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Research Article

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Analysis of Production Output using Inventory Control Method

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Abstract The research work focused on the analysis and optimization of inventory production output using inventory production control models and economic production quantity model in Evepon Manufacturing Industries. Production data were collected, analyzed and the results were discussed based on the models applied. The result shows that the economic production quantity of the Evepon plastic production quantity is 3635 units while the reordering quantity of the production output is 1125 units. However the lead time in production is 2.48 hours (2 hours, 28 minutes 48 seconds). The results developed creates standard for the case company to avoid under production or over production of their finished products.

Keywords Inventory system, Reordering point, Production output, Plastics, optimization and buffer

1. Background of the Study

Inventory refers to the goods and materials that an organization, company, or business holds to support production, support activities and for sale or service. In an effective and efficient business organization, good inventory management is very important for the successful operations. It is also vital in the control of materials and goods that have to be held (or stored) for later use in the case of production or later exchange activities in the case of services. Inventory Control is the supervision of supply, storage and accessibility of items in order to ensure an adequate supply without excessive oversupply or crippling underage. The principal goal of inventory management involves having to balance the conflicting economics of not ready to hold too much stock or entertain unhealthy shortage. Thereby having to tie up capital so as to guide against the incurring of costs such as storage, spoilage, pilferage and obsolescence and, the desire to make items or goods available when and where required (quality and quantity wise) so as to avert the cost of not meeting such requirement [1].

Inventory problems of too great or too small quantities on hand can cause business failures. If an item is not stocked when the customer thinks it should be, the retailer loses a customer not only on that item, but also, on many other items in the future.

The aim of this research work is the modelling of the Economic Production Quantity using Inventory control Production models in the aforementioned case study company.

2. Inventory Management Concept

Inventory Management is the overseeing and controlling of the ordering, storage and use of components of a company in the production of the items it will sell as well as the overseeing and controlling of quantities of finished products for sale.

There is need for the use of a proper inventory control model in any business organization. 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 [2]. The cost of maintaining inventory is included in the final price paid by the consumer [3].

The development of small and medium scale industries is very important to the growth of a nation especially a developing country. Small and medium scale enterprises are particularly relevant in creating employment opportunities, mitigating rural urban drift, producing specialized items in small quantities to meet diverse needs, mobilization of local resources as well as the stimulation of technological development and innovation [4-6] as they acknowledged the superiority of small-scale industrialization strategy in promoting economic growth. As a matter of fact, a positive correlation between the emergence of an active small-scale industrial sector and the commencement of rapid economic growth and development can always be established. A practical illustration is the recent transformation of some South East Asian economies from rudimentary states to high-industrialized ones in the second half. To achieve the desired contribution of SMEs to the industrial growth of a nation, the management of inventory in these organizations is of utmost importance. Inventories are goods that are kept to meet future demand and to ensure production continuity. It is a very important asset in any business organization. The management of this vital asset is very important for the efficiency, effectiveness and profitability of the business. The astute manager who understands the virtues of each of the component of inventory could use them selectively to implement corporate strategy in the market place [1,7]. An organization can strategically build up inventory for market promotion and also to stabilize production schedule. Inventory management is crucial to organization success since holding too little or too much stock has negative effect on the organization's performance. The problem of inventory has continued to receive much attention in most businesses. Inventory levels of raw materials, semi-finished and finished goods need to be effectively managed to control the cost of inventory [2]. It is common to find the balance sheet of an average company having inventory running to 60% of its current assets as capital tied down [8]. Apart from this, much has to be expended additionally to keep it useful. To keep production going, some level of inventory is desirable.

