

Impact of Inventory and Warehousing Costs in Total Logistics Cost of Manufacturing Companies in Southwestern, Nigeria

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Abstract: The research aims to analyse the impact of cost parameters of total logistics cost with emphasis on Inventory and warehousing costs, with a view to minimizing cost and enhance effective warehousing services in manufacturing companies. The inventory is basically the carrying cost, while the warehousing costs include Picking/Retrieval costs, packing costs and loading costs. The research adopted case study approach. Twenty manufacturing companies formed the sample of the study, based on multi stage sampling techniques that incorporated cluster, stratified and purposive sampling methods. Apart from parametric test statistical techniques adopted, data analyses were done using a software application that incorporated Cobb-Douglas production function, which was packaged and tailor-made for the study. It was revealed that there were relationships between components of warehousing and inventory, however, most of the inventory carrying cost components (capital, storage and space, inventory risk costs) was significant. In other words, Inventory risk cost has a significant relationship with most of all variables (dependent and independents). The research recommends that companies should adopt scientific warehousing management system that is information technology in orientation, as well as lay emphasis on inventory in attempt to cut cost, simultaneously maintaining customers service.

Key words: Impact, costs, logistics, inventory, warehousing, parameters

INTRODUCTION

The important components of total logistics cost are transportation cost, warehousing costs, inventory carrying cost and order entry/customer service cost. Empirical studies however, reveal that inventory carrying cost and warehousing costs have higher percentage close to transportation. For instance, about 61% of the total logistics costs comprise of non-transportation related logistics cost (Christopher, 1992, 1998). Suffice it to stress that the inventory carrying costs and warehousing costs are highly interdependent on the efficiency of the transportation system. Similarly, the increased use of information technology in logistics management had improved the efficiency of supply chains and equally had a balancing effect on the total logistics cost (Davenport, 2002; Somuyiwa and Adewoye, 2008).

However, value of the product affects logistics cost, in the sense that the actual logistics costs involve with high valued products are higher as compared to the actual logistics costs involved with low valued products. In a related manner, product cycle time affects the inventory carrying costs as there is a capital cost associated with

commodities that are held up in the inventory. In other words, smaller companies incurs higher logistics cost as compared to larger companies.

In the light of this, the research examines the cost inherent in this most vital aspect of logistics cost, with a view to minimizing cost and enhance customer service.

In a related manner, hypothesis stated for the study in null form is that there is no significant relationship among components of inventory and warehousing cost of total logistics cost.

MATERIALS AND METHODS

Study area: South-Western part of Nigeria lies between latitude 6°N and 8½°N of the equator and longitude 3°E and 5°E of Greenwich Meridian Time (GMT). The zone consists of six states. These are Lagos State that stretches along the seaboard, Ogun, Oyo, Osun, Ondo and Ekiti State. The South-Western Geo-political Zone occupies an area of 79,048 km². The zone covers about one-twelfth of Nigeria and into it are packed almost 25 million or about one-fifth of the entire population of the

Country. The area is washed in the South by the Gulf of Guinea. On the east, it is bounded by South-Eastern Nigeria. On the west, it shares a common frontier with the Republic of Benin and on the north, it is bounded by North Central Geo-Political Zone that consists of Kwara State, Kogi State, Niger State and others. The majority of the people in South-Western Nigeria are Yorubas, which occupies major urban centres of this Geo-political Zone.

In a related development, major population concentration are found in the state capitals and other important towns in the region like Ikorodu, Epe and Badagry (Lagos State); Abeokuta, Ijebu Ode, Ijebu Igbo, Shagamu, Ilaro, Ifo, Otta and Aiyetoro (Ogun State); Ogbomoso, Iseyin, Oyo, Ibadan, Kishi, Igboho and others (Oyo States). Other towns include Iwo, Gbongan, Ikire, Ifon, Ede, Ikirun, Ilesha and Oshogbo (Osun State); Owo, Ikare, Akure, Ondo, Okitipupa and Oka Akoko (Ondo State) and Ise Ekiti, Efon, Alaye and Ado Ekiti in Ekiti State.

