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Investigation and analysis of inventory management in a construction company - a case study of Hi-Tech Nigeria Limited

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ABSTRACT

This study investigated the inventory management in a construction company – a case study of Hi-Tech Nigeria limited. In a quest to find out how inventory is being managed in Nigeria construction companies. The ABC Pareto principle was successfully used to classify the parts into three broad categories according to the following criteria, fast movers, average movers and slow movers. Using statistical analysis done with SPSS tool, basic classification of the 118 items recorded, based on 3 points sale, A=1, B=2, C=3, based on paretus principle, tagged critical items, moderate and non-critical items, the outcome of the PARETO analysis which has demonstratively confirmed the validity of 20/80, Rule. It was quite apparent form the study, that low-cost items comprise 80% of the bulk of the inventory. But, as the PARETO principle avers, this class of items accounts for only 20% of the inventory cost, the critical items A= 3, displayed maximum mean value or the highest total cost of #123,062.0, skewness statistic 4.4 and standard error of 0.223. It is therefore clear that theory and practice have a meeting point. It is evident from the result that the firm studied does not practice an optimal inventory policy as observed from the research results and the real-life practice of their daily operations. The research has determined the optimal lot size for each item in the inventory studies.

1. INTRODUCTION

Inventory is essential to materials management on site, in other for the materials to be readily available at the time of need. Inventory holds the material required for construction and also store spare parts and tools. In many Nigeria construction companies that many construction projects suffer from cost overrun and exceed the delivery date. This inventory challenge could be solved by proper implementation of the inventory management system adopted by the construction company. Which will increase the productivity on site and the progress of project will be consistent. Inventory management consist of many processes like selecting the materials and their procurement, cost involve in transporting them and storage of materials. The effective material management process plays major role in the construction industry. Material Management involves the process of planning, executing and controlling field and

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office activities in construction organization. For a construction company to successful manage its construction materials is a function of the updated data-based information available and well utilized.

Experts all over the world, especially those concerned with economic planning and record – keeping have stressed the need for periodic stock-taking of commodities meant for commercial and other purpose. To this end, several models that facilitate and effectuate stock – taking have been developed. There is a general classical economics order quantity model. This model observed that the holding cost per unit is a non – linear function of the length of time the item is held in stock; also, the parameters of unit cost, selling price, demand rate and set-up cost being constants.

In the construction industry, stock-taking is done in some cases, this subject area is very important st successes would ensure that material wastages being observed presently in construction sites is minimized. The present research work has realized this concept, and it is geared towards ascertaining the practices that would ensure proper inventory management in the construction company taking as a case study; the results of such findings as it applied to the Nigerian construction companies based on the assertion that most of them operate under similar conditions. It has been observed that record keeping and stocking – taking are not properly done in Nigerian construction companies. Such negligence has enhanced theft, fraud and poor project execution. Moreover, the attitude of poor stock-taking has brought about situations whereby workers run out of materials when projects are yet to be completed. The overall effect is that more money than is originally budgeted is spent at the end of the project execution and more time than originally expected is used up, all these amounting to losses. The current study investigated inventory management in a construction company – a case study of Hi-Tech Nigeria limited.

Harsh et.al (2022) investigated inventory management is a critical part of construction Industry. They reported that, inventory management system consist of different tasks like finding suitable materials, procurement process of those materials, transportation. Materials on construction site cost around 50-60% of the total cost of the project, so it becomes very crucial to handle the materials methodically. The main objective of their paper was to study the existing research on inventory management in Indian construction industry and to observe the importance of inventory management and different costs associated with inventory management. Udaya et.al (2020) studied the going practices for material management in construction project and inventory control techniques like ABC classification, EOQ analysis and SPSS software. They analyzed data collected from residential project and some literature review as well, and concluded that the supervision was inefficient, poor communication between the team which overall lead to improper and frequent moving of material on construction site. All these lead to cost increased not only in project but also in holding or storing of the

inventory materials that all finally delays the completion of the project.

