Determination of Inventory Control Policies at Urafiki Textile Mills Co Ltd in Dar-es-Salaam, Tanzania

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Abstract

Many firms/industries, whether manufacturing or purchasing, face great challenges in managing inventories. Poor inventory management may result in under-stocking, overstocking as well as high inventory total cost. This paper examines inventory situation at Urafiki Textile Mills Co Ltd in Dar-es-Salaam, Tanzania. The objective of this paper is to develop the Economic Order Quantity (EOQ) model that will be used to determine number of units of an item to order at a time and the re-order point (r), that is the level to which stocks of items are allowed to fall before ordering other items, for raw materials. The resulting EOQ for each raw material is compared to the actual ordered quantities so as to see whether there is any relationship between them in operational cost reduction. The study used cross section secondary data from Urafiki. The comparison of operational cost reduction was done by using normal distribution test. Excel was used to find EOQ and the re-order point. The results show that the relationship between the EOQs and the ordered quantities at Urafiki in terms of operational cost reduction was significant. Therefore, it was concluded that the ordered quantities at Urafiki Textile Mills were not optimal. Therefore, it is recommended that in order to manage inventory effectively, Urafiki needs to employ inventory control methods such as the EOQ model to obtain reasonable ordered quantities for its raw materials. The inventory level to be maintained is given in the text.

Keywords: Inventory; EOQ; re-order point; cost reduction; Urafiki; textile mills.

1. Introduction

Inventories are idle stocks of goods stored and waiting to be used. Other writers define the term inventory as a physical resource that a firm holds in stock with the aim of selling or transforming it into a more valuable state. For a manufacturing firm, there must be some inventory of raw materials and work-in-process that are maintained in order to keep the factory running [1-3]. The purpose of maintaining raw material inventory is to uncouple the production function from the purchasing function so that delays in shipment of raw materials do not cause production delays. However, there are expenses associated with financing and maintaining inventories which are a substantial part of the cost of doing business. Sometimes, a firm may keep larger inventory than is necessary in order to meet demand and keep the factory running under current conditions of demand. If the firm exists in a volatile environment where demand is dynamic (i.e., rises and falls quickly), an on-hand inventory could be maintained as a buffer against unexpected changes in demand. This buffer inventory or safety stock can also serve to protect the firm if a supplier fails to deliver at the required time, or if the supplier's quality were found to be substandard upon inspection, of which would otherwise leave the firm without the necessary raw materials. Other reasons for maintaining an unnecessarily large inventory include buying to take advantage of quantity discounts (i.e., the firm saves by buying in bulk), or ordering more in advance of an impending price increase.

1.1 Background to Urafiki Textile Mills Co Ltd

Urafiki Textile Mills Co Ltd, now called Tanzania–China Friendship Textile Company Ltd, is located along Morogoro Road at Ubungo industrial area. It is one of the largest textile firms in Tanzania and it was established in 1968 with assistance from the Chinese Government under their technical assistance programs. Its principal products include linen, kitenge (cotton-like covering attire), drills, general prints, curtain, bandage materials and bed sheets for export and local consumption. In its production, the company needs raw materials such as cotton, grey fabrics, chemicals and dyes.

For continuous production and demand satisfaction, the company needs to stock raw materials and before stocking, it is important to know the quantity of every type of the raw materials to order at a time that will be used in production process which will satisfy demand and minimize total costs of inventory. Urafiki Textile Mills procures raw-materials from suppliers and process them into finished goods and sales the finished goods to distributors/agents who then sell to retailers/customers. In 1990, the firm failed to operate because of financial problems, it is said that it lacked capital and that it had outdated machines. Between 1992 and 1994, the factory was privatized to the Chinese Government through joint venturing, Tanzania owns 49% and China owns 51%. This agreement became effective since 1997.

1.2 The Economic Order Quantity

The Economic Order Quantity (EOQ) is the order quantity that minimizes total variable costs of inventory (holding and ordering costs). EOQ gives the optimal quantity that a company is to order every time when replenishing its stock. This quantity gives a good indication of whether or not current order quantities are reasonable.

Inventory position at Urafiki

Urafiki Textile Mills is amongst the largest textile industries in Tanzania. In this company, raw materials are ordered through experience or when inventory levels become low in the warehouse. Sometimes, raw materials are ordered as a result of visual check by the staff working in the warehouse. This implies that there is no proper way that the company employs to manage its inventory. This can have two outcomes one being overstocking where unnecessary inventory accumulates and is kept in the warehouse at high cost. The second outcome is understocking where there is not enough materials in stock which causes delay in production. Therefore, a formalized and standardized inventory control system should be established to solve these problems and way of solving these problems is to determine the EOQ which minimizes the total cost of inventory and to determine the level to which the stock is allowed to fall before ordering more items i.e. the re-order point.

