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Influence of Information System on Cargo and Fluid Distribution of Selected Sectors -Cum-Logistics Companies in South Western Nigeria

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ABSTRACT: *This study investigated the role of information system in distribution of goods and fluid of selected logistics companies in Southwestern Nigeria. The objectives of this study are to determine the investment level of selected companies on information system across the identified industries (Oil, Beverages and beer, Cement, Gas) with a view to analyse how investment in information system influence them. Secondly, the paper examined the contributions of information system to level of safety of goods, drivers' performance, goods and fluid products' security, business analysis and vehicle maintenance. Descriptive analysis was used to analyse the first objective and ANOVA was used to explain the result from both primary and secondary data collected. Results revealed the composition of investments for the selected sectors.*

KEYWORDS: Impact, information system, distribution, cargo and fluid

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I. INTRODUCTION

Manufacturing companies produce products so as to get to the required customers. In the past, information about products was not easily and readily available. Producers or manufacturers rely on market forecast and make a lot of mistakes and errors. Many a times there may be under forecast or over forecast which may not make them to realize maximum benefits and consequently wasted resources respectively. To correct these uncertainties, postponement has been recommended by some researchers. However, the basic notion of geographic postponement is to build and stock a full-line inventory at one or a few strategic location (Bowersox et al, 2002). According to Daganzo (1995), distribution of manufactured products must be carried out to convey items from production to consumption in cost-effective ways. Emmason (2012) observed that, the information flow between functional areas within an organization and between supply chain member organizations were paper based which made the paper based transaction and communication to be very slow. Monitoring activities in the distribution of goods is essential for cost reduction, efficient service delivery and management of resources especially for manufacturing companies. Accenture (2000) expressed that; information system in ensuring security of goods can be in form of planning and execution of goods delivery.

The distribution of goods (Dangazo, 2005) from production to consumption will follow the following paths:

(i) carried (handled) from the production area to a storage area,

(ii) Held in this area with other items, where they wait for a transportation vehicle,

(iii) loaded into a transportation vehicle,

(iv) Transported to the destination, and

(v) Unloaded, handled, and held for consumption at the destination.

Prajogo and Olhager (2012) enumerated the benefits accruable to the use of information system as follows:

- Integration of communication process and enhance genuine cooperation to achieve objectives
- Monitoring and Evaluations
- Accuracy
- Reduction in Lead-times
- Order quantity reduction
- Electronic invoicing system
- Frequent and reliable deliveries

It can also:

- Facilitate sharing information and highlighting important features
- ensure faster and more flexible responses to facilities' demands
- ensure replenishment and movements triggered by actual demands

These processes will generate distribution and holding costs. Before the advent of information system, organizations do not know how many items they have lost and money wasted in manual operations and employing personnel for goods' security due to poor accountability and possible human errors. Although, installation and connection of the information system still remain a challenge in terms of cost as noted by (Bowersox, Closs and Hall, 1998) but the costs are justifiable in the long run as Enterprise Resource Planning (EPR) is today the central core of supply chain management. Laudon and Laudon (2013) asserted that, there is no gain saying in that; the traditional ways of transacting businesses have changed since the emergence of information system. Traditional ways of receiving order quantity through manual clerical operations are wearisome, ineffective, wasteful, costlier and required personnel for monitoring and evaluations. To this end, the employment and incorporation of information technology into logistics and supply chain management has led to Logistics Management Information System. According to Laudon and Laudon (2013) "the growth of enterprise-wide information systems with extraordinarily rich data means that managers no longer operate in a fog of confusion, but instead have online, nearly instant, access to the really important information they need for accurate and timely decisions".

Throughout the history of mankind, wars have been lost and won through logistics strengths and capabilities or lack of them (Christopher, 2005); the concept of Logistics Management Information System (LMIS) has been identified has a measure to enhancing logistics system.