Ramya et.al (2020) stated that material management is a major problem in a construction project for many years. In construction field construction materials consumes 50 to 60 % of overall cost of a project, successful material management of construction has to be based on the innovative techniques. They explored material management techniques used in present days and identify the factors that affects material management. They applied ABC principles to analyze a residential building. They recommended material management techniques to determine the required quantities of materials for reducing the time and errors. Jon S. (2017) has referred to the management of products that are meant to be consumed internally by an organization as maintenance repairs, and operations (MRO) inventory Pakkala et.al (1989) have reported on order-level probabilistic inventory model for deteriorating items with two warehouses, further discussed the effects of varying production rates on inventory control based on the minimal lattice paths, which was represented on two – dimensional planes, thus giving rise to the focus of the fluctuations of inventory. It should however be noted that not so much well recognized work has been focused on inventory management in Nigerian construction companies. Such study if successful would unravel some mysteries that have remained hidden in the execution of Nigeria construction. Such as the reasons why government projects are usually much more costly than individual projects of the same qualities why some construction companies fold up without any previous problem signal and why such projects are abandoned without any notable reason.

Beek (1981) studied multi-echelon inventory models dealing with the goods within the finished goods section of a production division, it proffered a solution to the modification of the standard EOQ problem in which freight costs are at least partially determined by the integer number of car loads required to fill the order. Scull et.al (1990) analyzed the use of multiple suppliers to replenish stock items with the replenishment order split into several portions (one for each supplier) and with the orders for these portions placed simultaneously with the respective suppliers. Buffa et.al (1989) examined a firm's logistics cost including shipping and inventory; recognizing the carrying cost as substantial percentage of its selling price. The current study attempts to find out how inventory is being managed in Nigerian construction companies. Already, the effects of poor inventory management have been considered briefly under the introductory section. Such effects, as earlier said, have prompted scholars to embark on deliberate researches aimed at ascertaining best inventory management practices. On the whole, the current work would provide an insight into possible ways of minimizing wastages in the construction sector as well as provide the Federal Government with answers relating to the uni-deal execution of her projects. The overall benefit is that this work would make available the un-supposed wastes for other important uses. The economy of the nation would be improved

by amount equal, not only to the losses being recorded in Federal Government projects, but also to the wastages and losses that are not being accounted for on individual projects.

2. METHODOLOGY

2.1 Research Design

Our approach was carried out, by obtaining primary data on inventory items used by Hi Tech Nigeria Limited. The data spans a period of three years. The data was examined and reorganized in line with the following criteria:

i. Listing in terms of decreasing cost
ii. Listing in terms of decreasing frequency of usage
iii. Listing in terms of decreasing stock quantity

Next a holistic look was taking on the entire inventory items on the basis of a decreasing quality listing and the economic order quality (EOQ) value determined for each item. The weekly demand, the lead – time and hence the reorder point were computed for each inventory item. A randomly selected inventory item had been EOQ plot sketched and the result was quintessential model; thus confirming the adequacy of the model employed

2.2 Source of Data Acquisition

The inventory data was obtained from the original book of entry of inventory of spare parts for HIT-TECH construction limited, Warri, Delta State and Nigeria. The data are concerned with inventory of replaceable items for civil construction machinery and equipment. Bulk of the items inventories comprise of relative low cost parts, confirming the PARETO principle of 20/80 rule; meaning that 20 percent cost of inventorable goods account for 80 percent amount of the entire inventory and vice-versa.

2.3 Data Size

The gross totals of 146 inventory items were studied. And the record covers the period 2012 – 2014, that is 3 years. The nominal stock quantity, the actual stock quantity, the unit price, the valve and location of each item in the spare parts store were all obtained as original record.

2.4 Method of Data Collection

Due approval and consent from the organization used as case study for the inventory data obtained. In consequence, the firm willingly gave out data on the understanding that the information would be used strictly for academic research purposes only. The personal observation of the stock of item in the store as well as personal interviews of the staff of the user and issuing departments were conducted as a way of verifying certain information that were not clear in the record obtained.

2.5 Samples and Sampling Techniques

Were branch office of the company was used as a sample case study. It was used as a convenience sample and it is believed to be both random and purposive sample. In other words, purposive and random sampling techniques were adopted which, as the author believes, is a representative of the national population of the company studied. And, perhaps, this could also represent the entire construction industry by way of extension.

2.6 Area of Study

As has been limited in section (3.5) above, the geographical area of study is Warri in Delta State of Nigeria. The company operates in several major cities of Nigeria where they are able to secure civil construction and projects having to do with roads, bridges, buildings, dams etc.