Despite the marvel of computer, automation and scientific management, the production process and marketing activities cannot still avoid the need to have inventories. The necessity of keeping stock arises because of the time lapse between purchasing, production and eventual sale to customers [9]. The major concern is how inventory can be controlled to minimize waste and cost. Thus an efficient inventory policy is always an important requirement for the successful management of manufacturing and distributing enterprises. Inventory planning is a major tool of capacity planning and every organization must ensure effective inventory planning to enhance efficient and effective capacity utilization. The main purpose of a basic material requirement planning as to control inventory level, assign operating priorities for items, and plan capacity to load the production system as well as to order the right part, order the right quantity and order at the right time [10]. In their contribution to importance of inventory, Chase and Aquiliano (1985) [11] mentioned that the objectives of inventory management under the material requirement planning system are to improve customers' service to minimize inventory investment, and to maximize production operating efficiency. Garrison and Noreen (2000**)** [12] opined that the selection of the right level of inventories involves balancing three groups of costs. These costs are: inventory ordering cost, inventory carrying costs, the cost of not carrying sufficient inventory and opportunity cost. Plane (1994) [13] observed that if inventory levels are low, the cost associated with keeping inventory on hand is small, but orders are placed more frequently to replenish items, to avoid running out of stock always. If inventory levels are very high, maintaining these inventories is expensive but there may be benefits from obtaining larger lot sizes from suppliers. Schreibfeder (2001) [14] stressed that cost of carrying is a critical factor in deciding what products to stock and when to re-order them as well as the best quantity to order. However, companies and organization often use an imprecise 'rule of thumb' to estimate their cost of carrying inventory and the resultant effect is bad inventory management.

Just in time inventory (JIT) is the modern concept in inventory management aimed at reducing inventory costs. With just in time inventory, the exact amounts of good items arrive at the moment they are needed. Adam and European Journal of Business and Management defines Just in Time as a manufacturing system whose goal is to optimize processes by continuously pursuing waste reduction. Chase and Aquilano (1985) [11] stated that Just in Time (JIT) requires the production department to project precisely the necessary units in the necessary

quantities at the necessary time with the objectives of achieving plus or minus zero performance to schedule; it means that production of one extra piece is just as bad as being one piece short. Anything over the minimum amount necessary is viewed as waste. The idea of JIT is to drive all queues toward zero in order to minimize inventory investment, shorten production lead time, react faster to demand changes and uncover any quality problem. Barker (1989) [15] opined that the JIT is a dynamic approach introduced in recent years that demand total commitment from management. Kaynak and Pagani (2003) [16] stated that production and operations research has shown that JIT Purchasing can potentially have benefits to the firms in the form of increasing product quality, improving supplier/buyer relationships, and increasing sales. Akintoye (2004) [17] stressed that the closeness of a company to the ideal JIT situation depends on the type of production process and the nature of suppliers industries. Inventory decisions are of interest to many functional and line managers in every organization since these decisions may have direct impact on their departmental performance**.** Forgionne (1986) [18] stressed that inventory policy involves resolving organizational conflicts since all departments connected with inventory in the organization have different views of what quantity of inventory to keep. Sound management should consider all view points and develop a policy that minimize total related inventory cost. Dominiak and Louderback (1997) [19] in their contribution to the issue of conflict of functional department in respect of inventory levels to be maintained noted that sales managers, finance manager and production managers have different views on the desirable inventory level. This conflict of inventory objective is always resolved with great difficulty in a manufacturing environment. Brigham (1983) [20] opined that proper inventory management require close coordination among the sales, purchasing, production and finance departments since improper co-ordination among the departments can lead to disaster and sub optimization.

Good in inventory represents a cost to their owner. The manufacturer has the expense of materials and labour. "The wholesaler and retailer also have funds tied up". Therefore, the basic goal of the researchers is to maintain a level of inventory that will provide optimum stock at lowest cost. However, inventory management in its broadest perspective is to keep the most economical amount of one kind of asset in order to facilitate an increase in the total value of all assets of the organization – human and material resources [21. The major objective of inventory management and control is to inform managers how much of a good to re-order, when to re-order the good, how frequently orders should be placed and what the appropriate safety stock is, for minimizing stock outs [22]. Thus, the overall goal of inventory is to have what is needed, and to minimize the number of times one is out of stock.