The critical issue in LMIS in this context is about how to monitor the flow of items received, distributed and of course how it achieves the targeted purpose. In order words, inventory planning, demand assessment, stock control and replenishment must be well understood (Somuyiwa, 2015). For replenishment, it is important to understand the nature of demand; order quantity, safety stocks as well as replenishment lead times and related stocks. However, for stock control officers, the activities may be a tedious task especially in keeping adequate and accurate records of all transactions. Then; if we desire change in operations and management of supply chain of products it is possible to use computerized system for the purpose of receiving materials, picking materials, i.e. stock and inventory checking with the computerized system, stock balances can be easily determined. This will minimize loss of items, internal and external theft and enhance accountability, quick reference including better decision making at all levels across the logistics and supply chain. Not only in terms of efficiency is a computerized information system is useful but, also for the sake of sustainability. LMIS is a system that can be operated and monitor remotely while activities will run as expected achieving the desired assortment and quantity of products to the correct location on time, damage-free, and correctly invoiced, and easily reference is our expectation.

II. REVIEW OF RELEVANT LITERATURE

The logistical work has remained the same over decades. Nowadays, due to curiosity for improvement of what we do and how we can do it better has reinvented logistics processes. There are different postulations in relation to the influence of information system on distribution of goods in literature. Bowersox et al (2002) stated that, the concept of logistic and supply chain also imply a highly efficient and effective network of business linkages that can serve to improve efficiency by eliminating duplicate and nonproductive work. For instance, Cervero (2011) believed that, accessibility to the distribution centres and network planning most be given paramount attention. According to Haralambides & Gujar, (2011) however, the challenges is in determination of number of locations and depots to insert in a logistic network. In distribution of goods today, the fundamental challenge of integrated management is to redirect traditional emphasis on functionality to focus on process achievement (Bowersox et al, 2002). However, it must be pointed out that, the execution of the supply chain strategy is dependent upon integration of the organization's major processes. This can be in form of store catalog, logistics allocation, production, commodities volume planning, Research &Development, finance, information technology, and compliance management. To do this, there is perhaps need for role of information system and information technology in order to optimize information and product flows through interdependent links across all units in supply chain logistics. Bowersox et al (2002) explained that "one of the ways to achieve effective logistics system is to have a system that supply chain participants voluntarily share operating information and jointly plan strategies". Similarly, they opined that, there should be a process specialization paradigm in commitment to focusing collaborative arrangements on planning joint operations toward a goal of eliminating nonproductive or non-value-adding work by organizations in a supply chain.

According to Anderson, (1954) logistics or supply chain gaps exist as a result of one or more of the following reasons:

1. ***Space gaps***, with suppliers physically separate from customers (for example, bauxite is mined in Australia but is used by distant manufacturers

2. ***Time gaps***, when there is a difference between the time a product become available and the time when customers/client want to buy/use it

3. ***Quantity gap***, between the amounts available from suppliers and the demand from customers/client

4. ***Variety gap***, when customers/clients want a wider variety of products than is available from a single supplier

5. ***Information gap***, when customers do not know about the availability or source of products, and suppliers do not know about potential customers

Consequently, in order to bridge this gap, a formidable supply chain-cum logistics structure must be built with the help of accurate and dynamic information system. Depending on the structure of the organizations involved, order processing demand management must feature the followings:

1. Order receipt
2. Order processing
3. Estimating delivery times to customers
4. Production of despatch information
5. Customer/ Client's feedback

When managing inventory paramount objectives looked into the issue of batch processing, obsolesce, damage, order management and re-order levels. These challenges can be taken care off by increasing the frequency of transportation or high rate of product turn out from the stock. Increasing transportation cost will eventually increase the cost of fuel and other associated cost of bringing the little, little consignments. In other words, if the space for storage is rented, there will be need to evaluate the cost of storage and the necessity of transportation otherwise, ***cross docking*** may applied. **Cross-docking*:*** to operate out of an 'empty' building. Product ordered by product line (Store Keeping Unit SKU) from suppliers in quantities sufficient to meet the next day's total customer orders is delivered to the site and unloaded, often along one (goods receipt) face of the building. It then goes directly to a (manual or mechanized) sorting system, which distributes the required quantities of each product to allocated order locations so that the orders build up, product by product, until the orders are complete.

