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QR INVENTORY CONTROL SYSTEM AND TIME RELATIONSHIP IN MANUFACTURING ORGANIZATIONS: A STUDY OF SELECTED FLOUR PRODUCING FIRMS IN NIGERIA

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ABSTRACT

Purpose: *The study aims to assess the Q/R inventory control system and Time relationship in Nigerian manufacturing organizations.*

Design/Methodology*: The study employed a quantitative research design. The research design attempts to build a mathematical model that captures the relationship between variables. The focus of this study was on raw material inventory and demand requirement with respect to Time at the three selected flour manufacturing firms.*

Findings*: Finding indicates that the reorder points of wheat inventory at the studied firms depend on Time.*

Research Limitation/Implications*: The study focuses on the relationship between inventory demand and Time at Nigeria flour manufacturing firms, thereby limiting generalizing to other sectors.*

Practical Implication*: The aspect of time to place on order provides an answer to the minimum stock level at which additional quantities of raw material to be ordered.*

Social Implications*: The result have important social implications in that an inventory control approach that leads to the availability of raw material and finished goods within the manufacturing sector is identified.*

KEYWORDS: *Q/R Inventory, Time Series, Manufacturing Organization*

INTRODUCTION

Inventory plays a very significant role in the modern organization and constitutes a significant part of their assets. Juan, et al (2018) opined that it has to be adequately managed to serve as a function when a minimum cost is required. They explained further that inventory management involved making two basic decisions: The quantity to order with each order placed and the point in time when the order has to be placed. Gulsah (2010) explained that inventory turnover ratio measures the number of times inventory is sold or replaced in a period. Perhaps, it is the most widely used metric measure of a company's operational performance used in evaluating performance over time as well as comparing inventory performance among firms.

In order to achieve better economic performance in any organization, the firm has to meet customers need.

Bowersox, Closs, and Cooper (2002) and Musenger (2005) underlined three fundamental attributes of customer service which are availability, operational performance and service reliability.

Availability here explains the capacity of a firm having inventory when desired by a customer. It is uncommon for the firm to spend considerable time, money and effort in generating customer demand but fail to have products available to meet up customer demand. Traditionally, organizations practice stocking inventory in anticipation of customers order. Musenga (2005) further explained the availability of high level of inventory requires good planning. He ascertained that exact inventory availability cannot be conceived or attended instead average availability is possible based on three performance measures namely which are stock out frequency, fill rate and completed order.

Operational Performance

Bowersie et al (2002) and Musenga (2005) explained that operational performance is all about required time to deliver customer orders. Performance cycle in question is market distribution, manufacturing support or procurement, operational performance.

Service Reliability

According to Bowersie et al (2002) and Musenga (2005), service reliability involves the combined attribute of logistics and firm's ability to perform all related activities as well as customer provision in critical information regarding operational logistics and status. They explained reliability attributes as the ability of shipped goods to be damage free; accurate invoicing and error free.

This study focused on the determination of the relationship between reorder point of wheat inventory and time at selected flour manufacturing firms in Nigeria. The Reorder point is the level at which the stock of inventory material is allowed to fall before ordering for other raw material in the selected flour manufacturing firm in this study.

The Problem

Wheat, the major raw material for the production of flour at the selected firms in this study is imported. This accounts for a gap between the ordering and the delivering period (Lead Time). It is in view of this that this study is undertaken to determineif there is any significant relationship between the Reorder point of wheat inventory and time at the studied firms.

OBJECTIVES

To determine the reorder point of wheat inventory with respect to time, in order to maintain the desired inventory level at a given time at the studied firm.

Hypothesis

Ho, Time does not have any significant relationship with Reorder point of wheat inventory at the studied firms.

LITERATURE REVIEW

The following are some of the related literature reviewed in this study:

Juan et al (2018) conducted a study on the calculation of Recorder point for items with an exponential and Poisson distribution of lead time demand. The paper aims the estimation of lead time and the reorder point that produce minimum inventory cost using the exponential and Poisson distribution for each of the corresponding products under study when a service level is required. The estimation process in their study explores carefully what happens to the reorder point and inventory cost when the service level changes. They found out that the variation of the minimum inventory cost as a function of the reorder point was different for both items. This implies a linear relationship for high and low service levels for the items with exponential distribution and also a parabolic relationship for intermediate levels and these reorder points located at extreme values of the range under study, depending on the cost structure of stock out and inventory maintenance. They also found out a linear relationship between the cost variation and the items with poison distribution.