There have been considerable increase in the population figures of these states; for instance, Oyo State was estimated to be 3.5 millions in 1991 and 5 millions in 2005. Lagos was estimated to be 10 million in 2005, while Ogun State was estimated to be 3.5 million in 2005 population census (NPC, 2006). It is interesting to note that all these can be attributed to the economic activities, which tangentially determine the rate of the distribution of these products.

Data set for this research was sought from 20 manufacturing companies that are within the ambit of Food, Beverage and Tobacco sectoral group, between the years of 2002 and 2006. The choice of this particular manufacturing group is predicated on its ubiquitous nature of these companies in the study area. Again, their products directly affect people's life such that they have socio-cultural implication, especially their rate of consumption. Above all, the sectoral group is one of the most quoted sectors at the stock market; consequently, accessibility to information about it was not problematic.

Sequel to the model and equations were developed for the paper through Cobb-Douglas production function that is related to inbound logistics but now adopted to outbound logistics, as presented thus:

$$WIC = f(R^{\alpha} P^{\beta_1} L^{\beta_2} C^{\beta_3} I^{\beta_4} S^{\beta_5} R^{\beta_6}) \quad (1)$$

$$WIC = \alpha + \beta_1(R) + \beta_2(P) + \beta_3(L) + \beta_4(C) + \beta_5(I) + \beta_6(S) + \beta_7(R) + e \quad (2)$$

Where:

- α = Constant
- WIC = Vol./Quantity of products in stock in a year
- R = Retrieval/Picking cost
- P = Packing cost

- L = Loading cost
- C = Capital cost
- I = Inventory Service Cost
- S = Storage space cost
- K = Inventory risk cost

$\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7$ are the associated output elasticities and e represented the error term. Also for estimation purposes, the function was linearized by taking logarithms of Eq. 1 and adding an error term. This is done by using a system of Eq. 3a-e, one for each year:

$$\text{Log}(WIC_{01}) = \alpha_{01} + \beta_1 \text{Log}(R_{01}) + \beta_2 \text{Log}(P_{01}) + \beta_3 \text{Log}(L_{01}) + \beta_4 \text{Log}(C_{01}) + \beta_5 \text{Log}(I_{01}) + \beta_6 \text{Log}(S_{01}) + \beta_7 \text{Log}(K_{01}) + e_{01} \quad (3a)$$

$$\text{Log}(WIC_{02}) = \alpha_{02} + \beta_1 \text{Log}(R_{02}) + \beta_2 \text{Log}(P_{02}) + \beta_3 \text{Log}(L_{02}) + \beta_4 \text{Log}(C_{02}) + \beta_5 \text{Log}(I_{02}) + \beta_6 \text{Log}(S_{02}) + \beta_7 \text{Log}(K_{02}) + e_{02} \quad (3b)$$

$$\text{Log}(WIC_{03}) = \alpha_{03} + \beta_1 \text{Log}(R_{03}) + \beta_2 \text{Log}(P_{03}) + \beta_3 \text{Log}(L_{03}) + \beta_4 \text{Log}(C_{03}) + \beta_5 \text{Log}(I_{03}) + \beta_6 \text{Log}(S_{03}) + \beta_7 \text{Log}(K_{03}) + e_{03} \quad (3c)$$

$$\text{Log}(WIC_{04}) = \alpha_{04} + \beta_1 \text{Log}(R_{04}) + \beta_2 \text{Log}(P_{04}) + \beta_3 \text{Log}(L_{04}) + \beta_4 \text{Log}(C_{04}) + \beta_5 \text{Log}(I_{04}) + \beta_6 \text{Log}(S_{04}) + \beta_7 \text{Log}(K_{04}) + e_{04} \quad (3d)$$

$$\text{Log}(WIC_{05}) = \alpha_{05} + \beta_1 \text{Log}(R_{05}) + \beta_2 \text{Log}(P_{05}) + \beta_3 \text{Log}(L_{05}) + \beta_4 \text{Log}(C_{05}) + \beta_5 \text{Log}(I_{05}) + \beta_6 \text{Log}(S_{05}) + \beta_7 \text{Log}(K_{05}) + e_{05} \quad (3e)$$

Where, WIC, R, P, L, C, I, S and K were defined in Eq. 2. Moreover, hypothesis stated was tested using Pearson Product Moment Correlation Coefficient.

