International Journal of Management (IJM)
Volume 11, Issue 7, July 2020, pp. 835-848, Article ID: IJM_11_07_074
Available online at http://www.iaeme.com/IJM/issues.asp?JType=IJM&VType=11&IType=7
ISSN Print: 0976-6502 and ISSN Online: 0976-6510
DOI: 10.34218/IJM.11.7.2020.074

ANALYSIS OF INVENTORY MANAGEMENT PRACTICES FOR OPTIMAL ECONOMIC PERFORMANCE USING ABC AND EOQ MODELS

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ABSTRACT

The success of many businesses is related to their ability to provide goods and services at right quality, quantity and at the right location. Based on this premise, this study examines inventory management practices in Covenant Bakery and their effects on economic performance. The study aims at determining the degree of importance of each of the inventory items and EOQ for the inventory items. The ABC analysis and EOQ technique were adopted for this study. Amongst others, the study also found that for the organization to minimize total cost Covenant Bakery economic order quanity to be purchased for flour, sugar and butter are 206, 38, and 21 bags respectively per order. Therefore, study recommmends that the organization should maintain tight control over category flour, suagar and butter and loose control for the rest of the inventory items.

Key words: Inventory, ABC, EOQ, Economic, Performance.

Cite this Article: Kehinde Busola, E., Ogunnaike Olaleke, O., Adegbuyi, Omotayo, A. Ibidunni, Ayodotun, S., Analysis of Inventory Management Practices for Optimal Economic Performance using ABC and EOQ Models, *International Journal of Management,* 11(7), 2020, pp. 835-848.
http://www.iaeme.com/IJM/issues.asp?JType=IJM&VType=11&IType=7

1. INTRODUCTION

In today's globalized economy, the success of any organization in the dynamic business environment requires firms to improve on the performance of production, reduce cost in supply chains as well as ensure that customers are satisfied thus leading to economic performance (Stanciu, Constandache and Condrea, 2014). The policy of short term profit maximixation is not a leverage for organizational succes, and therefore, these policies should be followed with the development of sustainable economic performance. When an

organisation is evaluating economic performance, there is need to take into consideration the character of the firms and indicators should be selected to fill the organisation's mission (Agboola, et al., 2020). The tradition method of measuring economic performance in some organisation is based on the primary goal of such organisation which is usually to maximise profit (Ibidunni, Ufua, Okorie, & Kehinde, 2019).

In order to enhance an organization's economic performance, inventory optimization is such a vital function. Organizations can no longer work as an independent entity but as a mutual part of the business. This means that these organizations must have a better understanding of, and coorperation with their suppliers and buyers. Too much and too less inventory in all levels of the chain in supply can have an effect on the product availabilility to customers. Several monitoring systems and processes can be employed to check inventory imbalances to minimize the supply and demand dynamics. To simply put, these monitoring systems and process materials are classified into different groups (Dhoka and Choudary,2013). This can be done via adopting an effective ABC classification of inventory.

For a long time, the management of inventory in most consumer based firms in Nigeria is often criticized for being a cost center, this is as a result of the fact that organization spent money to bring in stock, meanwhile ignoring the warehouses which were holding too much stock (Richu 2014; Kimaiyo & Ochiri, 2014). Research has shown that several organization are faced with the problems arising from capital tie down, inability to ascertain time and quantity to purchase, failure to know the frequency of ordering of materials (Banjoko, 2004). The case study organization has recognized the importance and need for inventory management and to able to classify their materials in their order of priority, cost and frequency of use as a major source of efficiency, which leads to profitability and competitive advantage (Bhadiyadra, 2018; Agarana, Anake, & Adeleke, 2014). This has spurred the need to research on the role of ABC classification in inventory management.