Sahari, *et al* (2012) in their study "Inventory Management in Malaysian Construction Firms: Impact on Performance" empirically examined the relationship between inventory management, firms performance and intensive capital on a sampled financial data from 82 construction firms in Malaysia from 2006 to 2010. The objective of the study was to investigate the relationship between inventory management, performance, and intensive capital. Inventory management in their study was measured using days of inventory (which equals Q = D.Lt) formula to find out how long inventory is held. By employing regression and correlational techniques, they found out that inventory management has a positive correlation with firms' performances. This implies that improving organizational inventory management leads to improvement in the organization's efficiency.

Kundu, Chakrabarti, and Chakrabaati (2013) also conducted a study on the EOQ model depending on deteriorating items with alternative demand rates that allow shortages by considering valued money time. The objective of this study was to determine the optimal ordering quantity with deteriorating items. The second objective was to minimize the total cost function of the inventory system over a long period of time. They argued on the demand changing rate as being deterministic or uncertain while the deterioration rate of the item takes time. In their analysis, the holding and shortage cost is taken as the linear function of time. They observed the total cost function per unit of time and later developed a model using gradient-based non-linear optimization techniques illustrated by numerical example.

METHODOLOGY

The study employed a quantitative research design. The research design attempts to build a mathematical model that captures the relationship between modeled variables. The focus of the study was on raw material (wheat) inventory and demand requirement with respect to time at the three selected flour manufacturing firms.

Reorder point shows the number of days in the production horizon a given firm will replenish its stock of wheat inventory after demand (depletion) has reached a certain level. Following the model used by kuo et al (2012) and adopted by chuckwuma (2015) the reorder point of wheat inventory was estimated using, regression model as follows

$$Q_{wi} = \alpha + \beta t + £i \quad (1)$$

Where:

Q_w=quantity of wheat inventory always available at the beginning of a production process for the ith firm

α and β =The parameters to be estimated

£i=the stochastic disturbance

The above equation was estimated for each studied firm using ordinary least square (OLS) criteria on the strictest assumption that the estimated functions are linear. This assumptionswere made to simplify the estimation of the cost models.

Area of Study

This study covered raw materials (wheat) used for the production of bread flour; wheat meal and semovita of the selected flour manufacturing companies in Nigeria. These firms include "Flour Mills of Nigeria Plc Lagos"; "Dangote Flour Mills Plc., Calabar" and "Honeywell Flour Mills Plc., Lagos". Lead capital (2008) affirms that the three selected firms for the study constitute a major flour producing firms in Nigeria with 63 percent combined market share. Based on the above assertion, the three firms were judgmentally selected for the purpose of this study.

Methods of Data Generation

The study used secondary sources of data. The data include the annual demand, carrying cost ordering cost, total costs of inventory of raw materials (wheat) used at the three studied firms. These data were obtained from the company's historical records covering a ten (10) years period (2004 – 2013) and used for calculating the specific attributes of the variables.

RESULTS

Reorder Points of Wheat Inventory at Honeywell Flour Mills Plc with Respect to Time

LQW = f (LT)

Dependent variable: LOG (QW)

Method: Least squares

Sample: 2004 2013

No. of Observations 10

Table 1: Reorder Points of Wheat Inventory at Honeywell Flour Mills Plc With Respect to Time

Variable	Coefficient	St. Error	t-Statistic	Prob.
C	11.47146	0.335660	34.17584	0.0000
LT	-0.855677	0.201860	-4.238968	0.0028

Source: Eviews 7

R^2 = 0.691939

Table 1 shows the recorder point (ROP) coefficient function for wheat material inventory at Honeywell Flour Mills Plc. The quantity of wheat inventory (QW) as the dependent variable was regressed on time (LT) and independent variable.

The following function was generated using the estimated coefficient in table 1.

ROP = 11.47 – 0.86LT (2)

Equation (2) is the estimated equation for the normal functional form of the reorder point function for raw material (wheat) at Honeywell Flour Mills Plc.