Drury (1996) [23] defined inventory as a stock of goods that is maintained by a business in anticipation of some future demand. This definition was also supported by Schroeder (2000) [24] who stressed that inventory management has an impact on all business functions, particularly operations, marketing, accounting, and finance. He established that there are three motives for holding inventories, which are transaction, precautionary and speculative motives. The transaction motive occurs when there is a need to hold stock to meet production and sales requirements.

A firm might also decide to hold additional amounts of stock to cover the possibility that it may have under estimated its future production and sales requirements. This represents a precautionary motive, which applies only when future demand is uncertain.

The speculative motive for holding inventory might entice a firm to purchase a larger quantity of materials than normal in anticipation of making abnormal profits. Advance purchase of raw materials in inflationary times is one form of speculative behavior.

2.1. Reorder Point (ROP) and Safety Stock

Another important technique used along with the Economic Order Quantity is the Reorder Point (ROP) and Safety Stock. The reorder point will advise when to place an order for specific products based on their historical demand. It also allows sufficient stock at hand to satisfy demand while the next order arrives due to the lead time [25].

The ROP quantity reflects the level of inventory that triggers the placement of an order for additional units**.** Whereas, the quantity associated with safety stock protects the company from stock outs or backorders [26]. Safety stock is also known as a "buffer".

In determining the reorder point the following three factors need to be at hand:

- Demand - Quantity of inventory used or sold each day
- Lead Time - Time (in days) it takes for an order to arrive when an order is placed
- Safety Stock - The quantity of inventory kept on hand in case there is an unpredictable event like delays in lead time or unexpected

2.2. Empirical Review

According to Ashok, (2013) [27] the research work is to examine the relationship between inventory conversion period and firms‟ profitability. The dependent variable, gross operating profit is used as a measure of profitability and the relation between inventory management and profitability is investigated for a sample of five top Indian cement companies over a period of ten years from 2001-2012. This study employs Regression analysis to determine the impact of inventory conversion period over gross operating profit taking current ratio, size of the firm, financial debt ratio as control variables. The results indicate that there is a significant negative linear relationship between inventory conversion period and profitability.

According to Kamaruddin et al, (2012) [28] Inventory control provides method to manage the flow of materials or goods in the supply chain. Since controlling inventory is not the only mechanism to ensure an adequate inventory levels, it is also able to reduce inventory related cost. The manufacturing sector holds large inventories with quite complicated process and policy related to inventory control, especially when involving external party whether they are supplier or customer. The manufacturing companies always confront with issues related to inventory management, which includes bullwhip effect on demand, increase of inventory cost, late delivery, and inventory shortage. Therefore, a key challenge for manufacturing company is to determine how to control the inventory flows effectively as to get the best overall inventory performance. Since inventory control manages to cover a wide range of aspects, it is chosen to focus on specific element such as inventory monitoring and ordering; control limits; and replenishment decisions. Lacking of an inventory control practices that normally occurred among manufacturing companies had lead this paper to propose a framework on inventory control practices to acquire that knowledge.

3. Research Method

The research method used in this research work is the application of the inventory control existing models to model and to optimize the inventory control system in Production output when there is reserved stock. The resulting output of the analysis will help to eliminate over production and under production in the case company

3.1. Assumptions of Inventory Models

Deterministic models in inventory control system have the following assumptions:

i. Demand for a given period of time is known.
ii. Demand is uniform and constant over a period of time.
iii. No limitations are imposed by strong production and administrative capacity of the concern.
iv. The cost of an order and storage cost per unit of material are independent of the order quantity.
v. Replenishment of orders are instantaneous.
vi. The rate of consumption and delivery are equal.
vii. Buffer stock of finished goods, if kept, is independent of order quantity.
viii. Order costs are the same irrespective of order size i.e. number of items ordered.
ix. The setup costs are constant and the rate of production is known.

