

Inventory Management of Resources with Discounts in a Manufacturing Industry (Case Study of a Bottling Company)

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Abstract

This article is primarily concerned with the analysis of inventory control of items with price break in companies with particular reference to the Store, Purchasing and Production departments of the Nigerian Bottling Company (NBC). Inventory constitutes the most significant part of current assets of larger majority of Nigerian manufacturing industries. Inventory management has become highly developed to meet the rising challenges in most corporate entities and this is in response to the fact that inventory is an asset of distinct feature. Because of the relative largeness of inventories maintained by most firms, a considerable sum of an organization's fund is being committed to them. The main objective of this study is the application of quantity discount model as an existing tool of optimization in inventory management. The answer to the fundamental question of how best an organization which handles inventory can be efficiently run is provided for in the analysis and findings of the study.

Keywords: Demand and Sales; Optimization; Price; Production; Quantity Discount.

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The optimal solutions were obtained and compared with the existing inventory policy of Nigerian Bottling Company to determine their relative benefits. Data were analyzed using MATLAB optimization software to solve the model. The results of model application suggest that improvement in the company inventory planning situation can be realized if such planning model is adopted. Consequently, recommendations to meet the demands of customers, hedge against price increase, protect against stock-outs and most of all smooth production costs conclude the research study.

1. Introduction

Inventory management refers to all the activities involved in developing and managing the inventory levels of raw materials, semi-finished materials (work-in-progress) and finished goods so that adequate supplies are available and the costs of over or under stocks are low[11] Inventory management seeks to provide optimum models to help minimize cost, problems and limitations involved in inventory. In order to control complex and dynamic operation tasks, operation managers should discriminate between different stock items, so that they can apply a degree of control to each item. In the last two decades there have been a spate of programs developed by industry, all aimed at reducing inventory levels and increasing efficiency on the shop floor. Some of the most popular are just-in-time manufacturing, lean manufacturing, and flexible manufacturing. Finally, in every profit-oriented concern, the need for effective and efficient management of resources is crucial as well as time flow of information so as to necessitate effective decisions to be made at appropriate time. In general, inventory is subsequently achieved by establishing these two factors which include:

(1)When to order?

(2)How much to order?

In deciding when to replenish, ordering and lead times are taken into account in determining the ordering level, that is a point where order for an item is placed so that the supply can come in before inventory at hand is used up. In deciding what quantity to order, parameters such as quantity discount, transportation charges and present inventory level are considered so as to optimize cost [3].

Inventory system of an organization can be described in figure 1.0 below.