Based on the assumption of instantaneous replenishment or replacement of wheat inventory material at the studied firms, in the determination of reorder points, it is assumed that the available inventory is depleted to zero while an order is placed and received immediately. In view of this assumption, the reorder point equation for the wheat inventory was estimated as follows for the purpose of determining the reorder point at which placement of the order for wheat should be made.

LQW = f(LT)

From table 44, LQW = 11.47146 - 0.855677 LT

Estimated reorder point equation

ROP = 11.47 – 0.86LT

At LT = 0, ROP = 11.47

Since depletion occurs at period (T), when inventory depletion is zero such that

ROP = 0,

Therefore 0 = 11.47 – 0.86T

$\therefore T = \frac{11.47}{0.86} = 13.34 \cong 13$ days

If reorder period is 13 days and 11.47 tons of wheat are used up daily production runs, then total quantity depleted will be13 (days) X 11.47 tones

Therefore ROP = 149.11 tones

Figure 1 below shows the graphical illustration of the reorder point (ROP) of wheat inventory at Honeywell Flour Mills Plc.

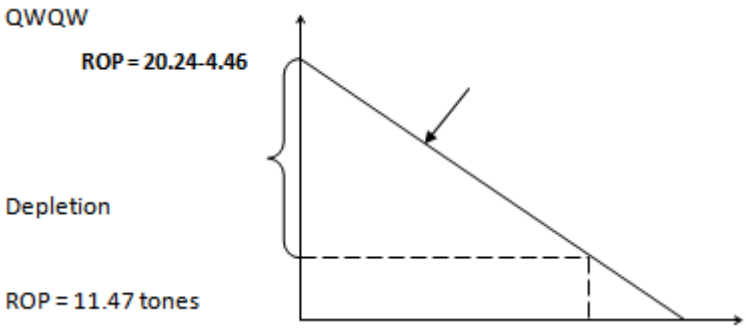

Figure 1: Reorder Point for Wheat Inventory at Honeywell Flour Mills Plc

Source: Computed by the Researcher

Reorder Point of Wheat Inventory at Dangote Flour Mills Plc with Respect to Time

LQW=f (LT) Modell

Dependent Variable: **LOG (QW)**

Method: **Least Squares**

Sample: **2004 2013**

No of Observations: **10**

Table 2: Reorder Point of Wheat Inventory at Dangote Flour Mills Plc with Respect to Time

Variable	Coefficient	St. Error	t-Statistic	Prob.
C	20.23744	3.351274	6.038731	0.0000
LT	-4.458868	1.041468	-4.281332	0.0002

Source: Eviews 7

R^2 = 0.728641

Table 2 shows the Reorder point (ROP) coefficient function for wheat material inventory at Dangote Flour Mills Plc. The quantity of wheat inventory (QW) as the dependent variable was regressed on time (LT) as an independent variable.

The following function was generated using the estimated coefficient in table 2.

ROP = 20.24 – 4.46LT (3)

Equation (3) is the estimated equation for the normal functional form of the reorder point function for raw material (wheat) inventory at Dangote Flour Mills Plc.

It is assumed that the available wheat inventory is depleted to zero while an order is placed and received instantaneously, in view of this assumption, the reorder point equation for the wheat inventory was estimated as follows:

LQW = F (LT)

From table 2, LQW = 20.23744-4.458868LT

Therefore estimated reorder point equation for Dangote Flour Mills Plc was given as

ROP = 20.24-4.46 LT

At LT= 0%, Therefore ROP = 20.24

Since depletion occurs at period (T), when inventory depletion is zero such that ROP = 0,

Therefore ROP = 20.24 - 4.46LT

That is 0 = 20.24-4.46 LT

This implies that LT = $\frac{2024}{}$ = 4.54 days

4.46

If the reorder period is 4.54 or approximately 5 days, and 20.24 tonnes of wheat were used up during production runs, then total quality depleted will be:

5 days x 20.24

Therefore ROP = 111.20 tonnes

Figure 2 below shows the graphical illustration of reorder point (ROP) of wheat inventory.