Manufacturing organizations around the world do not ignore the need for inventory management practices in their day to day activities to attain economic performance (Swaleh & Were, 2014). The nature of inventory problems in the case study organization is associated with placing and receiving orders repeatedly. This would result in money meant to be channeled into other areas in the organization would be tied up in stock, and the firm would run out of stock of some other resources needed in the organization (Kehinde, 2019). Thus, managers must be able to apply the most suitable inventory management technique into their business operations. Therefore this research aims to use the EOQ model to determine how inventory should be managed.

2. OBJECTIVES OF THE STUDY

The primary objective of this study is to ascertain the role of inventory management practices in manufacturing firms.

i. To classify the inventory items of the Bakery into ABC categories using ABC Models

ii. To use EOQ model to manage inventory in the Bakery.

a. To determine the economic order quantity at a period for flour, sugar and butter

b. To determine the Total Cost of ordering flour, sugar, and butter

c. To determine the re-order point for flour, sugar and butter.

2.1. Inventory Management

Inventories are vital for the success of consumer based organizations in today's global environment. Inventories cut across inventory items, work-in-progress, finished products, and consumables for sales (Azizul & Anton, 2009). Inventories can be categorized into different

types. They include: buffer inventory for unexpected certainties of demand and rise in supply, cycle inventory when the supply is less than the demand (Rai, 2014). The role of inventory management is the balance that exists with the minimization of total cost and expansion of customer satisfaction (Nemtajela & Mbohwa, 2017). The inventory level has significant implications on the profitability of a firm because it defines to understock and overstocking as well as the holding cost or/and shortage cost.

Inventory management involves different activities that are performed by the organization for production maintenance, constant stock, minimize cost, and decrease loss. For successful inventory management, organizations must adopt any inventory management model. Inventory management models provide answers to how much to order as well as when to order. An instrumental inventory model is the ABC classification and economic order quantity (EOQ).

2.1.1. ABC Classification

ABC classification is a simple management tool of categorizing inventory items according to their substantial impact on the overall expenditure of a firm (Bhadiyadra, 2018). Modern organizations carry inventories items of a hefty diversity of materials and finished goods, and management of these items involves entails answering the questions regarding what quantity to order and when to order. This would make for efficient management of costs of production and the company's assets.

Traditionally, ABC classification has been grounded on price volume basis and on the basis that there are a relatively lesser number of inventory items that account for the bulk of the price volume, which is tagged category A. Category A items are those items with high-value and high demand. At the other extreme are inventories in category C, which account for a very small share of the total cost volume. Category C items are low in demand and low value. Lastly, at the mid of the to extreme categories is category B.

In today's competitive environment, there have been several arguments on using cost for inventory ABC Classification alone, as other criteria can be critical as well. They include durability, scarcity, substitutability, stackability, repairability, lead time, commonality, transportation cost, the likelihood of spoilage, transportation mode, batch quantities imposed by suppliers, etc (Ravinder & Misra, 2014). All these methods and many more have been developed to perform multi-criteria ABC analysis that can be implemented in today's organization.

ABC analysis is based on Pareto Analysis (Chu, Liang, & Liao, 2008) which states that 20% of items (materials) contribute to 80% of sales(finished products). These items are classified as category A, because a small portion of items in the inventory contribute the majority of maximum sales for the organization. The next category is B, which states that about 80% to 95% of items contribute to the next 15% of the sales, while the last 5% contribution to revenue is generated by items (raw material) classified in category C (Dhoka & Choudary, ABC Classification for inventory optimization, 2013).

2.1.2. Economic Order Quantity

Economic order quantity is another inventory model that enables the purchase order to be put at fixed order quantity and helps in mimization of the total inventory cost (Chiu & Chiu, 2006). EOQ is the most important and simplest model developed for years for single commodities, for determining the optimun order size for each item and decreases cost of ordering and carrying items (Langfield, Thorne, & Hilton, 2008)

2.1.3. Economic Order Quantity Costs

In EOQ the following costs have to be considered;

- Holding Costs: This is also known as the carrying cost. It covers expenses that are created from storing stocks, stocks that would be traced, depreciation of stocked items and others.
- Set up Costs: The costs arise from changing of production from one batch to another by acquiring materials needed for the process. It is also known as the production change costs

Figure 1 Economic order quantity graph

- Ordering Costs: This inventory cost deals with administrative costs in dealing with production or procurement orders, with tracking of orders.
- Shortage Costs: This arises from stock out of inventory, as demand cannot be achieved, causing orders to be canceled or placed on procurement order.