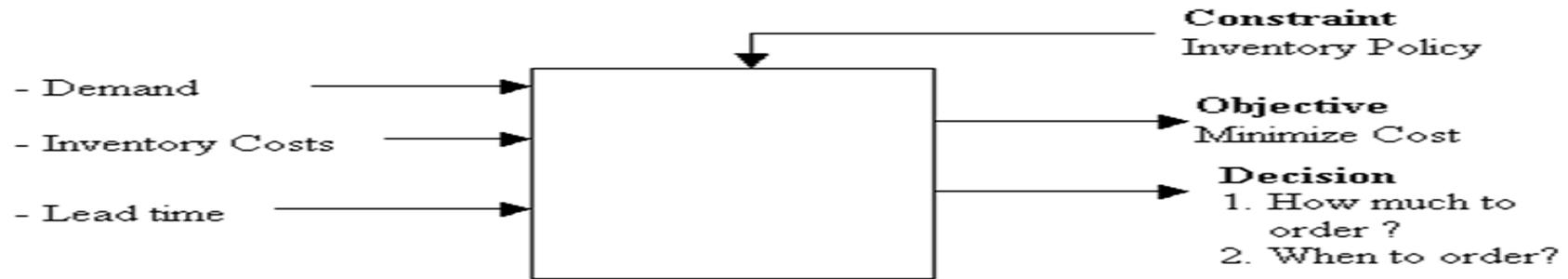


Figure 1.0: Inventory System

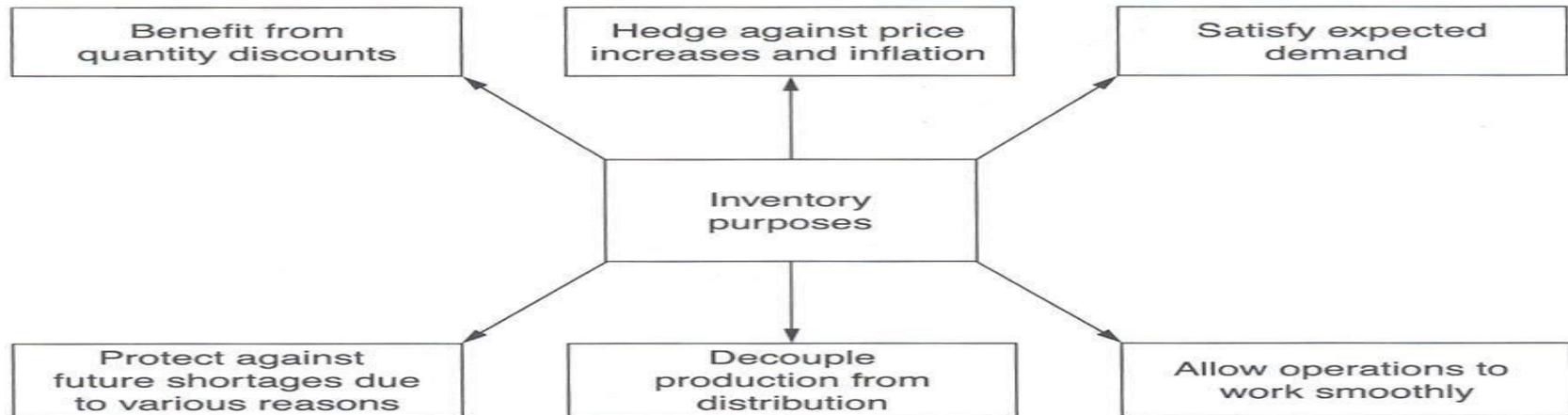


Figure 2

Inventory can help organizations in many ways [10]. The researcher has taken Nigerian Bottling Company as a case study so as to determine the optimum amount of inventory demand, minimum cost of production at lowest price, and capital constraints in the industry.

The objectives of this study are as follows:

- (1) Study, observe and identify an existing inventory control system practiced in Nigerian Bottling Company, Asejire Plant.
- (2) To develop a quantity discount model that will be used to determine the Economic Order Quantity (EOQ) of the company and,
- (3) Minimization of the company's production cost at lowest price.

2. Quantity Price Discount: Types & Concepts

The relationship between the prices on orders of different sizes after the seller has achieved a few fundamental decisions regarding the manner in which he wants a smooth and efficient business [4]. There are two general types of quantity discount schedules offered by supplies: the all-units discounts and the incremental discount. Purchasing large quantity in all-units discount schedule results in a lower unit price for the entire lot; whereas, in incremental discount schedule, lower unit facility is available only to units purchased above a specified quantity. The quantity at which prices change is called price-break quantity and the calculated break-even demand volumes to determine quantity discount desirability [5].

2.1 EOQ and Price Discount

Based on the simple EOQ model, a model for determining the optimal stock replenishment strategy for temporary price reduction can be derived [2]. They extended the logic to a composite EOQ model that can be segmented into a family of hybrid models with broader operational flexibility. The composite EOQ provides malleability and flexibility to changing operational requirements by desegregating complexity. The resourcefulness of an expert system with its attendant economics is approached.

The models for determining optimal all-unit and incremental quantity discount policies were presented [13]. He also investigated the effect of the quantity discounts on increasing demand and ensuring Pareto efficient transactions under general price-sensitive demand functions. He developed a simple and efficient solution approach for determining the all-unit and the incremental optimal decision policies for general price-sensitive demand functions. The procedure for determining the economic ordering policy for a product for which the supplier has offered reduction in price during given specified period by assuming demand to be constant over an intimate time horizon [7]. They proffered the simpler procedure requiring few EOQ calculations for determining the lot size [6]. They reviewed industrial practice to offer special incentives to motivate the buyer; to order in larger than regular order quantities during a limited time only [8]. The active area of research in Inventory models is a model with temporary price discounts [12]. They extended the fact that some commodities may deteriorate during storage. Models for the exponentially deteriorating items with temporary price discount were developed under regular and non-regular replenishment time. The main goal was to maximize the total saving during the temporary price discount order cycle.

