Decision Making & Risk Assessment for Inventory Management of Consumer Goods from Economic Order Quantity Perspective

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Abstract

Fast-moving industries like consumer goods constantly need to keep an effective and responsive inventory management system in place to get the correct products to customers at right time. Optimizing inventories while taking the shelf life of consumer items into account is a difficult task for most industries. Increasing the effectiveness of inventory optimization is the primary factor in determining the profitability of any FMCG industry. Consumer goods industries are following various tools for inventory management such as economic order quantity, minimum order quantity, just in time, ABC-XYZ analysis &stock keeping norms etc. Among them economic order quantity (EOQ) is widely followed by most of the fastest growing consumer goods companies. Ithelps to identify the ideal quantity of stock that a business should buy to meet demand while lowering holding and storage costs. However, it poses a challenge in situations where there are shelf-life limitations. Considering the situation, supply planners need to take judgmental call-off for ordering materials. This study will examine how to make judgments on ordering martials using a quantitative method while taking into account batch size, EOQ, and shelf life. From the viewpoint of the FMCG industry, the study's main goal is to optimize inventory while ordering materials using a quantitative tool in various scenarios. In order to choose the optimal choice for working capital optimization, the study will evaluate various ordering decisions, costs associated with various ordering environments, and risk associated with each. It is evident from the study that the FMCG sector should use this quantitative method to promote effective inventory management.

Keywords
Inventory management, consumer goods, economic order quantity, call-off quantity and shelf life

1. Introduction
Inventory establishes a major section of organization's investment. Significantly, the achievement or misfortune of a business depends upon its inventory management performances. Managing inventory poorly leads to sales declining and may cause the business to fail (Mathabaet al. 2011). Fast Moving Consumer Goods(FMCG) usually refers to those goods that are used for a short period of time, have low value, are easy to consume, have a wide distribution of consumers, have a high frequency of purchase, and have a long purchase duration (Lin S. 2019). Due to the low-margin nature of the FMCG business, value is primarily generated through well-negotiated supplier contracts as well as large sales volumes (economy of scale), increasing the need for efficient supply networks and logistics (Holmberg & Osterlind 2019). Quick response to consumer's demand is crucial for a FMCG company since it could have an impact on the company's position in the market and its ability to expand. As a result, effective inventory management becomes a key component of managing FMCG business processes and can significantly boost competitive advantage. The economic order quantity (EOQ) refers to the ideal order quantity a company should purchase in order to minimize its inventory costs, such as holding costs, shortage costs, and order costs. EOQ is necessarily used in inventory management, which is the oversight of the ordering, storing, and use of a company's inventory. Inventory management is tasked with calculating the number of units a company should add to its inventory with each batch order to reduce the total costs of its inventory (Erlenkotter 1990). For the FMCG industry, the economic order quantity (EOQ) formula is crucial for inventory control. The best ideal order quantity at the company's lowest price might be determined with the help of an economic order quantity. Also it is crucial to take the shelf life into account while procuring materials. Thus, by creating a quantitative approach from an EOQ model,

the study will evaluate how to employ EOQ in an FMCG industry.The study's overall goal is to evaluate how FMCG companies may minimize the risks and working capital expenses of ordering materials with limited shelf life& how to consider call-off quantity & compare the different ordering situations. The study will take into account a material SKU with a certain shelf life from one of the top FMCG industries to identify various ordering quantities, costs, and risks associated with each using the established quantitative technique by modifying the EOQ model.