According to Tony (1997), the Pareto analysis (or ABC analysis) is the technique which forms the basis of inventory control thinking and is an important management principle which can be applied to minimize effort and to obtain best results. It can also be applied to time management, credit control and many other areas of control. Although, Pareto law has been constructively criticized; its relevancy in inventory management is still valid. To gain best control, effort has to be directed to the most important areas called the *80/20* rule because *80%* of the effect is provided by *20%* of the cause. Warehouses also make use of Warehouse Management Systems (WMS) whose basic objective is to help manage warehouse resources. The emphasis for warehousing has now shifted and become focused on facilitating the flow of goods to the customer; meeting the requirements of customer service standards; incorporating value-added activities, such as postponement, as a means of reducing the numbers of product lines or stock keeping units (SKUs) in a system, and increasing the flexibility to meet customer requirements. To re-order for commodities, Bowersox et al (2002) postulated the formula below:

The basic reorder point formula is: R= D X T

Where:

R = Reorder point in units;

D = Average daily demand in units; and

T = Average performance cycle length in days

According to Muller (2003), in practice; there must be methods of attaching addresses to stock items and to know the stock location. He described what he referred to as stock location system to maximize the followings:

a) Use of space
b) Use of equipment
c) Use of labor
d) Accessibility to all items
e) Protection from damage
f) Ability to locate an item
g) Flexibility
h) The reduction of administrative costs

However, maximizing all these factors at the same time in reality tends to be herculean task.

Rushton et al (2008) stated that "The selection of the most appropriate transport mode is thus a fundamental decision in distribution, the main criterion being the need to balance costs with customer service. The inherent attributes of each mode needs to be carefully analyzed and trade-off concepts need to be carefully evaluated. Speed, price, reliability and safety are major considerations in mode selections. Other factors that used to be considered include the volume of products; the nature of the goods, perish ability, fragility, security and climatic conditions. Apart from the time of required moving commodities can be known through transit stock. Transit stock highlights the need to understand not only how inventory physically moves through your system, but also how and when it shows up in your records. For a supply chain to realize the maximum strategic benefit of logistics, the full range of functional work must be integrated. Decisions in one functional area will impact cost of all others. It is this interrelation of functions that challenges the successful implementation of integrated logistical management (Bowersox et al, 2002).

According to Tony (1997) "It is the logical aim of tight inventory control, effective process planning and plant design, workforce motivation, cost reduction, logistics and even material requirements planning (MRP). As the increasing demand of time accuracy and decentralization of production, (Tseng et al, 2005) the need to reduce stock costs has led to the Just-In-Time (JIT) delivery principle. The optimization of these together inevitably leads to the JIT approach. He explained that, the elements of JIT are the techniques to be developed, for example:

a) supply what is required
b) supply the quality required
c) reduce lead times
d) organize effectiveness
e) use all the expertise available (i.e. people who do the jobs plus technical backup)

Bowersox et al (2002) opined that information system is the major requirement that can bridge the gaps in Logistics system. They proposed the requirements for planning an informative logistics system as indicated in the fig 2.3 below:

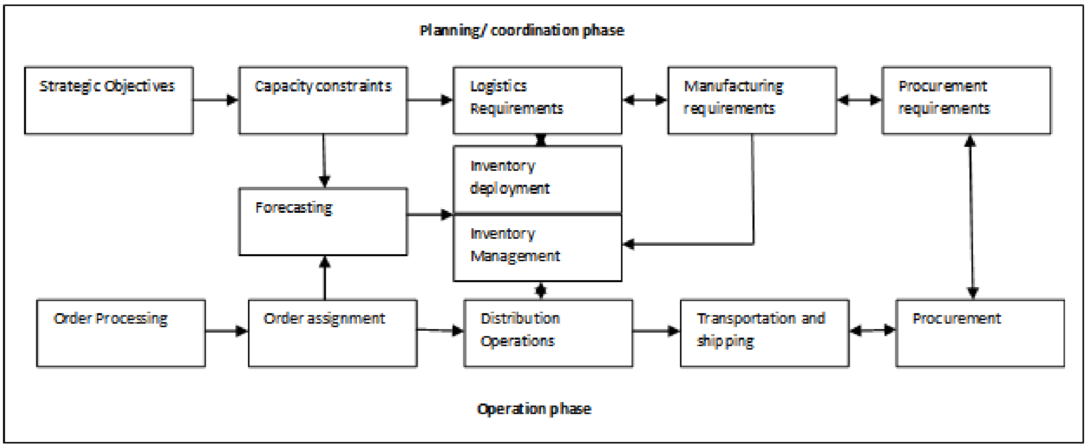

Fig 2.1: Logistics Information requirements

Source: Adapted from Bowersox, D.J; Closs, D.J and Cooper M.B (2002): Supply Chain Logistics Management The McGraw-HilVIrwin Series *Michigun State* University.

In this case, there are two phases to logistics information systems: Planning/coordination phase and operation phase. In planning/ coordination, the objectives to be achieved will be stated, all challenges militating against the objectives in form of capacity constraints are noted, eliminated if possible and then we can proceed to what are the requirements of logistics. Similarly from another dimension; the logistics requirements must be in line with manufacturing and procurement requirements. Inventory can be deployed. Forecasting helps order processing and order assignment which leads to distribution through transportation by fulfilling procurement requirements. Adepoju and Kingdom (2017) expressed that, development of Information and Communication Technology (ICT) incorporated in transport systems to enhance effective mobility has led to Intelligent Transport Systems (ITS). ITS is a general name used to address latest technologies and innovations incorporated in vehicles, transport infrastructures and users of transport facilities to foster efficient mobility and quality of life. The diverse technologies in place in vehicle, transport infrastructures and users had great impact in accident reduction and consequently sustainable development. For instance, there are applications related to trip information systems, collision avoidance system, navigation systems, traffic control systems, vehicle to vehicle communication systems, Automated Diagnostic System, Emergency system, Electronic payment system, vision enhancement system among others that have contributed to social, environmental and economic development. These days, vehicles are working with pressing of remote control and even of recent successful attempts have been made towards flying vehicles. Alan (2014) suggestions for fleet management espoused the areas like; the usage of Closed Circuit Television Camera (CCTV), Tachograph for vehicle security, fuel and driver management. The security can be of various forms to the fleet. Alarms can be fitted to all points of access into the vehicle. Tachographs/Tracking devices can be fitted to monitor the vehicle for tracking and tracing purposes. Willams (2008) in his book "Intelligent Transport Systems Standards" deeply expressed the significant services area of contributions of ITS to mankind development. Such services include accident prevention and mitigation, emergency services response and support, driver assistance, traveler information, traffic management, infotainment en-route, public transport, commercial transport and services, theft prevention and after theft recovery, and public safety and security. Bluetooth, WiFi, GPS, Satellite Navigation, Radar and sensors are all kinds of infrastructures necessary for the creation of ITS.