2.2 Price Discount Policies under JIT Environment

Most manufacturers rarely use formal price break (quantity discount) analysis while placing purchase orders; and too often discounts are totally ignored because of lot sizing rules in an MRP-II system [9]. He presented the issue of price breaks how it was dealt with in the JIT environment, how policy was changed, the program written to analyze the opportunities, and the implementation results of the new policy and program. During the last two years, asking for and taking advantage of price breaks had saved the present company several hundred thousand dollars.

3. Methodology

Research methodology represents the strategies involved in collecting and analyzing data collected, in order to have meaningful interpretations of the research findings. This section attempts to give an insight into the way and manner in which this research was carried out. This includes the mode of data collection, how these data were analyzed and the research design.

3.1 Methods of Data Collection

Essential information for this research work was collected through primary and secondary sources the combinations include:

- (i) Interview with some key personnel in the stores, purchasing, production and inventory departments of the company.
- (ii) Observation of the production process was done to see the flow of goods in the conversion process. Materials handling and storage were also observed and so was the patrol/inspection procedures.
- (iii) Record analysis of relevant data was obtained from the company's annual report and journals.
- (iv) Theoretical background information was gathered through review of related literature on price discount.

3.2 Method of Data Analysis

The data collected were analyzed using quantity discount model.

The discount quantity model was used to determine the optimum inventory level per year, which was compared with the expected value of existing inventory plan.

3.3 Quantity Discount Model

Inventory system in which the purchasing price depends on the quantity purchased is generally referred to as system with Quantity Discounts [1]. Quantity Discount Model is associated with Economic Order Quantity in such a way that the unit procurement price remains constant irrespective of the number of units purchased. As the discount quantity increases, the unit cost goes down but the holding cost goes up because of large orders.

However, it is common business practice for suppliers to offer quantity discount to purchaser so as to provide incentives for purchasing large quantities by offering lower unit cost. These are the basic approaches that could be used to evaluate discount quantity. They include cost comparison approach, price change approach and price break approach.

NOTATIONS

D = Annual Demand (Unit/year)

P = Purchase Price (Naira/unit)

Q = Order Quantity

Q* = Optimal Order Quantity

C₁ = Holding

Cost

(Naira/unit

year) C₃ =

Ordering Cost

(Naira/order)

f = Percentage of the annual holding cost unit price (%)

TC = Total Inventory Cost

Average inventory is $\frac{Q}{2}$

Total holding cost/year is $\frac{fC_1Q}{2}$3.3.1

Annual ordering cost is $\frac{C_3D}{Q}$3.3.2

Annual total cost is PD.....3.3.3

$b_3 \leq Q_4 < b_4$ P4.....3.4.4

$b_4 \leq Q_5$ P5.....3.4.5

$P_5 < P_4 < P_3 < P_2 < P_1$

Step 1 (a) Consider the lowest price P_5 and determine Q_5^* using EOQ

(b) If $Q_5^* \leq b_4$, then $EOQ (Q^*) = Q_5^*$ and determine optimal cost $TC (Q_5^*)$

(c) If $Q_5^* > b_4$ then go to step 2

Step 2: (a) Calculate Q_4^* based on price P_4 and

(b) Compare Q_4^* with b_3 and if

$b_3 \leq Q_4 < b_4$

(c) Compare $TC (Q_4^*)$ and $TC (b_4)$ but if $TC (Q_4^*) \geq TC (b_4)$, then $EOQ = b_4$, otherwise $EOQ = Q_4^*$

Step 3: (a) Calculate Q_3^* based on price P_3 and

(b) Compare Q_3^* with b_2 and if

$b_2 \leq Q_3 < b_3$

(c) Compare $TC (Q_3^*)$ and $TC (b_3)$ but if $TC (Q_3^*) \geq TC (b_3)$, then $EOQ = b_3$, otherwise $EOQ = Q_3^*$

Step 4: (a) Calculate Q_2^* based on price P_2 and

(b) Compare Q_2^* with b_1 and if $b_1 \leq Q_2 < b_2$

(c) Compare $TC(Q_2^*)$ and $TC(b_2)$ but if $TC(Q_2^*) \geq TC(b_2)$, then $EOQ = b_2$, otherwise $EOQ = Q_2^*$

Step 5 Calculate Q_1^* at price P_1 and Q_2^* at P_2 and compare with $TC(b_1)$, $TC(b_2)$ and $TC(Q_1^*)$, to find EOQ. Quantity with the lowest cost will naturally be the required EOQ.