Models Applied in Inventory Control System is the Inventory Production Models as shown below:

Economic Production Quantity (EPQ) Model

$$\text{Holding Cost per Year} = \frac{Q}{2}F(1-x) \quad (1)$$

Where $\frac{Q}{2}$ is the average inventory level and F (1-x) is the average holding cost, therefore multiplying these two results in the Holding cost per Year.

$$\text{lOrdering Cost per Year} = \frac{\mathrm{D}}{\mathrm{Q}}\mathrm{K} \quad (2)$$

Where $\frac{D}{Q}$ are the orders placed in a year, multiplied by K results in the ordering cost per year.

We can notice from the equations above that the total ordering cost decreases as the production quantity increases. Inversely, the total holding cost increases as the production quantity increases. Therefore in order to get the optimal production quantity we need to set holding cost per year equal to ordering cost per year and solve for quantity (Q), which is the EPQ formula shown in equation 3. Ordering this quantity will result in the lowest total inventory cost per year.

EPQ Model

$$EPQ = Q = \sqrt{\frac{2KD}{F(1-x)}} \quad (3)$$

Variables

K = ordering/setup cost

D = demand rate

F = holding cost

T = cycle length

P = production rate

$x = \frac{D}{P}$

Q = order quantity

If the demand is constant and the lead time is known, then the reorder point is written as the following:

Reorder Point= Daily usage X Lead time (in days) (4)

When a safety stock is maintained, then the reorder point is written as the following:

Reorder Point= [Daily usage X Lead time (in days)] + safety stock (5)

Optimal (economic) order quantity $Q_0 = \sqrt{\frac{2PD}{HC}}$ (6)

The length of an order cycle (i.e. the time between orders) is:

Length of order cycle = Q_o/D (7)

Total ordering cost = $(D/Q) * Co$ (8)

Co = Ordering cost per order

4. Obtained Inventory Data

The inventory data obtained from Evepon Industries limited are shown on table 1. The Inventory data were presented on monthly basis for the three years (2012 to 2014) for the seven products considered as from table 1.

Table 1: Monthly Inventory Data in Plastic Pipe Company for 2012 (Evepon Industries Limited)

	Product 1 1 unit =1kg		
Date (MM/YY)	**2012**	**2013**	**2014**
	Units	**Units**	**Units**
Jan	128047	60103	160944
Feb	214392	47816	103584
Mar	196203	170542	112909
Apr	347008	163722	112913
May	141773	131343	171305
Jun	151660	142455	215858
Jul	198743	71699	146227
Aug	137973	102887	147808
Sep	28162	78700	72697
Oct	51432	61028	172304
Nov	112578	109894	32896
Dec	18353	153491	89872

Having in mind that product 1 is the finished products of the case company and the essence is to develop the economic production quantity so as to minimize over production or underproduction of the finished product to avoid excess inventory. However, the unit cost of the finished product is ₦250.

4.1. Modeling and Analysis of Data

Software programme was developed in Microsoft excel for the optimization of the inventory control systems for the case company under study. The following results were obtained and presented in table 2 below.

Table 2: The Results of the Finished Products when there is Shortage

Finished Products	Results
Production Rate	5065.907
Usage Rate	211.0794
X=(D/P)	0.041667
X=(D/P)	0.041667
Hrs/Days it takes to Achieve EPQ/EOQ	21.32616
EPQ=	3617.729
Economic Production Quantity(EPQ)=	3635.3
Cycle time=	17.13918
Run time=	0.714133
Maximum Inventory=	3500.751
Average Inventory	1750.375
	5.33154
Lead time=	2.476557
Reordering Point(ROP)=usage X Lead time	1125.378