2. Literature review

Rayetet. al. (2016) discussed about proper supply chain management practice & its importance for FMCG industries of Bangladesh from customer's perspective. They also discussed about industries realization on customer driven supply chain configuration which helps them to participate in achieving growth. Mahidaetet. al.(2021) focused on their research segment to determine and evaluate the profitability and liquidity of some selected FMCG Companies of India. For evaluation, various accounting and statistical tools has been used in their study. Singhetet. al.(2017) described that since the beginning of inventory practices, many developments took place which can be categorized into three phases, based on the review of various works. The first phase is related with development and utilization of Economic Order Quantity (EOQ) model and methods for optimizing costs and profits. Second phase deals with inventory optimization method, along with MRP I i.e. Material Requirement Planning & MRP II i.e. Manufacturing Resource Planning with the purpose of balancing capital investment constraints and services level goals. The third and recent phase has emerged inventory control with electrical control theory. Tom Jos et al (2013) states that Inventory control is the most important function of inventory management and it forms the nerve center in any inventory management organization (20). According to the research of Vidanapathiranaetet. al.(2016), maintaining appropriate stock level refers to the proper management of the inventory of the company, and it can be identified as one of the most critical factors when it comes to FMCG industry. The research statistically proved that pre-identified factors such as collaboration, information sharing, accuracy of information, use of modern technology in warehousing has a strong relationship with the efficient management of inventory in FMCG industry in Sri Lanka. Nemtajela and Mbohwa(2017)addressed relationship between inventory management and uncertain demand. Their findings implied that poor inventory management will result in demands not being satisfied, organizations will either have too much or too little on hand, and this will result to the organizations' failure. Susanto(2018)showed how to minimize the total cost of raw material inventory more economically in accordance with the production needs. Economic Order Quantity is the method used to support this research. For this purpose, this method generates total inventory cost consisting of a minimum ordering cost and carrying cost. From this result, the inventory level and the number of raw material demand become more economic suitable with the production needs.Sukhiaetet. al. (2014) discussed how to minimize the total cost of raw material inventory that is more economical suitable with the production needs using Economic Order Quantity method this method can generate maximum ordering with low ordering cost. Agarwal (2014) developed a model based on EOQ equations to find optimal solution in closed form which helps to know about the behavior of the inventory system. The closed-form solution is also easy to compute. The objective was to find the economic order quantities for both the retailer and the warehouse which minimize the total cost. Zeng et al (2019) in their paper introduce a modified version of Wilson's model, which takes into account trends in consumer demand and offer flexibility in reordering time. The illustration of the proposed model was presented, showing the significant economic benefit under particular conditions. Nishad and Arunkumar(2018) discussed about inventory management procedure through Economic Order Quantity (EOQ) and its advantages to various enterprises. The paper additionally exhibited a literature review to demonstrate uses of this strategy and change in ordering cost, cost of inventory, lead time, reorder point. This paper concludes with specifying the important contribution of economic order quantity technique in attaining the success.

3.Research method

Economic order quantity (EOQ) is the ideal quantity of units a company should purchase to meet demand while minimizing inventory costs such as holding costs, shortage costs, and order costs. This production-scheduling model was developed in 1913 by Ford W. Harris and has been refined over time. The economic order quantity formula assumes that demand, ordering, and holding costs all remain constant. The formula for EOQ is:

$Q = \sqrt{2SD/H}$ (1)

where:
Q=EOQ units
D=Demand in units (typically on an annual basis)
S=Order cost (per purchase order)
H=Holding costs (per unit, per year) (Jason Fernando 2022)

The total cost of inventory is the sum of the purchase, ordering and holding costs. As a formula:
TC = PC + OC + HC (2)
where TC is the Total Cost; PC is Purchase Cost; OC is Ordering Cost; and HC is Holding Cost. (Oskar Olofsson, 2022)

These two formulas in a modified version are used to calculate economic order quantity, economic order quantity respecting shelf life, cost associated with each ordering quantity & risks associated with each ordering quantities for a high value SKU of one of the leading FMCG industries. Also graphical representation is shown by plotting ordering quantity vs cost so that better decisions can be made. 25 KG full cream milk powder that is imported to produce different sized SKU of milk powder is considered as an ordering material to conduct the study.

Consumption (units/month), unit per pallet, purchasing cost($/unit), fixed order cost, inventory carrying cost (% p.a.) &storage cost per pallet per year are collected for this particular material SKU to complete the quantitative analysis & comparisons.