Literature/conceptual clarifications

Inventory control: In the flow through the warehouse, that entails four basic operations, the goods can be misplaced or disappear. In order to uncover the in accuracies, some sort of inventory control must be performed. There are two main ways of taking physical inventory that is counting the inventory (Fawcett *et al.*, 1992). The first is the traditional process of counting the goods once a year for the entire inventory. This has however, a number of drawbacks, which include shutting down of warehouse operations, involvement of both experienced and inexperienced personnel, long working hours that are all likely lead to mistakes.

Costs related to inventory control: The counting of inventory reveals potential differences between records and reality. These discrepancies naturally generate costs.

Lovorn (2003) proposes two types of costs within the inventory carrying costs: service and risk costs, which are related to inventory.

Service costs include insurance and taxes: As inventory levels and storage space increases the cost for insurance increase. The insurance premiums also depend on the product value and type. In some countries even taxes come into play (Long, 2003).

In a similar vein, risk costs are elements such as obsolescence, damage and shrinkage. When goods become obsolete their value deteriorates. This could happen to products such as perishables. Shrinkage can occur because of loss or theft. The risk of theft can be a major problem and is correlated with the attractiveness of the products attributes and the ease with which it may be removed (Fawcett *et al.*, 1992).

Tied up capitals: The capitals that are tied up in the logistics operations are mainly caused by the inventory, work in progress, materials and the facilities that are related to product holding. The inventory tied up capitals causes capital cost. It is a kind of opportunity cost, as it cannot be used in the circulation and creates new value for the owners. Quantitatively, it equals the interest rate multiplied by the value of the inventory (Chopra and Mendl, 2001).

The amount of capital tied up is very much related to the service level of logistics. If the logistics service provides more frequency and reliable delivery, then the inventory level could be reduced, so does the inventory capital tied up. Similarly, the lead-time also has a direct impact on the inventory level. The shorter the planned lead time is the lower the level of inventory (Bradley and Nolan, 2002).

Warehouse operations: In every warehouse, there are always some basic operations being executed. According to Ballou (1999), the basic warehouse operations are movement and storage. The same separation is done by naming the operations storage system functions that are separated into inventory handling (storage) and materials handling (movement). In the light of this, warehousing can be defined as the storage of goods, which can lead us to assume that storage is what is most important in the field of warehousing. But movement is also a very vital aspect of warehousing and can be divided into four more distinct operations (Braddy, 2000):

- Receiving goods into the warehouse from the link or transport network

- Transferring goods into a particular location in the warehouse
- Selecting particular combinations of goods for customer order or raw materials
- Loading goods for shipping to the customer or to the production line

Warehouse cost: The costs incurred by the warehouse, while processing the orders obtained from the retailers. The different costs that make up this are shown in Eq. 4:

$$WHC = R + Pa + L \quad (4)$$

Where:

- R = Retrieval cost to retrieve the pallets, cartons or items needed to fulfill the order
- Pa = Packing cost to pack and prepare the orders for transportation
- L = Loading cost to place the packed orders in the vehicles prior to transportation

The retrieval, packing and the loading costs specified in Equations comprise different components to account for different unit load costs. These components are shown in Eq. 5-7:

$$R = R_p + R_c + R_{IT} \quad (5)$$

$$Pa = Pa_p + Pa_c + Pa_{IT} \quad (6)$$

$$L = L_p + L_c + L_{IT} \quad (7)$$

Where:

- R_i = Picking cost per unit load
- Pa_i = Packing cost per unit load
- L_i = Loading cost per unit load
- I = P, C, IT
- P = Pallets
- C = Cartons
- IT = Items

Picking/retrieval costs: Picking costs refer to the cost of retrieving a pallet, carton or item from its storage location and transporting it to the staging area to be packed and prepared for transportation. During the picking operation the workers receive information regarding the Store Keeping Units (SKUs) and the number of pallets, cartons or items of each SKU that they have to pick. The workers then proceed to the respective storage locations and locate the SKUs that have to be picked. It is worthy to mention that there are certain differential equations of calculus origin that could be used to arrive at unit cost of each activity, however, these are not within the ambit of

this research. For instance, with respect to pallet retrieval, only a single pallet can be retrieved for every trip of the forklift. Hence, the retrieval cost for pallets is a multiple of the number of pallets retrieved for the order. However, when cartons and items are retrieved, the pickers move through the storage racks and pick all the cartons or items as they pass by the SKU located in the racks. Therefore, a single trip through the storage racks results in the picking of cartons and items for the entire order. Hence, the retrieval cost of cartons and items is a linear function of the number of cartons and items in the order and not a direct multiple of them as in the case of pallets.

Packing costs: During packaging the workers prepare the cartons and items for transportation. The pallets are generally stored in a form that is easy for them to be transported; the cartons are placed on a pallet and they are stretch wrapped in place before they are placed in their storage location. Therefore, if a pallet is picked for an order, the study involved in its packing is negligible. Cartons that are picked are placed on a pallet and then stretch wrapped into place. Items are placed in a carton and then to make the transporting easier, these cartons are also stretch wrapped into place on a pallet. Typically most of the packing is done in the form of pallets to enable easy loading and unloading of orders. It is assumed that the time taken to pack the carton or the item of any SKU is the same as all the SKUs are of the same shape and size.

Loading costs: The loading operation involves placing the packed orders into the vehicles transporting them. Typically the loading is performed using vehicles or conveyors; in general the loading equipment used depends on the unit loads that are being loaded. Since the loading operation is a straightforward operation and different warehouses use different types of equipment, the expressions used to determine the time taken to load a truck is taken as a variable and not as a function of the distance traveled and the speed.

Previous section details how the cartons and the items in the orders are packed to form mixed pallets for ease in transportation. Hence, the loading operation involves only pallets. Consequently, the time taken to load a carton and an item are functions of the time taken to load a whole pallet. It is assumed that the pallets are loaded one at a time. The distribution industry typically loads the pallets one at a time or two at a time. In the light of all these, it is imperative to examine the relationship among these inherent costs of inventory and warehousing activities in order to determine and ascertain where attention could be focused, such that efficient and effective logistics activities could be achieved.

RESULTS AND DISCUSSION

Inventory and warehousing cost analysis: The model initially defined in methodology section was used to determine the relationships among components of inventory and warehousing costs in total logistics cost, using the averages of the year under study (2002-2006), as presented in Table 1.

It is shown in Table 2 that four of the independent variables are significant at 0.01 and/or 0.05 level of significance with correlation values that are relatively less than ± 0.8 . These variables are Loading cost (LOAD), Capital cost (CAPT), Storage and Space Cost (STSC) and Inventory Risk Cost (INRC). It is interesting to stress that out of these four, only three of these variables belong to inventory cost, while LOAD only belong to warehouse cost. The implication of this is that most of these inventory cost are germane in warehousing and inventory costs. Similarly, Retrieval cost (RETV) has a positive and linear relationship with Packing cost (PACK) (0.857), LOAD (0.507), CAPT (0.777), INSC (0.724), STSC (0.543) and INRC (0.874). Again PACK has positive relationship with LOAD (0.576), CAPT (0.725), Inventory Service cost INSC (0.767), STSC (0.571) and INRC (0.776), while CAPT (Inventory cost) has a strong relationship with other inventory cost variables (INSC (0.724), STSC (0.642) and INRC (0.811)). Another important thing that is worthy of mentioning is the fact INRC has a significant relationship of 0.01 level of significant, with most of all other variables (dependent and independents). This goes to confirm that all variables for both warehousing cost and inventory cost are all germane to model cost drivers at this activity centre of outbound logistics.