III. METHODOLOGY

South western Nigeria (Vanguard, 2017) comprises of Lagos, Oyo, Ogun, Osun, Ondo, and Ekiti States with many logistics and distribution companies that distribute variety of products to different destinations. The study adopted systematic random sampling technique to collect information on the impact of information system on distribution of goods and liquid products in Southwestern Nigeria. Hence, the study identified the following areas where logistics companies operate in their distribution of variety of the itemized products:

1. Oil
2. Beverages and beer
3. Cement
4. Gas

Wikipedia (2016) noted the followings populations of

Sector of Distribution	Population of sectors of Distribution selected in South Western Nigeria	Logistics companies with selected sectors/sole distribution	20% of population=sample size
Oil & PMS	59	571	114
Beverages and Beer (Lagos, Ibadan, Ijebu)	6	17	3
Cement (Lafarge, Dangote, Elephant)	3	36	7
Gas	4	66	13
Total	72		137

Source: Authors' computation (2017)

I37 respondents were used and the secondary data from the records were also analysed.

IV. RESULT AND DISCUSSION

The comparative analysis of investment of the different segment in distribution of cargo and fluid revealed the followings in fig 4.1.

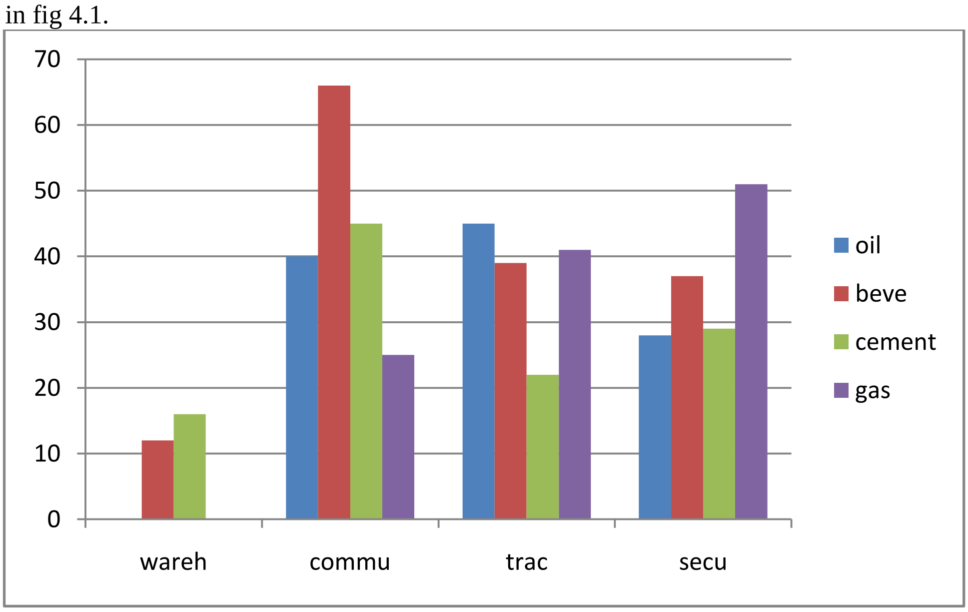

Fig 4.1: Analysis of involvement of information system on fluid and cargo distribution

Source: Authors' computation (2017)

From the fig 4.1 above, cement production and distribution companies are the ones investing in warehousing information system as there was no record of investment for oil and gas industries. This may be attributed to the fact that, these commodities are not required to be stored except at depots. However, cement distribution and production industry invest more in warehousing information system that beverages production companies. Secondly, it can observed from this result, that beverages distribution is more concerned with communication, followed by cement, by oil and lastly by gas industries respectively. Tracking devices are mostly used on oil carrying vehicles, then by oil and gas, beverages distribution vehicles and vehicles that are used for distributing cements in respective order in South western, Nigeria. The security investment in relation to information system by these sectors indicated that, gas sector invested more on information security followed by beverages and the margin between cement and oil are very close but investment in cement sector is a bit more than that of oil sector.

Using the information system by the selected sectors, there was need to examine the performance of the companies against identified factors expected to boost the overall performance of the selected segments. Therefore, the following factors were identified:

1. Safety

2. Driver's performance

3. Goods and fluid's security

4. Business analysis

5. Vehicle maintenance costs

One –way ANOVA was used to analyse the combined information gathered from all the respondents.