3.1Modified EOQ formulas

The quantitative formulas are modified to apply it in a practical FMCG environment. EOQ formula is considered as the base of these modifications. Consumption is the monthly certain demand that is used in EOQ calculation. As the consumption quantity is monthly, it is converted into yearly. Inventory holding cost depends on the inventory carrying cost & storage cost in FMCG industries. Inventory carrying cost is dependent on unit purchasing cost. Storage cost is based on the number of pallet stored. So based on that storage cost is calculated by taking number of unit per pallet & storage cost per pallet per year into consideration.

For calculating maximum consumption during shelf life, daily consumption is converted into monthly basis & multiplied by shelf life tenure. Financial Inventory carrying cost per year is quantified by unit purchasing cost & the percentage of inventory carrying cost per unit purchased. Storage cost per year for pallets is calculated based on number of unit per pallet & storage cost per pallet. Then total holding cost is found from inventory carrying cost & storage cost. Ordering cost depend on number of order placed per year & fixed cost per order. Then total variable cost is calculated from holding cost & ordering cost. When the purchasing cost is added with the total variable cost, the overall cost can be found.Below formulas are used in this study to calculate different quantitative objectives:

$$\text{EOQ} = \text{sqrt} \ \frac{\text{Consumption}*12*2*\text{Fixed order cost}}{(\text{Inventory carrying cost} * \text{Purchasing Cost}) + (\text{Storage cost per pallet per year/Unit Per pallet})}$$

$$\text{MCDSL} = \frac{\text{Consumption}*12}{365} * \text{shelf life}$$

$$\text{FICCPY} = \frac{\text{Order qty.}}{2} * \text{Inventory carrying cost(\%)}*\text{Purchasing cost}$$

$$\text{SCPYFP} = \frac{(\text{Order qty.})/2}{4} * \text{Storage cost per pallet per year}$$

$$\text{Holding cost} = \text{FICCPY} + \text{SCPYFP}$$

$$\text{Order cost} = \frac{\text{Consumption}*12}{\text{order qty.}} * \text{Fixed Order cost}$$

$$\text{Total cost} = \text{Holding cost} + \text{Order cost}$$

Figure 1. Modified EOQ formulas from FMCG perspective

Where, EOQ = Economic order quantity,
MCDSL = Maximum consumption during shelf life
FICCPY = Financial Inventory carrying cost per year
SCPYFP = Storage cost per year for pallets

4. Analysis and results

Table 1 shows the consumption units per month for 25 KG full cream milk powder which is considered as an ordering material SKU to complete this study. Based on the collected historical consumption trend & upcoming forecast, per month demand is considered 2000 units. EOQ consider certain demand to complete the calculation. From the calculation, the EOQ is coming 1321 units. But the material has a shelf life of 18 months. So considering shelf the maximum monthly consumption is coming 1184 units. So respecting shelf life EOQ need to be considered as 1184 units to ensure that the material life doesn't expired. It is feasible to send 1800 units at a time for the supplier. So a call of quantity is decided to compare it with other three ordering quantities & find the most feasible ordering plan.

Table 1. Different economic order quantities

Consumption (Units/month)	2000
Unit Per pallet	4
Purchasing Cost($/unit)	25
Fixed Order Cost	300
Inventory carrying cost(% p.a.)	30%
Storage cost per pallet per year	3
EOQ	**1321**

Shelf life (Month)	18
Maximum consumption during shelf life per month	**1184**

EOQ respecting shelf life	**1184**

Production batch size	1800

Decided call of qty.	**1500**

For this particular four ordering quantities Table 2 shows the total cost the company should pay to procure the material yearly where the yearly demand is coming 24000 units. Inventory carrying cost for shelf life EOQ is the lowest where for the batch size EOQ it is coming maximum. As the shelf life EOQ is the lowest, the storage cost for it also coming the minimum while the ordering cost for it is maximum because of more numbers of orders to be placed. Purchasing cost is same for all the ordering environment.