2.7 Models Employed/Method of Data ***Analysis***

Three basic operations research (OR) models were evoked and used for data analysis. And they comprise of the following

i. ABC Analysis (PARETO principle or 20/80 rule)
ii. EOQ model
iii. Graphical diagnostics check as a form of sensitivity analysis

We shall expatiate in what follows:

1. The ABC classification was done in three parts as follows:

(a) Part 1

The observations were arranged according to the decreasing order of cost. In other words, item with highest cost was listed first and the one with the least cost was listed last.

(b) Part 2

Next, using frequency of usage as the main criterion, items with the highest frequency were listed first and this procedure was used to list all items in decreasing order of frequency such that the last item has the least frequency.

(c) Part 3

In this version, inventory items were listed according to decreasing stock quantities. In other words, the actual stock quantity column in the original book of entry was examined and items widely the highest magnitude were listed first while the one with least magnitude was listed last. The worksheets for parts 1,2 and 3 appear to follow the method of PARETO Analysis in particular.

i. Economic Order Quantity (EOQ) Model

In this approach, the EOQ model given by:

$$Q^{*} = \sqrt{\left\{\frac{2DCo}{Ch}\right\}} \quad (1)$$

Was applied to every item in the inventory list. To underscore the theoretical basis, upon which this model is based, the formula in equation 1 above is derived as follows:

Let Q be the lot size

And let C_o^1 and C_c^1 be the annual ordering cost and carrying cost respectively.

Accordingly, the annual ordering cost per order is given by:

$$C_o^1 = CD/Q \times C_o \quad (2)$$

Similarly, let the annual carrying cost per be C_c. So that the expression for C_c is given by

$$C_C^1 = Q/2 \times C_c \quad (3)$$

Arising from (2) and (3) we can define the combine the total annual carrying cost and annual ordering cost (TC) as follows:

$$TC = C_o^1 + C_c = D/Q \times C_o + Q/2 \times C_c \quad (4)$$

Differentiating (4) with respect to Q

$$d(TC)/dQ = - DC_o/Q^2 + C_c/2 \quad (5)$$

taking a second derivative with respect to Q again, we have

$$d^2(TC)/dQ^2 = - D/Q^3 + C_o/O \quad (6)$$

Since the $d^2(TC)/dQ^2 > O$, a minimum is implied. Therefore, from (5), by setting d(TC)/dQ=O.

We can obtain a quantity Q* called the economic order quantity, meaning the minimum quantity that can give rise to a corresponding minimum total with respect to annual carrying and order costs.

Accordingly,

$$-D/Q^2 \times C_o + C_c/2 = O$$

$$Q^* = \sqrt{\{\frac{2DCo}{Ch}\}}$$

And this lot size is called Q* as explained above so that, Graphical diagnostics check as a form of sensitivity analysis.

The optimal stock quantity, Q* for each inventoriable item was computed and placed vis-à-vis with the actual lot size, Q. the residual given by,

$$R=Q - Q^*$$

obtained for each stock item. Finally, a plot of R against inventory number-based quantity gives an exponential distribution that decays as stock quantity diminishes.

2.8 Diagnostic check

A typical inventory item data analysis was used to plot super – imposed graphs of the following:

i. Total cost against quantity, Q
ii. Ordering cost against quantity, Q
iii. Carrying cost against quantity, Q

Please note that verifying quantity for the plots, for the selected inventory item, were obtained by dividing the basic data (outcome) for TC, Cc and Co by a sequence positive integer.

3. RESULTS AND DISCUSSION

The computations associated with the determination of EOQ for each stock item. The computation of the reorder point,

$$r= md \quad (7)$$

where m= lead time (weeks), d= weekly demand (quantity per week)

EOQ plot for typical stock items, particular that C_c column is obtained by regarding annual carrying cost per unit as 25% of inventory while the annual ordering cost per order is 5% of unit inventory cost.