2.1.4. Economic Performance

When an organisation is evaluating economic performance, there is need to take into consideration the character of the firms and indicators should be selected to fill the organisation's mission. The tradition method of measuring economic performance in some organisation is based on the primary goal of such organisation which is usually to maximise profit. Modern approaches deals with value of the product offered by the organisation when trying to interlink all organisational activities together with the individuals who are connected to the business processes. Assessing the performance of a business is primarily useful to organisation's shareholders (Kumar, 2010). This is because, the Economic performance indicators can either be profit or cost minimization.

- Profit Maximization: Profit maximization means that an organisation is engaging in either maximum output of a stated amount of input or the organisation uses minimum input for producing a stated output (Dey, 2014). It is therefore assumed that for an organisation to maximise profit is done by the allocation of resources effectively under a market condition that is competitive in nature (Woubante, 2017). Therefore, the most known objective of a firm is to maximise profit. If an organisation chooses to remain in the ever competitive market condition knows that there is adequate need to effectively and efficiently use resources to the growth and maximization of profit (Ekeagbara, Ogunnaike, Ibidunni, & Kehinde, 2019).
- Cost Minimization: The production and availability of manufactured goods and services to consumers is crucial to the growth and survival of manufacturing firms as even the best goods in terms of quality, quantity, price and profitability has to be

always available to the consumer when such products or services are demanded for. This product is exchanged for money before it can be said that the product has bought to the organisation financial returns. Product distribution in and out of the organisation is therefore crucial to the organisation's life (Oni, 2004).

2.2. Empirical Framework

In Khalid and Lim (2018) the researchers examined different inventory management strategies such as material requirement planning (MRP), Just-in-time, and vendor managed inventory (VMI) using the qualitative method. It was concluded that each of these strategies play an important role in the management of inventory in any organization

Paradoxically, a research by Cannon (2008) opposed that the overall organization's performance should not be calculated with the inventory performance of the organization. Canoon (2008) examined the return on assets on the annual percentage change of the organization in inventory turnover. The study further observed that a bad influence on the return on investment was experience due to improvement on turnover.

Inegbedion, Eze, Asaleye and Lawal (2019) examined inventory management and organizational efficiency. The classical inventory management techniques were applied to a door sales organization's inventory system. The study computed EOQ, re-order level and inventory cycle time for the sx doors using the data obtained from 2011-2017.

Egbunike and Imade (2017) examined Just in time (JIT) model and financial performance of a small scale enterprise in Ogun State. The study aimed to find out the impact of JIT on the reduction of inventory cost and improved profitability. Using the survey design and regression analysis, the results of the study indicated that there exists a positive relationship between JIT implementation and the profit level of an organization in the small scale business industry.

Chuka, Oguejiofor and Sunday (2016) also provided an summary of inventory with the purpose of using a decision model to examine and calculate inventory in SMEs to optimize the inventory system in a firm in Enugu State. Data was collected and analyzed from the case study. The results of the research found the EOQ quantity of inventory items to be produced. The author also developed standards for the case company for use and applicability to reduce or eliminate problems relating to inventory control and production planning.

In John, Etim and Ime (2015), ia study was conudcted on inventory management and operational performance. The researchers here used a structured questionnaire to collect data, and analysis was done using mean and standard deviation. The study found that there exists a significant difference between effective management of inventory and optimal operating performance.