Table 2.Yearly total cost of different order quantities

Data for Cost Comparison				
Yearly cost with EOQ	**Cost with shelf life EOQ ($)**	**Cost with Standard EOQ ($)**	**Cost with batch size EOQ ($)**	**Cost with Call off qty. ($)**
Financial Inventory carrying cost per year	4,438	4,954	6,750	5,625
Storage cost per year for pallets	444	495	675	563
Holding costs	4,882	5,450	7,425	6,188
Order costs	6,083	5,450	4,000	4,800
Purchase costs	600,000	600,000	600,000	600,000
Total costs	**610,966**	**610,900**	**611,425**	**610,988**

Table 3. Total cost comparison of different order quantities

Yearly costs with EOQ	**$610,900**
Yearly cost with EOQ respecting shelf life	**$610,966**
Yearly additional cost due to shelf life restriction	**$66**
Yearly cost when ordering to batch size	**$611,425**
Yearly additional cost due to batch size ordering	**$525**
Yearly cost according to decided call of qty.	**$610,988**
Yearly additional cost for decided call qty.	**$88**

Table 3 shows that yearly cost with standard EOQ is the lowest. But prioritizing shelf life EOQ, the total cost is coming $66 more than the standard EOQ. Batch size ordering EOQ cost is the maximum comparing with standard EOQ cost. Cost associated with the call off quantity is quite similar with shelf life EOQ cost.

Risk is measured by a stock coverage month. The more the stock coverage months, the less the risks associated to fall in stock out situation which is shown in table 4. EOQ with batch size is the highest stock cover months compared with monthly consumption trend while EOQ with shelf life is the lowest.

Table 4. Total cost comparison of different order quantities

Risk assessment of call off qty.		
EOQ covers demand of	**0.7**	months
EOQ respecting shelf life covers demand of	**0.6**	months
EOQ according to batch size covers demand of	**0.9**	months
Decided call off qty covers demand of	**0.8**	months

For plotting the order quantity vs cost graph, table 5 shows how data are plotted based on the previous calculations. With the increasing number of order quantities, different costs have been plotted.

Table 5.Cost vs order quantity

X& Y -axis plotting	10	20	30	40	50	60	70	80	90	100
Order qty.	264	528	793	1,057	1,321	1,585	1,850	2,114	2,378	2,642
Financial inventory carrying cost per year	$991	$1,982	$2,973	$3,963	$4,954	$5,945	$6,936	$7,927	$8,918	$9,909
Storage cost per year for pallets	$99	$198	$297	$396	$495	$595	$694	$793	$892	$991
Holding cost	$1,090	$2,180	$3,270	$4,360	$5,450	$6,540	$7,630	$8,720	$9,810	$10,900
Order cost	$27,249	$13,624	$9,083	$6,812	$5,450	$4,541	$3,893	$3,406	$3,028	$2,725
Total cost	$28,339	$15,804	$12,353	$11,172	$10,900	$11,081	$11,522	$12,126	$12,837	$13,624

Vertical Y axis lines are plotted to represent the maximum & minimum costs associated with each order quantities.

Table 6.data related to vertical line plotting

Vertical Y-axis plotting		
EOQ	1,321	1,321
	1	$28,339
Max. order qty. respecting shelf life	1,184	1,184
	1	$28,339
EOQ respecting Shelf life	1,184	1,184
	1	$14,169
Decided call of qty.	1,500	1,500
	1	$28,339

Figure 2 is the graphical representation of the plotted data in table 5 & 6. The graph clearly shows that with the increasing number of order quantities ordering cost is exponentially decreasing while the holding cost is increasing proportionally.