Table 1: EOQ Computations for oil Filter; **Numerical Divisor**

1	QUANTITY	1	2	3	4	5	10	20
2	Cost Per Order	₦6,000	₦3,000	₦2,000	₦1,500	₦1,200	₦600	₦300
3	Average inventory	6.7	3.3	2.2	1.7	1.3	0.7	0.3
4	Carrying cost (Cc)	₦1,500	₦750	₦500	₦375	₦300	₦150	N75
5	Ordering cost (Co)	₦300	₦600	₦900	₦1,200	₦1,500	₦3,000	N6000
6	Total Cost/Yr (TC)	₦1,800	₦1,350	₦1,400	₦1,575	₦1,800	₦3,150	N6,075

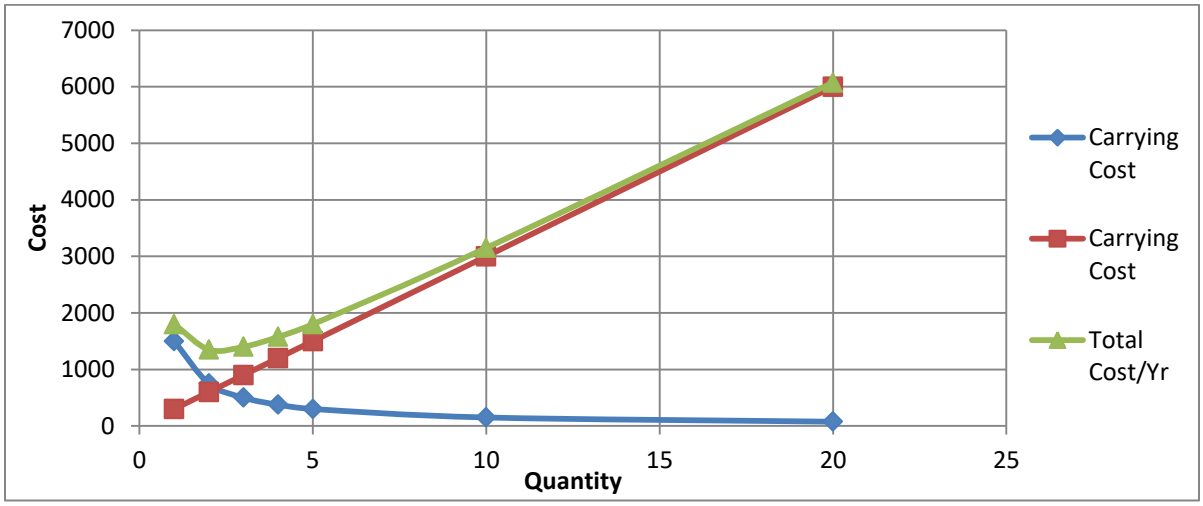

Figure 1: Combine plot of Carrying, Ordering cost and total cost against quantity

The EOQ results obtained have specified the optimal quantities of stock to be kept to assure good inventory management. The reorder, point, which is the stock quantity that signals the need to place order for the next batch of items, where also duly computed.

Perhaps, one other essential of this result of our study is the EOQ plot obtained for a pre-selected item from the stock. The plot has a close semblance of the theoretical EOQ plot, this is another bridge between theory and practice.

Statistical Analysis done with SPSS tool

Basic classification of the 118 items recorded, based on 3 points sale, A=1, B=2, C=3, based on paretus principle, tagged critical items, moderate and non-critical items. The outcome of the PARETO analysis which has demonstratively confirmed the validity of 20/80, Rule. It was quite apparent form the study, that low-cost items comprise 80% of the bulk of the inventory. But, as the PARETO principle avers, this class of items accounts for only 20% of the inventors y cost. It is therefore clear that theory and practice have a meeting point.

Table 2: Descriptive statistics

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error
UNIT PRICE	118	80.0	123062.0	8405.540	15259.8341	4.409	.223
Classifications	118	1.0	3.0	1.627	.8553	.804	.223
Valid N (listwise)	118						

From the table above, the critical items A= 3, displayed maximum mean value or the highest total cost of #123,062.0, skewness statistic 4.4 and standard error of 0.223.