4. Data Presentation, Results And Analysis

4.1 Data Presentation

The company operates three sets of store mainly; the raw material stores, the finished goods stores and the spare parts machinery stores. A store manager who operationally works in conjunction with production manager, since most of the products are used by this department alongside with bottling department that heads the raw material store. However, the store manager is responsible directly to the plant manager and the bottling manager.

The finished goods store is headed by the sales manager assisted by the bottling manager. The bottling manager helps to confirm the total number of bottles produced on regular basis. The sales manager takes responsibility as soon as production is completed.

The spare parts store is headed by the Plant engineer, the raw materials that are stored include the following: -

- a) Sugar: This is obtained locally from Dangote Nigeria Ltd and sometimes imported from oversea if need be. They are stored in bags, which are stacked in pallets arranged in such a way as to facilitate easy stock taking.
- b) Concentrates: The concentrates are got from Coca-Cola international while their chemicals are imported from Leventis London. They come in syrup forms stored in bottles.
- c) Crown Corks: They are supplied locally by Crown Product Limited, Ijebu-Ode. The Crown corks are kept in polythene bags and store in cases, safe from dust and moisture, which bring about rusting.

Table 4.1: Summary of data on raw materials for 2011

Name of Raw Materials	Annual Demand (000) in kg	Materials Unit Cost (₹)	Ordering Cost per order (000) (₹), C_3	Holding Cost as a % of unit cost f	Holding Cost (₹/unityear) C_1	No of Orders
Sugar	807	1264	12	6	75.84	$1000 \leq Q < 2500$
	807	1240	15	6	74.40	$2500 \leq Q < 8500$
	807	1207	18	6	72.42	$8500 \leq Q < 15500$
	807	1160	20	6	69.60	$15500 \leq Q < 25000$
	807	1130	24	6	67.80	25000
Concentrates	550	527	20	5	26.35	$1500 \leq Q < 8500$
	550	510	22	5	30.81	$8500 \leq Q < 17500$
	550	487	25	5	33.61	$17500 \leq Q < 28500$
	550	460	28	5	36.59	$28500 \leq Q < 40000$

	550	447	30	5	38.43	40000
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Source: Raw Materials Store Unit NBC 2012

4.2 Results

Table 4.2: Comparing existing inventory plan with quantity discount model for 2011

Crown cork/Bottles	900	377	14	3	11.31	1500 ≤ Q < 6000
	900	363	15	3	10.89	6000 ≤ Q < 20500
	900	353	17	3	10.59	20500 ≤ Q < 38500
	900	333	19	3	9.99	38500 ≤ Q < 60000
	900	320	20	3	9.60	60000
	Name of raw materials	Total Inventory Cost before applying QDM TIC(Q) ₦		Total Inventory Cost after applying QDM TIC(QDM) ₦		Difference between TIC(Q) and TIC(QDM) ₦
Sugar	1,405,728,300		912,735,570		492,992,730	35.07
Concentrates	459,186,425		246,300,930		212,885,495	46.36
Crown cork/bottles	526,382,515		288,308,640		238,073,875	45.22

4.3 Data Analysis

From table 4.2 above, it was observed that the total annual cost of inventory in 2011 before applying Quantity Discount Model, QDM was higher than after applying the model. This means that if Nigerian Bottling Company, Asejire Plant employed the quantity discount model, it would reduce its annual total cost substantially as shown in table 4.2.

Raw Materials Requirements: Using sugar as parameter, table 4.2 shows that store keeper should accept the offer of 6 per cent discount only because in this case his net saving per year would be ₦492, 992,730 which is an annual savings of 35.07 per cent. It can also be deduced from the result obtained in table 4.2 using concentrate as a parameter that the store keeper should accept the offer of 5 per cent discount for his net saving per year to be ₦212, 885,495 which is an annual savings of 46.36 per cent. Lastly, using crown cork/bottles as parameter, table 4.2 shows that store keeper should accept the offer of 3 per cent discount only because in this case his net saving per year would be ₦238, 073,875 with an annual savings of 45.22 per cent.

5. Conclusions

Inventory management has become highly developed to meet the rising challenges in most corporate entities and this is in response to the fact that inventory is an asset of distinct feature. The inventory management situation of the Nigeria Bottling Company, Asejire Plant has been revealed using the quantity discount model. If quantity discount 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 at lowest price and when to place new orders for each raw material.

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