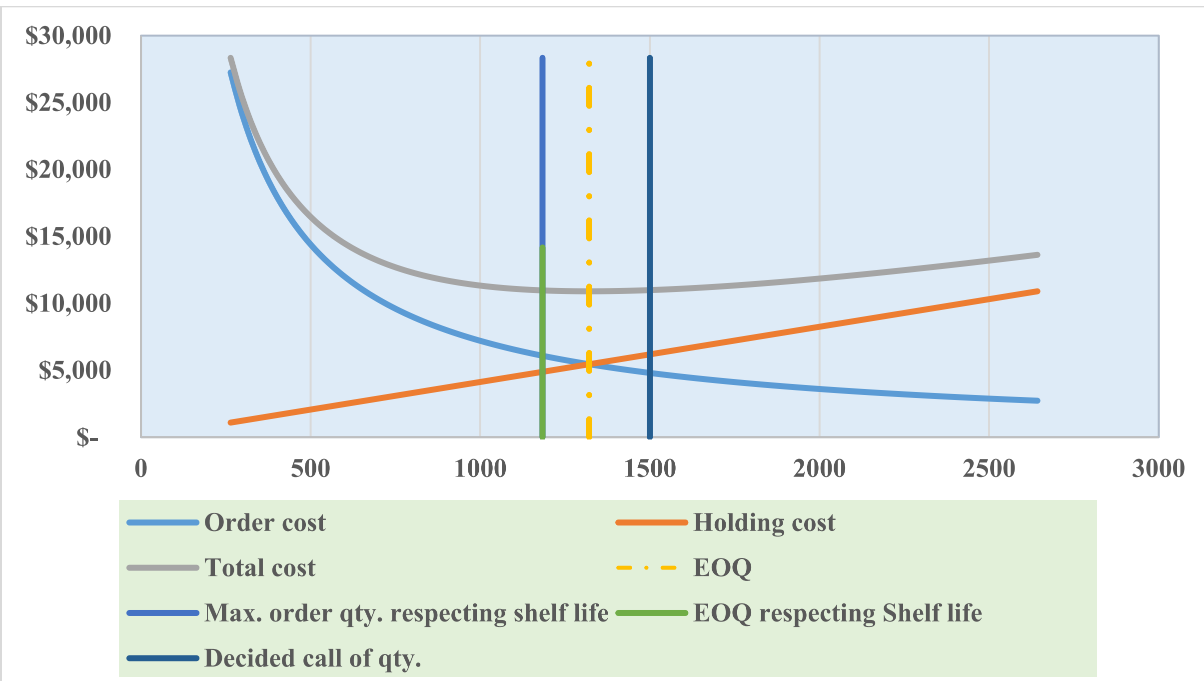

Figure 2. Data related to vertical line plotting

5. Conclusion

EOQ approach has some limitations such as the EOQ model assumes a constant demand over a certain period of time, no seasonal impact is taken into consideration & a fixed cost is considered in each level. Lead time of each order is taken constant & warehouse space is not taken into consideration in EOQ approach. Apart from the limitations, it is evident from the study that EOQ method can be used to minimize the total inventory cost of ordering materials by identifying best ordering quantities in each orders for any FMCG industry. Also based on the quantitative approach illustrated in this study can be used to compare different ordering situation to optimize the inventory provided that the shelf life of the product is not affected& any judgmental call can be made. This quantitative approach of EOQ can help FMCG industries to manage stock out situation, reducing material write-offs, carrying less surplus of inventory & reduce many more financial losses due to inventory piled up situation. Thus the approach of ordering materials is recommended for any FMCG industry.

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Biography

Tarequl Islam is an Industrial Engineer having working experience at Supply Chain & Production in RMG, FMCG & Packaging industries. Currently he is working as a Capacity Planner under the Supply Chain department of Avery Dennison RBIS Bangladesh which is a Fortune 500 USA based multinational company & a market leader in Material Science. He holds a bachelor degree with a focus on Industrial & Production Engineering from School of Applied Sciences & Technology, Shahjalal University of Science and Technology or SUST in short, Bangladesh. His research interests include operations research, human factors, healthcare systems engineering, simulation & advanced manufacturing.