Also, in 2017, inventory management EOQ model was used on a retailer selling a single perishable good in a deterministic setting. The proposed model was a traditional non-perishable EOQ, which shows that a good perishable commodtity acts in the same way to a non-perishable commodity with holding cost identical to the ration of contribution margin to a lifetime (Dobson, Pinker, & Yildiz, 2017).

Susanto (2018) carried out a research with an aim to reduce the overall cost of inventory items inventory following the needs of production. EOQ was used to support the study. Findings of this research showed that the inventory and the number of demand of invetory material become more economically suitable for the production needs and reduce storage cost swelling (Susanto, 2018).

3. METHODOLOGY

The aim of this research is to mathematically examine the role of inventory management practices on economic performance using ABC and EOQ models in a bakery situated in Ogun State, Nigeria known as Covenant Bakery. The study adopted operations (quantitative) research method. The quantitative data was collected through archival method which was obtained from the purchasing department of the business unit which was then presented in a prescriptive research design (Ogunnaike, Bishop, Akinsulire, Kehinde, & Oreagba, 2018). quantities to be purchased for the case study –SBUs

The study's population comprises of 9 inventory items when using the ABC Analysis, while using the EOQ technique, the population consists of 3 inventory items which include flour, sugar and butter which is judgmental in nature.

For this study, the source of data was the secondary data source, as information was gathered from archival documents of the organization from the purchase department.

3.1. Assumptions of ABC Analysis

ABC Analysis is based on Pareto Analysis which has the following rules (Dhoka & Choudary, 2013)

- A Category: These are items that are categorized among 10-15% of total inventory items and 60-70% comprises of total money spent on the inventory materials
- B Category: These are items that are categorized among 20-25% of total inventory items and 20-30% comprises of total money spent on the inventory materials
- C Category: These are items that are categorized among 50-70% of total inventory items and 10-15% comprises of total money spent on the inventory materials (Kumar, Lihare, Sahu, Lal, & Khaperde, 2016).

3.2. Assumptions of EOQ

EOQ is the ordering quantity which reduces the balance of cost between inventory re-ordering cost and holding cost. In order to be able to compute a basic EOQ, Lucey (1992) formulated some basic assumptions which are necessary for calculating EOQ.

These assumptions include

- Demand in EOQ is assumed to be uniform, constant, and continous over a period of time
- Lead time for the orders is constant
- The cost associated with placing an order is autonomous of order size
- There is no bound to order size due
- Delivery of units ordered is virtually instantanteous and lead time is zero
- The holding cost, shortage cost, unit cost and ordering cost remain constant over time
- There is no discount on quantity
- Shortages in the inventory are allowed and completely backlogged
- The cost of holding a unit of stock does not depend on the quantity in stock
- The time distribution to deterioration of the items the

Weibull distribution, i.e., $f(t) = \alpha\beta(t-\gamma)^{\beta-1} e^{-\alpha(t-\gamma)\beta}$, $t > 0$.

The instantaneous rate function is $\theta(t) = \alpha\beta(t-\gamma)^{\beta-1}$

3.3. Economic Order Quantity Formula

EOQ inventory formula was written by Cargal. This formula is written below

$$Q = \sqrt{\frac{2SD}{H}}$$

Where Q is the EOQ order quantity

D = Annual demand of the product in quantity per unit time

S= order cost of product independent of Q

C = Product unit cost

H = Cost of holding per unit

Ordering cost (S): Number of orders = $\frac{D}{Q}$

Annual ordering cost = $\frac{D}{Q} * S$

Holding Costs (H): iC

Annual holding Cost = $\frac{Q}{2} * H$

4. DATA ANALYSIS AND INTERPRETATION

Objective 1 To classify the inventory items in Covenant Bakery into ABC categories using ABC Models