1.3 Objectives of the Paper

1. To develop a model that will be used to determine the EOQ.
2. To find an optimal re-order level to which stocks can be allowed to fall before placing an order for more.
3. To test if the annual total cost of inventory (ordering and holding costs) before the application of the EOQ model is greater than, less than or equal to the annual total cost of inventory after the application of the EOQ model.

Hypothesis

Ho: The annual total cost of inventory (ordering and holding costs) before the application of the EOQ model is less or equal to the annual total cost of inventory after the application of it.
Ha: The annual total cost of inventory before the application of the EOQ model is greater than the annual total cost of inventory after the application of it.

Significance of the study

Many companies including the Urafiki Textile Mills Co. Ltd. do not have effective methods for managing their inventories. Therefore, the findings of this study are expected to help the management of the Urafiki Textile Mills and other such companies to formulate good inventory policies.

2. Methods

In developing the inventory policy, the following standard terminologies are used [2-4] amongst many others.

Ordering Cost: This is the sum of the fixed costs incurred each time an item is ordered. This cost has nothing to do with the quantity ordered. Instead, it is connected with the manual labour for processing the order. It is also known as purchase cost or set-up cost.

Shortage Cost: This is a cost associated with a temporary or permanent loss of sales, when demand cannot be met.

Economic Order Quantity (EOQ): This is the number of units which a company is supposed to add to the inventory for each order to minimize the total cost of the inventory.

All inventory models are expected to answer the two questions below:
1. How much material should the company order?
2. When should a company order?

2.1 The Economic Order Quantity (EOQ) Model

This is the most fundamental inventory model. It is applicable when the demand for an item has a constant or nearly constant rate and when the entire quantity ordered arrives in inventory at one point in time. We know for sure employment of the EOQ model for Urafiki is a simplification. Given the nature of the data available at Urafiki, this simplification is justifiable. This is because there are no records for orders placed but not honored and so on. Such records would pave ways of estimating probabilities of stock outs and so forth. However, this can be regarded as a starting point for which more complex, realistic and probabilistic models can be developed. However, even at this juncture, it can be shown that a significant amount of cost reduction to the firm can be enhanced by the use of EOQ hence the usefulness of this paper.

The basic formula for EOQ is given below [1-4].

$Q = \sqrt{\frac{2CD}{H}}$ this is the optimal quantity to order i.e. the EOQ.

where Q = Order quantity that will minimize the sum of ordering and holding costs.
D = Annual demand for an item.
H = Annual cost of holding one unit in inventory = PI.
P = Unit price for the items.
I = Annual holding cost rate expressed as percentage of carrying one unit in inventory per year.
C = Ordering cost.
TC = Total cost of inventory.
The derivation of Q can be found in almost every standard textbook of OR [2-5].

Raw Materials: These are materials used for the production of components, sub-assemblies or finished goods.

Inventory Management: This is the implementation of the management's inventory policies in a manner that assures that the objectives of having an inventory are reached.

Fixed Re-order Stock Level: Through this method, a business identifies the minimum level of stocks that it can have and places new orders when the stocks reach that level.

2.2 Literature Review

Inventory management in Tanzania

Kipingu [6] discusses the factors affecting efficient management of inventories in local governments in Tanzania. It was found that the EOQ is the most used method of inventory records control [6]. To show that inventory methods are scarcely used in Tanzania, it was noted that some respondents were not familiar with the word inventory. In his study, Patrick [7] found that non-application of inventory management and control techniques in dealing with inventories caused the following to the organization:
(a) Low inventory turnover due to overstocking, hence high inventory keeping costs.
(b) Frequent shortages.

He further argues that if ESSO Tanzania Limited had been using inventory management and control techniques, the company might not have experienced the above problems [7]. Lack of skilled personnel trained for materials management was singled out as the root cause of inefficiency in materials management and control.

Kisaka [8] analyzed the role of Economic Order Quantity model in reducing the cost of raw material inventory at Kibaha Animal Project. He compared total costs of raw material inventory incurred through the project-employed method with the total costs of raw material inventory which could have been incurred under the EOQ application. Kisaka found that there was a cost saving which could have been observed through employing the EOQ model.

Wild [2] and Axsater [3] used inventory technique methods in solving real inventory issues for business in a variety of industries from aerospace to retail consumables and from automotive to process chemicals. They noted that appropriate database was a pre-requisite for the application of the techniques. This implies that manufacturing entities such as Urafiki need to have a well identifiable database for the application of more sophisticated inventory models.

2.3 Study Area

This study was carried out in Dar-es-Salaam, Tanzania at Urafiki Textile Mills Co Ltd. The authors chose this company because it is among the largest and earliest textile mills to operate in the country and its products are very useful and well known inside and outside the country.

