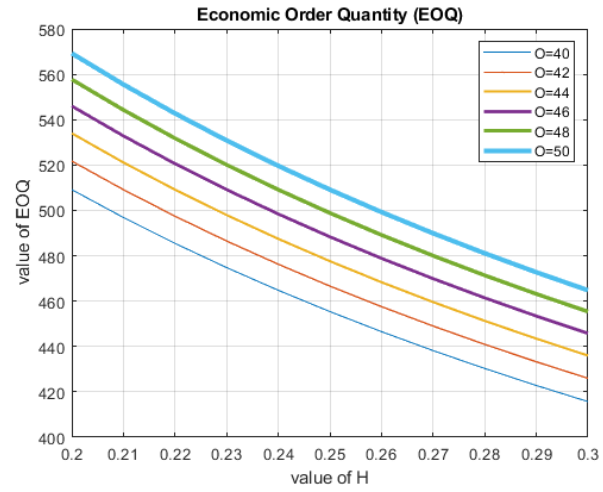

Figure 5

V. CONCLUSION

For profit maximization of the industry Economic order quantity (EOQ) inventory model is effective in inventory management by the reduction of ordering, carrying and total cost, is considered as promotional effort for customer satisfaction and developmental pricing strategy. Here demand is estimated by taking the previous data available and price fixation for a particular product throughout the year, will help the retailer sell the product according to their estimation though production is constant. Inventory order calculation and implication helps to reduce the risk of the retailer. Retailer will get the fixed price from the customer, though it is constant throughout the year. By this effective inventory management, a seller or retailer can not only give the customer satisfaction, profit maximization but also can do the responsibility towards society.

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