Table 1 Composition of dough makeup and marker prices per 50kg Bag

s/n	Items	Weight (kg)	%	Cost (N)
1	Flour	50	57.7	11000/50kg
2.	Sugar	6.5	7.51	13000/50kg
	Preservative	2	2.31	36000/25kg
3.	Butter	1.5	1.73	7500/15kg
4.	Salt	1	1.16	3600/50kg
5.	Milk	0.25	0.29	26000/25kg
6.	Yeast	0.1	0.12	700/(500g)
7.	Improver	0.1	0.12	650/500g
8.	Flavour	0.1	0.12	9000/5Litres
9.	Water	25	28.9	
	TOTAL		100%	

Source: Field Survey, 2020

Table 2 Plant Capacity with Corresponding Weekly Raw Material Requirement

Ranking	Items	Bags /Cartons	Qty (Kg)	Price/kg	Value	%
1	Flour	80	216000	220	47520000	59.1
2.	Sugar	15	40500	260	10530000	13.09
3.	Butter	15	12150	533	6475950	8.01
4.	Yeast	4	2700	1400	6048000	7.52
6.	Perservative	2	2700	1440	3888000	4.83
5.	Milk	2.5	3375	1180	3584250	4.46
7.	Flavour	1	54	4240	1144800	1.42
8.	Improver	10	540	1200	648000	0.81
9.	Salt	3	8100	72	583200	0.73

Source: Field Survey, 2020

Interpreation: Results of the ABC analysis show the classification of items according to their ranking. Flour rank first with over 59%, followed by sugar at 13.09%, while the third rank is butter with 8%. Yeast and Persevative ranks 4th and 5th respectively with a percentage of over 7.52% and 4.83% respectively. Milk ranks 6th with a percentage of 4.46. The bottom ranked set of items include flavour, improver and salt with a percentage of 1.42%, 0.81% and 0.73% respectively.

Flour is ranked in class A as it constitutes over 59% of the total percentage, Sugar and Butter are in class B with over 21% of the total value and the remaining ingredients are in class C, based on total inventory cost.

The EOQ and optimum cost of inventory for the various inventory items of production are calculated below using the formula

Objective 2: To examine the Economic order quantity on inventory of materials in Covenant Bakery

Flour

Annual demand (D) = 5250 bags
Carrying cost (H) = 102
Ordering cost (S) =416

a. EOQ (Q) = $\sqrt{\frac{2SD}{H}}$

Therefore Q = $\sqrt{\frac{2 * 416 * 5250}{102}}$

Q= $\sqrt{42824}$

Q=206 units

Total Cost (TC) = $\sqrt{2DSH}$

TC =$\sqrt{2 * 5250 \times 416 * 102}$

TC = 21107

b. Expected number of order =D/Q
5250/206
= 25 Orders

c. Reorder point where lead time = 4 days
ROP = (Annual demand/no of working days in yeara)*Lead time
ROP=(A/365)* L
ROP =(5250/365)*4
ROP = 57bags

Sugar

Annual demand (D) = 250 bags
Carrying cost (H) = 102
Ordering cost (S) =300

EOQ (Q) = $\sqrt{\frac{2SD}{H}}$

a. Therefore Q = $\frac{\sqrt{2 * 300 * 250}}{102}$

Q= $\sqrt{1471}$

Q=38 units

Total Cost (TC) = $\sqrt{2DSH}$

TC =$\sqrt{2 * 250 \times 300 * 102}$

TC = 3912

a. Expected number of order =D/Q
   250/38
   =7 orders

b. Reorder point where lead time = 4 days
   ROP = (Annual demand/no of working days in yeara)*Lead time
   ROP=(A/365)* L
   ROP =(250/365)*4
   ROP = 3 bags

Butter

Annual demand (D) = 250 bags

Carrying cost (H) = 102

Ordering cost (S) =300

a. EOQ (Q) = $\sqrt{\frac{2SD}{H}}$

Therefore Q = $\frac{\sqrt{2 * 94 * 250}}{102}$

Q= $\sqrt{461}$

Q=21 units

b. Total Cost (TC) = $\sqrt{2DSH}$

TC =$\sqrt{2 * 250 \times 94 * 102}$

TC = 2189

c. Expected number of order =D/Q

= 250/21

= 12 orders

d. Re-order point where lead time = 4 days
   ROP = (Annual demand/no of working days in yeara)*Lead time
   ROP=(A/365)* L
   ROP =(250/365)*4
   ROP = 3 cartons