2.4 Types of Data Used and Their Collection

In this study, cross section secondary data, particularly for 2006 from Urafiki Textile Mills Co Ltd, were used. The authors collected data for the annual demand and the price per unit for each raw material. Data on annual ordering and holding costs and the lead times for each raw material were obtained from raw materials ordering record for 2006 from the company. As for the data on raw materials collected see Mwansele (2008).

Table 1 shows the summary of the data on raw materials for 2006. Some data were not given directly; so some calculations were made to get such data. For example, the researchers made some calculations to get data on ordering costs.

Data analysis

The EOQ and the re-order point for each raw material were calculated using the appropriate formulae. Then, the total annual cost for the actual ordered quantities and for the EOQ were compared using a statistical technique known as the Z-test.

Z-test

Normally, the Z-test is used for comparing the mean of a sample to some hypothesized mean of the population, in case of a large sample or when the population variance is known. It is also used for establishing the significance of the difference between means of two independent samples, in case of large samples or when population variance is known. For the details of the Z- test, see any standard statistics textbook [9, 10]. More details on the calculation of this test for our paper are found in [11].

2.5 Calculation of the EOQ and the Re-order Level

The calculations of EOQ and Re-order level for each raw material [11] are presented in Table 1.

The EOQ model employed in this study is based on the following assumptions:

1. Demand is constant throughout the year at D items per year. This is so done to take advantage of the formulae. This assumption can be justified because at the end of the day, the demand of the material is cumulated on yearly basis and not on a periodic basis.
2. The company ordered the same amount of a given raw material every time when making orders. This helps the calculation of ordering costs easy because the ordering costs of the studied raw materials were not directly provided; the ordering costs comprised costs related to transportation, freight and clearing charges.

Table 1: Summary of data on raw materials for 2006 (field data).

Name of raw material	Annual demand (D)	Average price of unit (P) (Tshs)	Ordering costs (Tshs)	Annual holding cost rate (I)	Lead-time (m) (days)
Cotton lint	1,941,648.5 Kgs	1404/=	6,411,451/=	0.25	14
Grey fabrics	4,006,169.28 Metres	568/=	8,961,222/=	0.25	30
Chemicals	1,204,798 Kgs	1015/=	6,186,429/=	0.25	30
Dyes	69,000 Kgs	5685/=	1,504,843/=	0.25	30

3. Purchasing price per unit is constant (no discounts).
4. Lead-time for each order for every raw material is known.
5. Receipt of inventory is not instantaneous, that is, ordered items for some raw materials such as cotton lint arrive in the inventory at different batches in different times without affecting the demand.
6. Planned shortages are not allowed.

3. Results and Discussion

Inventory for the various materials

Cotton is the major raw material used by the company in the production of different goods. It is used in producing most of the goods in the company. It is ordered seasonally during harvest times. After the Urafiki Textile Mills Co. Ltd. has placed an order for cotton, the material arrives in two weeks time. It is not necessary that the entire ordered amount arrive at the same time. Orders for this raw material arrive at different times. The company uses cotton from Shinyanga, Mara and Mwanza, and therefore prices vary according to where the material is bought. The most used chemicals at the Urafiki Textile Mills Co. Ltd. include Sodium Hydroxide, Maize Starch, Sodium Bicarbonate, Ludigol (salt resistant), Sodium Alginate, Liquid Soap, Urea, Whitening Agent (VBL) and Designing Agent, all of which are imported from China.

Inventory for dyes

Another type of raw material used by the company is dyes. This raw material is also imported from China.

3.1 Calculating the EOQ, Annual Total Cost and the Re-order Point for the Various Raw materials

By employing the EOQ model and input data from Table 1, the Economic Ordering Quantity (EOQ) , which is given as $Q^* = \sqrt{\frac{2CD}{H}}$ for the various materials are presented in Table 2, Re-order Point in Table 3 and Annual total cost in Table 4. Total cost is given as

$$TC = (\tfrac{1}{2} \times Q^* \times H) + (\frac{D}{Q^*} \times C)$$

The re-order point is as given as:

r = dm, where, r = Re-order point, d = Demand per day, m = Lead-time for a new order in days, D = Annual demand, C = Ordering costs, H = Holding cost.

Table 2: The EOQ for each raw material.

Name of raw material	EOQ
Cotton lint	266,332.95 Kgs
Grey fabrics	711,081.02 Metres
Chemicals	242,256.41 Kgs
Dyes	12,088.94 Kgs

The Re-order point

The second aspect regarding the time when to place a new order gives an answer to the minimum stock level at which additional quantities are ordered. After making some calculations [11], the value of the re-order point was obtained and Table 3 summarizes the results:

Table 3: The re-order point for each raw material.

Name of raw material	Re-order point (r)
Cotton lint	108,732 Kgs
Grey fabrics	480,741 Metres
Chemicals	144,570 Kgs
Dyes	8280 Kgs

Having worked out the EOQ, comparison was made to ascertain whether there were any differences in operational costs.