In a related development, ANOVA model in Table 3 that exhibits regression coefficients and order of importance of the explanatory variables, when step wise multiple regression is adopted with CAPT, INSC, STSC and INRC taking first, second, third and forth, respectively. It is pertinent to stress that all these variables (inventory cost) are significant at either 0.05 and/or 0.01 level of significance.

Similarly, in terms of the order of importance of the independent variables in explaining the variation in the criterion, the β -coefficient (the standardized partial slope, which guarantees that measurement unit of the independent variables are comparable, when we are interested in the relative effect of the independent variables (Oyesiku, 1995). In Table 4 PACK (3.94) and LOAD (-0.81) (warehousing cost variables) were the least. The implication is that emphasis should be placed on warehousing cost components in the area of cost reduction and paramount interest should be on inventory

Table 1: Average of warehousing and inventory components (2002-2006) records (warehousing and inventory) in millions N'

Companies	WICS	RETV	PACK	LOAD	CAPT	INSC	STSC	INRC
ForeDaiPlc	8.6	1	0.7	0.50	10	8	3.2	2.3
LiveFedPlc	245	1.1	0.8	0.90	11	8.5	3.9	3.4
OktOilPlc	137	0.9	0.5	0.30	7.1	7.1	2.6	2.5
GuinesPlc	46.2	3.8	2.7	1.70	18.7	11.5	17.3	11.6
IntBrewPlc	8.62	3.2	1.3	0.40	7.9	7	8.9	9.3
NigBrewPlc	51.8	4.06	2.0	1.40	21.4	11.4	203.4	17.8
NigBottPlc	99.6	4.2	3.4	1.80	12.4	9.6	11.8	10.6
ConBrewPlc	6.84	3.4	1.4	0.40	3.71	7	9	10.1
7upPlc	91.2	1.14	0.6	2.80	11.7	6.4	2.1	1.1
NasacoPlc	79.4	1.2	0.5	0.70	9.8	5.9	3.2	2.7
UniDisPlc	90.4	1.3	0.5	0.60	10.1	6.4	3.62	2.6
DanSugPlc	61.4	1.4	0.7	0.98	9.45	7	3.9	3.1
BigTretPlc	95.1	2	0.8	0.90	9.16	5	2.1	2.0
TateIndPlc	105	2	0.9	1.00	9.5	5	2.3	2.1
CadburyPlc	227	3.3	2.1	1.40	12.8	17.3	5.2	12.0
NestlePlc	310	3.45	2.8	1.90	13.6	10.9	5.6	13.2
UTCNigPlc	45	1.06	0.9	0.60	5.9	6.2	2	1.5
WAMCO Plc	128.4	1.6	0.1	1.10	10.3	7	3.9	3.3
DanFloPlc	209.8	1.7	1.0	1.60	11	9.7	4.1	3.9
FlourMilPlc	202.6	2.7	1.8	0.90	11	10.2	3.1	2.0

Field Survey (2008)

Table 2: Correlation coefficient between dependent and independent variables

Variables	WICS	RETV	PACK	LOAD	CAPT	INSC	STSC	INRC
WICS	1.000	0.347	0.426	0.515*	0.671**	0.466	0.715**	0.729**
RETV		1.000	0.857**	0.507*	0.777**	0.724**	0.543*	0.874**
PACK			1.000	0.576*	0.725**	0.767**	0.571*	0.776**
LOAD				1.000	0.517*	0.364	0.216	0.371
CAPT					1.000	0.724**	0.642**	0.811**
INSC						1.000	0.711**	0.761**
STSC							1.000	0.657**
INRC								1.000