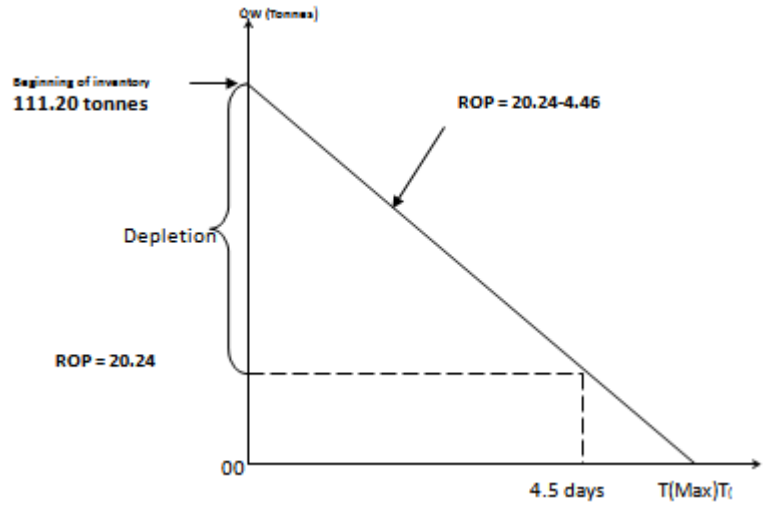

Figure 2: Reorder Point of Wheat Inventory of Dangote Flour Mills Plc

Source: Computed by the Researcher

Reorder Point of Wheat Inventory at Flour Mills of Nigeria PLc with Respect to Time

LQW=f (LT)

Dependent variable: LOG (QW)

Method: Least squares

Sample: 2004 2013

No. of Observations: 10

Table 3: Reorder Point of Wheat Inventory at Flour Mills of Nigeria Plc with Respect to Time

Variable	Co efficient	St.error	t-Statistic	Prob.
C	8.086415	2.057393	3.930418	0.0022
LT	-8.762045	1.625522	-5	0.0007

Source: Eviews 7

R^2 = 0.638409

For the purpose of determining the reorder point at which placement of order to wheat inventory at flour mills Nigeria PLC; model 8 is expressed as:

LQW = f (LT)

Table 3 shows the reorder point (ROP) coefficient function for wheat material inventory at Flour Mills of Nigeria Plc. The quantity of wheat (QW) as the dependent variable was regressed on time (LT) which is an independent variable.

The following function was generated using the estimated coefficient in table 3.

ROP = 8.09 – 8.76LT (4)

Equation (4) is the estimated equation for the normal functional form of the reorder point function for raw material (wheat) inventory at Flour Mills of Nigeria Plc.

From table 3

LQW = 8.086415 — 8.762045 LT

Therefore estimated reorder point equation for Flour Mills of Nigeria Plc is given as

ROP = 8.086415 - 8.762045 LT

That is, ROP = 8.09 - 8.76 LT

At LT=0, ROP= 8.09

If depletion occurs at period (T) when inventory depletion is zero, such that ROP = 0, Therefore rop = 8.09 — 8.7 LT

That is 0=8.09 - 8.7LT

This implies that LT = 8.09 = 0.93 days

8.7

If reorder period is 0.93 days or approximately 1 day, and 8.09 tonnes of wheat were used up during production runs, then total quantity depleted will be 1-day x 8.09

Therefore ROP = 8.09 tonnes.

Figure 3 below shows the graphical illustration of the reorder point of wheat inventory at Flour Mills of Nigeria Plc.