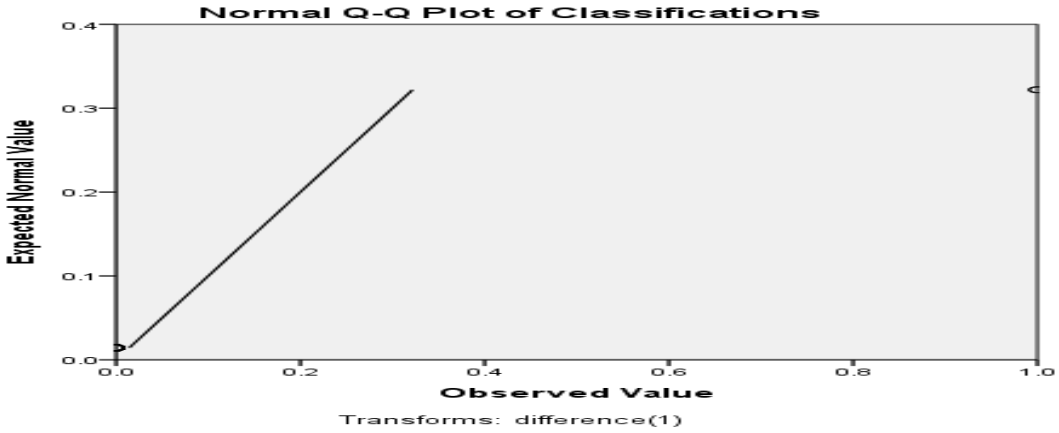

Figure 2: Q-Q Plot of classifications

The figure above is the Q-Q Plot of the items classifications of expected normal value against the observe value. It is a linear graph.

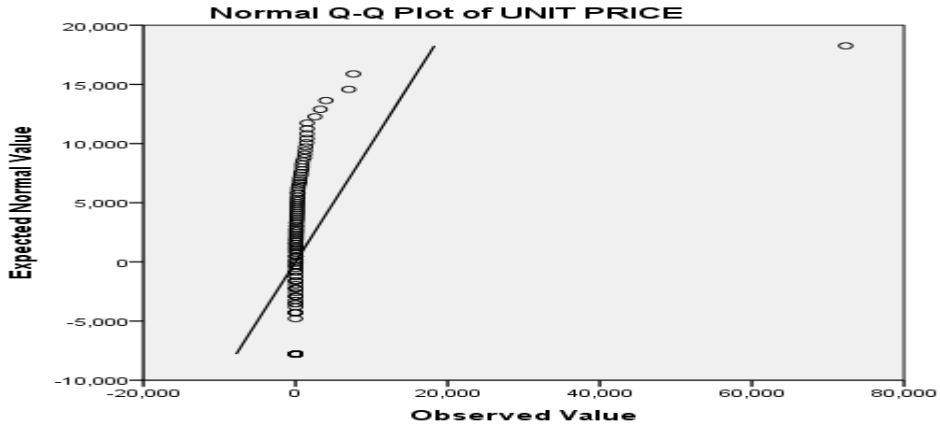

Figure 3: Q-Q Plot of unit price

The figure above is the Q-Q Plot of the price, of expected normal value against the observe value.

Most companies in Nigeria really do not have good inventory management system. They believe in the use of hand, common

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sense and experience. Although, this is not completely a bad idea by itself, but there is the compelling need to be trendy particularly on what constitute the current inventory policy and more importantly, the best inventory practices (BIP). Obviously, adherence to the above hallmarks undeniably would escort one to the realm of the practice of using EOQ model that specifies the optimal lot-size that can minimize total cost of inventory.

Without this approach, any inventory management would lead to avoidable over-expenditure and lots of corporate good will which companies strive to build in order to remain competitive in the light of volatile global competition. Another interesting outcome of this research is the novel plot obtained by computing noise and graphing it against inventory item number. The result confirmed that the company is out of tune with optimal inventory policy.

4. CONCLUSION

This study investigated the inventory management in a construction company – a case study of Hi-Tech Nigeria limited. In a quest to find out how inventory is being managed in Nigeria construction companies. The ABC Pareto principle was successfully used to classify the parts into three broad categories according to the following criteria, fast movers, average movers and slow movers. Using statistical analysis done with SPSS tool, basic classification of the 118 items recorded, based on 3 points sale, A=1, B=2, C=3, based on paretus principle, tagged critical items, moderate and non-critical items, the outcome of the PARETO analysis which has demonstratively confirmed the validity of 20/80 Rule. It was quite apparent form the study, that low-cost items comprise 80% of the bulk of the inventory. But, as the PARETO principle avers, this class of items accounts for only 20% of the inventory cost, the critical items A= 3, displayed maximum mean value or the highest total cost of #123,062.0, skewness statistic 4.4 and standard error of 0.223. It is therefore clear that theory and practice have a meeting point. It is evident from the result that the firm studied does not practice an optimal inventory policy as observed from the research results and the real-life practice of their daily operations. The research has determined the optimal lot size for each item in the inventory studies.

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Conflict of Interest

There is no conflict of interest associated with this work.

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