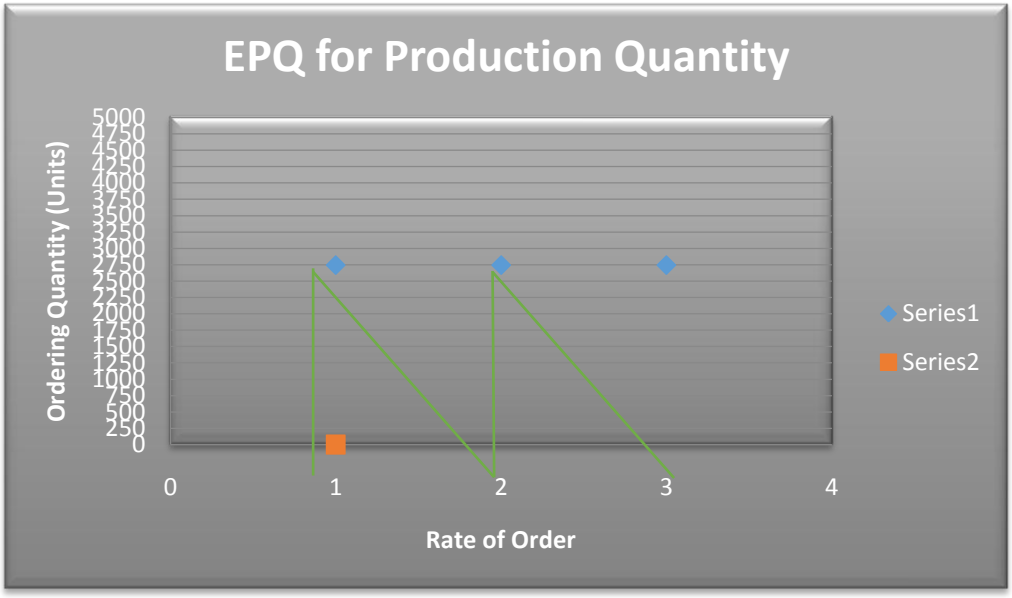

Figure 1: Average Economic Production Quantity for Finished Product

Figure 2: Economic Production Quantity with Shortage

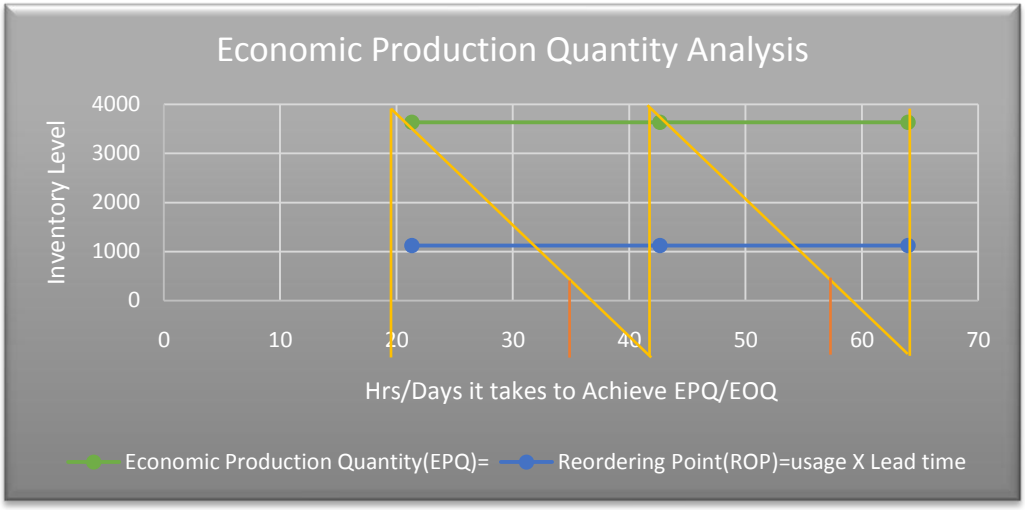

Figure 3: Economic Production Quantity Analysis

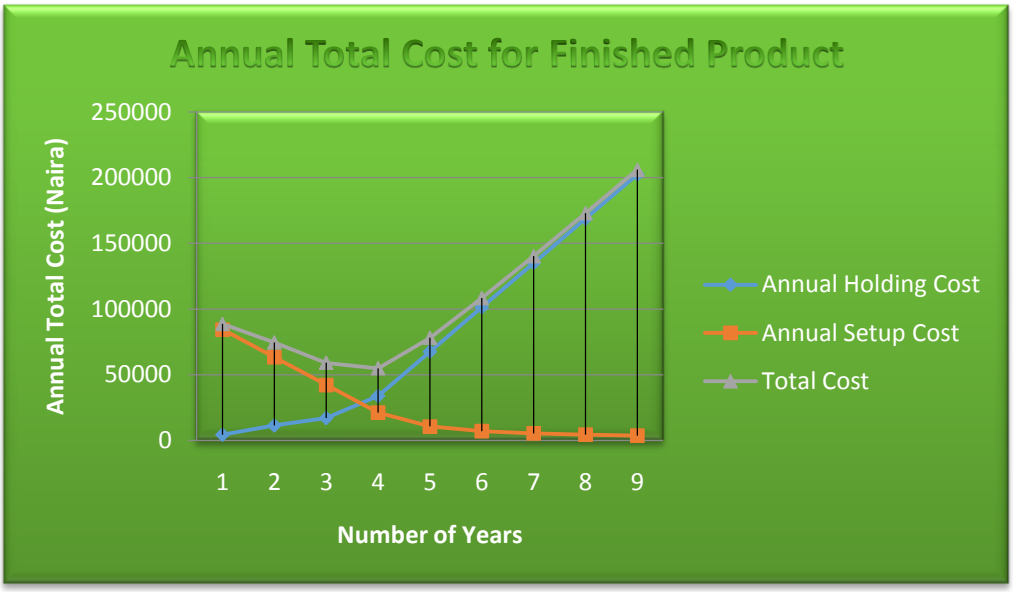

Figure 4: Annual Total Cost for Finished Product

5. Discussion/ Comparative Analysis

The study of the production quantity of plastic pipe product shows that one unit of plastic pipe material in production is equivalent to one kilogram (1 kg) of plastic pipe product. The application of the inventory control models show that the economic production quantity of the plastic pipe product is 4501.514 units, also the average economic order quantity of the plastic pipe product is 2250.757 units and the Maximum economic ordering quantity is 4151.434units, while the shortage on the inventory system is 350.0797units. The Length of production cycle within days or days it takes to achieve economic production quantity (EPQ) is 0.89 days and the penalty per unit shortage cost is N1.26. However, the annual holding cost or annual carrying cost of the product is N33761.35, while the annual production cost or setup cost of the product is N21100.85. The unit cost (i.e. 1 kg) of the product is N250, while the unit setup cost and the unit holding cost of the plastic pipe product are N62.5 and N15 respectively. However, the reordering point of the product is at 1125.3785units while the lead time of the product is 5.33 hours. Furthermore, the production rate of the plastic pipe product is 5065.907 units per day while the usage rate of the plastic pipe product is 211.079 units. In plastic pipe production, the cycle of the product is 17.14, while the running time of the product is 0.71 hours. The inventory control system also shows the maximum inventory of the plastic pipe product to be 3180.29 and the average inventory of the plastic pipe product to be 1659.28. The time it takes to consume the Maximum economic ordering quantity from inventory stock (t_1) is 0.82 days, while the time between the optimum economic ordering quantity and the maximum ordering quantity (*i.e.* when Shortage occurs (t_2)) is 0.069 days.

6. Conclusion

In conclusion, the researcher studied the inventory control system of plastic pipes and its raw materials in the case study company. The application of the existing inventory control models was adopted to establish the economic production quantity for the produced plastic pipes. The application of this inventory control models and tools help the researcher to establish a standard for the case study company in particular and any manufacturing company that has inventory system. This system will help to resolve the inventory control problems in the establishment.

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