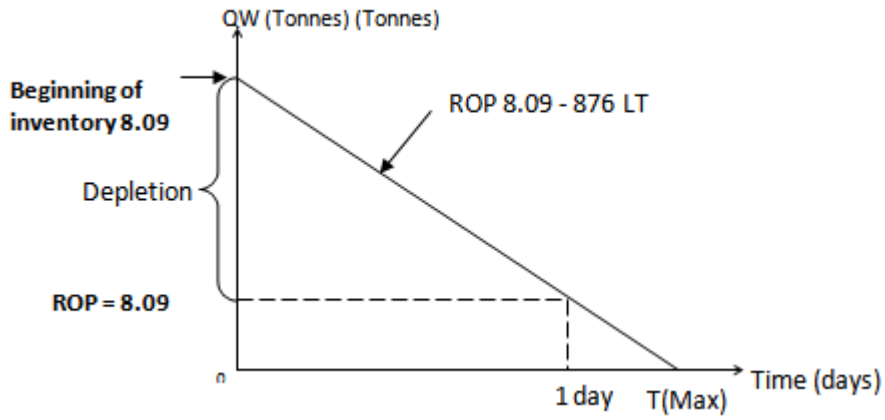

Figure 3: Reorder Point of Wheat Inventory at Flour Mills of Nigeria Plc

Source: Computed by the Researcher

DISCUSSIONS OF THE FINDINGS

Table 1 shows the reorder point (ROP) coefficient function for wheat material inventory at Honeywell flour mills Plc. The equation in the model regressed LQW on LT. The regression coefficient of LT carries a negative sign (-0.855677) and the t-value is statistically significant at 5%. This implies that LT has a significant and negative relationship with LQW. The significance of the parameter (time indicated by LT) is confirmed by the t-probability (0.0028). Thus, it was found that an increase in time (LT) will contribute to decreasing Q wheat (quantity of wheat) of Honeywell flour mills plc by 0.9%. This implies that the higher the time for production runs, the low the quantity of wheat inventory kept at Honeywell flour mills plc. The findings support Kundu, Chakrabarti, and Chakrabarti (2013) who discovered that the time at which demand rate changes may be deterministic and that deterioration rate of the inventory item is time-dependent. R^2 of 0.652 implies that 65.2 percent of the total variation in the Q wheat (quantity of wheat of Honeywell is accounted for; by the independent variable namely time (LT) which is moderate for the firm. The computed DW is 1.6 at 5% level of significance with one explanatory variable and 10 observation.

Table 2 shows the reorder point (ROP) coefficient function for wheat inventory at Dangote flour mills Plc. The equation in the model regressed LQW on LT. The coefficient of the constant term is 20.2. The associated t-value is statistically significant at 5 percent level, indicating that keeping the independent variable, LQW will increase by 20.2%. The regression coefficient of LT carries a negative sign and the t-value is statistically significant at 5%. This implies that LT has a significant and negative relationship with LQW. The significance of the parameter (Time indicated by LT) is confirmed by the t-probability (0.0002). More so, it is found that an increase in time (LT) will contribute to a decrease in Q wheat of the firm by 4.5%. This finding is in support of Kundu, Chakrabarti, and Chakrabarti (2013) who found that the time at which demand changes can be determined and the deterioration rate of inventory is time-dependent. R^2 of 0.729 implies that 72.9% of the total variation in the Q wheat of Dangote Flour Mills is accounted for, by the independent variable namely time (LI). The computed DW is 2.43. At 5% level of significance with one explanatory variable and 10 observation, the tabulated DW for dL and du are 0.879 and 1.320 respectively. The value of computed DW is greater than the upper limit. Therefore, we conclude that there is no evidence of positive first order serial correlation.

Table 3 shows the reorder point (ROP) coefficient function for wheat material inventory at Flour Mills of Nigeria Plc. The equation in the model regressed LQW on LT. The coefficient of the constant term is 8.09. The associated t-value is statistically significant at 5 percent level, indicating that keeping the independent variable, LQW will increase by 8.09%. The regression coefficient of LT carries a negative sign and the t-value is statistically significant at 5%. This implies that LT has a significant and negative relationship with LQW. The significance of the parameter (Time indicated by LT) is confirmed by the t-probability (0.0007). More so, it is found that an increase in time (LT) will contribute to a decrease in Q wheat of the firm by 8.8%. The finding support Kundu, Chakrabarti, and Chakrabarti (2013) who found that the time at which demand rate changes can be determined and deterioration rate of inventory is time-dependent. The R^2 of 0.638 implies that 63.8% of the total variation in the Q wheat of Flour Mills of Nig. Plc is accounted for, by the independent variable namely time (LT). The computed DW is 2.3. At 5% level of significance with one explanatory variable and 10 observation, the tabulated DW for dL and du are 0.879 and 1.320 respectively. The value of computed DW is greater than the upper limit. Therefore, we conclude that there is no evidence of positive first order serial correlation.

CONCLUSIONS

The reorder points of wheat inventory at the studied firms depend on time. The aspect of time to place an order provides an answer to the minimum stock level at which additional quantities of wheat is to be ordered.

RECOMMENDATIONS

From the findings of this study, the following recommendation is necessary: It is no doubt if implemented judiciously, the economic performance of the organization would be enhanced.

Managers should reduce the period of inventory and promptly settle payments so as to provide opportunities for re-investment in different areas thereby increasing the firms' economic performance.

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