**Correlation is significant at the 0.01 level, *Correlation is significant at the 0.05 level. Output results of Cobb-Douglas function based on field survey (2008)

Table 3: Regression coefficients and order of importance of the explanatory variables

Explanatory variables	b	St. Coef.	Beta error	Level of Expl. %	Prob	F-value	t-value
CAPT	12.73	0.85	0.37	27.14	0.04	1.841**	2.84**
INSC	8.72	1.23	0.22	15.41	0.832	1.323**	2.46**
STSC	7.64	0.94	0.14	8.60	0.443	0.912**	1.62**
INRC	5.54	1.24	0.06	6.36	0.002	0.811**	1.10*
RETV	5.10	0.84	0.05	5.14	0.133	0.724**	0.97
PACK	3.94	0.78	0.02	2.35	0.753	0.517**	0.61
LOAD	-0.81	0.88	-0.03	0.81	0.878	0.042**	0.47

**Significant at 0.01 level, *Significant at 0.05 level, Output results of Cobb-Douglas function based on field survey 2008

Table 4: Stepwise multiple regression model

Constant	Multiple R	R ²	Adj R ²	F-value	Sig.
-32-613	0.821	0.674	0.57	2.188	0.000***

***Significant at 0.05 and 0.01 levels of significance, Output results of Cobb-Douglas function based on field survey (2008)

cost component, such that they can harness toward customer satisfactions. Perhaps, it is important to mention that the multiple R is 0.821, where the R² is 0.674 or 67.4% (Table 4). In other words, all the variables in the model can only contribute 67.4% of level of explanation to warehousing and inventory cost issues in outbound logistics. No doubt, this is statistically significant and it devoid any spuriousity, as it was confirmed by the F-value of 2.188 that is significant at 99 and 95% confidence interval. Consequent, the hypothesis that there is no significant relationship among components of warehousing and inventory cost of logistic cost is

rejected, while alternate hypothesis of there is significant relationship among component of warehousing and inventory cost of logistic cost is accepted. The implication of all these is that it will be worthwhile and profitable, if companies can employ the service of logistics service providers, such that most of the cost incurred at this activity center can be minimized, simultaneously meeting customers request. The warehouse cost components have been seen to have little significant effect on the warehousing and inventory cost. This is because the other costs are much higher than the warehouse costs and this should be monitored.

CONCLUSION

The warehouse or distribution centre plays a major role in a company's supply chain in the sense that it is

responsible for keeping inventory and for releasing the goods or inventory for distribution. From a warehousing perspective, there are many factors to be considered in order to have an integrated supply chain and to keep costs to a minimum.

The options whether to lease, rent or own the facility are some of the important factors to consider. There are basic functions in warehousing that need to be executed in order to get the product out to the customer. Another problem companies are facing is that they need to establish the optimum number of facilities to be used for inventory holding.

The fact is that the inventory holding increases with the number of locations due to the fact the every facility must have safety stock included in the basic inventory holding. Inventory cost amount for a major part in warehouse and in the supply chain as a whole.

There are basic cost such as procurement cost, holding costs, shortage costs, risk cost and quality cost. These costs are merely the basic cost and do not always keep a record of additional cost such as financial cost incurred with inventory holding due to lack of information sharing.

Similarly, inadequate information and the lack of supporting technology may lead to supply chain inefficiencies at warehousing and inventory activity centre, due to uninformed decision that can be made by management. This will be similar to incorrect decisions being made on sales number of facilities and in turn, on the inventory to be held. The crux of the matter is that a fine balance between all these elements and information is needed to ensure that the optimum inventory is held at the right location.

This research focused on warehousing and inventory and the interrelated roles, they play. It is of vital importance that inventory holding and the associated costs are kept in mind, when deciding on the facility to be used, the number of locations needed and what the purpose of warehouse will be.

The cost involved in these areas can become a big burden if not well monitored. All options need to be evaluated properly as the one element influences the other and can have a major impact on the total supply chain costs and on customer services.

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