Table 4: Total annual costs before and after applying the EOQ model.

Name of raw material	Total cost before applying the EOQ model TC (Q) in Tshs	Total cost after applying the EOQ model TC (EOQ) in Tshs	Difference between TC (Q) and TC (EOQ) in Tshs
Cotton lint	140,872,621/=	93,482,865/=	47,389,756/=
Grey fabrics	189,650,692/=	100,973,507/=	88,677,185/=
Chemicals	266,517,307/=	61,533,128/=	204,984,179/=
Dyes	19,957,017/=	17,178,379/=	2,778,638/=

From Table 4 it is observed that the total cost of an inventory before applying the EOQ model was higher than after applying the model. This means that if the company employed the EOQ model, it would reduce its annual total cost (holding and ordering costs) substantially as shown in Table 4. The differences in operational costs could be attributed to ordering costs as shown in Table 5 or to overstocking/understocking as shown in Table 6.

Table 5: Number of orders before and after applying the EOQ model.

Name of raw material	Number of orders before applying the EOQ model $(\frac{D}{Q})$	Number of orders after applying the EOQ model $(\frac{D}{Q*})$
Cotton lint	19	7
Grey fabrics	20	6
Chemicals	42	5
Dyes	10	6

Table 5 above shows that the number of orders was much higher before applying the EOQ model than it was after applying it. This applies to all types of raw materials dealt with in this study. By having a large number of orders, the company increases ordering costs, hence increasing the annual total cost of inventory.

Table 6: Demand and ordered quantities.

Name of raw material	Demand	Ordered Quantity
Cotton lint	1,941,648.5 Kgs	2,426,487.5 Kgs
Grey fabrics	4,006,169.28 Metres	1,435,242.24 Metres
Chemicals	1,204,798 Kgs	992,195 Kgs
Dyes	69,000 Kgs	82,750 Kgs

Table 6 shows that the company placed higher orders than the demand (overstocking) for two types of raw materials; which were cotton lint and dyes. This means that the company kept unnecessary stocks with regard to these two raw materials, which increase the annual total cost. Table 6 also indicates that the company placed fewer orders than the demand (under-stocking) for two types of raw materials which were chemicals and grey fabrics. In any business, this phenomenon is costly because a company cannot meet customers' demands.

3.2 Testing for the Relationship between Annual Operational Costs under EOQ and Without EOQ

The hypothesis was tested by using the Z-test. The details on the calculations for the test are shown in [11]. It was hypothesized that Ho: $\mu \leq \mu o$, where, μ = the average total annual cost of inventory before the application of the EOQ model, μo = the average total annual cost of inventory after the application of the EOQ model. After applying the Z-test, the null hypothesis was rejected at α = 0.05 for all types of raw materials that were studied. Table 7 summarizes the results after testing the hypothesis.

Table 7: Summary of the results of hypothesis testing and the conclusion.

Raw material	Rejection region	Calculated value of Z	Conclusion
Cotton lint	$Z \geq 1.645$	18.04	Reject Ho
Grey fabrics	$Z \geq 1.645$	35.4	Reject Ho
Chemicals	$Z \geq 1.645$	370	Reject Ho
Dyes	$Z \geq 1.645$	3.095	Reject Ho

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Therefore, it can be concluded that the annual total cost of inventory before the application of the EOQ model was greater than the annual total cost of inventory after the application of the model and hence the essence of the application of the EOQ and the usefulness of this paper.

4. Conclusion

It can be concluded that Urafiki Textile Mills needs a formalized inventory system to minimize operational costs. If the Economic Order Quantity model is objectively used, with the aid of some judgment by the management, holding costs and ordering costs will become low. The use of this model will help the company to know the exact amount of raw materials to order and when to place new orders for each raw material.

Recommendations

Since there is no formal inventory control system employed by Urafiki Textile Mills Co Ltd, to manage inventories for its raw materials, some aspects need to be improved in order to minimize the raw materials inventory costs. The following are recommended:

1. A large company like Urafiki Textile Mills should improve their ways of keeping records about purchasing and the daily consumption of the raw materials. If possible, the company should computerize these systems.

2. Lack of awareness on the quantitative techniques of managing inventories indicates that storekeepers and supplies staff are lacking some business management skills, therefore these staff should be undergoing on job training about stores and supplies management to improve their knowledge and competence in the field.

3. It is also suggested that periodic review where inventory are reviewed in a regular interval may be the appropriate policy for Urafiki Textile Mills Co Ltd to solve the 'when to order' problem.

Competing Interests

The authors declare that they have no competing interests.

Authors' Contributions

HAM collected the data under the supervision of FJS and RJA. The analysis was done by HAM under the direction of FJS and RJA.

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