Table 3 Summary of EOQ Model

	FLOUR	SUGAR	BUTTER
EOQ	206 bags	38 bags	21 bags
Total Cost	N 21107	N3912	N2189
Expected number of orders per year	25 orders	7 orders	12 orders
Re-order Point	57 bags	3 bags	3 cartons

Source: Field Survey, 2020

5. DISCUSSION OF FINDINGS

The overall purpose of this study is to ascertain the role of inventory control in Covenant Bakery of Covenant University Strategic Business Unit with the specific objectives, which include to determine the ABC classification of inventory and to use EOQ model to manage inventory in the SBU of Covenant University

The first objective was to determine how inventory can be classified based on cost criteria using ABC analysis. The weights were calculated and tabulated in table 4.1. From the result, it is seen that the cost of inventory value, the highest contributor to the inventory classification is flour. The second highest contributor is Sugar and Butter which holds category B. While the other ingredients fall below 5% of the total cost of inventory, therefore falling into category C in the ABC classification. Related studies such as Nwanya (2015) has been conducted in this field. The ABC analysis addressed in this research fit into an effective technique of managing inventory in the food industry (Ruteri and Xu, 2015)

The second objective was to determine the economic order quantity that enables the purchase order to be placed at a fixed order quantity. The parameters were collected and calculated for the A and B category of ABC since it constitutes 90 percent of the total inventory of production (add references). To calculate the EOQ, the annual demand for the organization, holding cot, and ordering costs are all needed. The annual demand was given by the organization and all other parameters were calculated. Therefore the EOQ for flour, sugar and butter is approximately 206 bags, 38 bags and 21 cartons, respectively.

The equation for re-order point shoulders that demand lead time itself is constant. Since most significant intervals is 4 days lead time, then the organization should make order when stock is 57 bags, 3bags and 3 cartons for flour, sugar and butter respectively. In terms of savings in cost and cost per bakery capicity, one of the findings from Nwanya (2015) compared favourably with this study. Flour, sugar and butter had the highest EOQ in descending order (Nwanya, 2015).

6. CONCLUSION

Organizations today need to manage inventory, one of such tools for inventory management is ABC analysis, in which inventory can be classified using different criteria. For any kind of planning and forecasting, if ABC Analysis is not done properly, it would result in issues in inventory management. Therefore, there needs to be a proper classification of inventory, which would enable the Economic order quantity model to be used for the appropriate management of holding and ordering cost. By using the EOQ model, any production firm can know the exact amount of materials to order and when to place new orders for each material.

RECOMMENDATION

Because of the findings and analysis of this study, the following recommendations are suggested.

- The organization maintains tight control over category A item (Flour) in terms of acquisition, handling, transportation, storage and allocation.
- To prevent the firm from tying down much of the firm's capital into the holding of inventory, the study recommends that the organization should order items more frequently than before as done in section 4.1 above for all category A and B inventory of items
- For category C items, the study recommends that there should maintain loose control on items and such items should be purchased in large quantities so as to take advantage of bulk purchases, discounts and transportation economies.
- Category C items contain more products but in less quantities, therefore purchase of such items is recommended to be done at the same time and less frequently than catgeory A and B as these would reduce the ordering cost and holding cost of items.
- The study also recommends that Covenant bakery perfect economic order quanity to be purchased for flour, sugar and butter are 206, 38, and 21 bags respectively.
- The study furher disagrees with the expected number of orders per year and recommends that the organization should make orders for flour, sugar and butter at least 25, 7 and 12 times respectively, and the reorder point should be when leftover stock is 57 bags, 3 bags and 3 cartons respectively

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