Safety: This was observed based on the number of times the vehicle with GPS/tachographs or monitoring devices of the selected companies involved in accident in relation to those that are not.

Driver's performance: The comparison between vehicles with information systems driver's performance in number of cases

Goods' security: The number of times the goods are accurately delivered between points of origin and destination

Fluid security: The number of times the fluids are accurately delivered between points of origin and destination

Business analysis: Usage of the computer and other accessories for transactions, documentation and analysis of the business

Vehicle maintenance costs: The amount spent on vehicle after the installation of tracking devices compared to when the devices were not installed.

Table 4.1: Analysis of Variance for the identified factors

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
safety	Between Groups	87.556	4	21.889	16.765	.000
	Within Groups	172.342	132	1.306		
	Total	259.898	136			
driver	Between Groups	217.525	4	54.381	87.377	.000
	Within Groups	82.154	132	.622		
	Total	299.679	136			
security	Between Groups	224.040	4	56.010	87.936	.000
	Within Groups	84.077	132	.637		
	Total	308.117	136			
business analysis	Between Groups	143.571	4	35.893	25.400	.000
	Within Groups	186.531	132	1.413		
	Total	330.102	136			
maintenance cost	Between Groups	13.031	4	3.258	2.029	.094
	Within Groups	211.889	132	1.605		
	Total	224.920	136			

Source: Authors computation (2017)

The analysis incorporated Tukey test at $p<0.05$ level of significance to determine the influence(s) of the factors or variables identified in relation to the statement of their comparison stated above.

In table 4.1 above, the F-values are greater than the sig. values except for **maintenance costs** for all variables selected. In other words, the impact of information system is not really affecting the maintenance of the vehicles of the selected companies. However, in terms of security of goods and performance of driver, they both have the same F-ratio values at $p<0.05$ significant level. This connotes that, the impact of information system on these two aspects is the same. It can be observed also from the Table 4.1 that, the information system has greatly enhanced the analysis of the business as a tool for monitoring and evaluating business performance. The Tukey test results for each variable are added as appendix at the end of this paper.

V. CONCLUSION AND RECOMMENDATIONS

Information system is vital to enhancing any business in today's world. The expectation of customers is very high and knowledge of products is just a few minutes away with recent information technology and systems. Therefore, companies should adopt modalities by which their information system can be improved with a view to monitor and integrate supply chain management systems from point of origin to various divergent destinations. It must be pointed out that, companies invest much in security and fleet management because they it plays vital role in not only guiding the behavior of drivers who occasionally sell goods or products and the security of the vehicles. The cost of the goods and product transported from one region to another in most cases are more than the total value of the vehicle, therefore companies especially third party logistics service providers should create measures at reducing theft of both the vehicles and that of the goods.

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Appendix

Safety

Tukey HSD[a,b]

impact	N	Subset for alpha = 0.05	
		1	2
A	20	1.7000	
DA	49	1.8980	
SA	36	1.9722	
ID	6	2.1667	
SD	26		3.9231
Sig.		.767	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 16.485.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Security

Tukey HSD[a,b]

impact	N	Subset for alpha = 0.05			
		1	2	3	4
SA	36	1.3889			
A	20		2.4000		
ID	6		2.6667		
DA	49			3.6327	
SD	26				5.0000
Sig.		1.000	.873	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 16.485.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed

business analysis

Tukey HSD[a,b]

impact	N	Subset for alpha = 0.05		
		1	2	3
SA	36	1.2778		
A	20	2.0000	2.0000	
ID	6	2.0000	2.0000	
DA	49		2.8367	
SD	26			4.2308
Sig.		.411	.262	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 16.485.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

maintenace cost

Tukey HSD[a,b]

impact	N	Subset for alpha = 0.05

		1
A	20	2.0500
ID	6	2.3333
DA	49	2.4694
SA	36	2.8889
SD	26	2.9231
Sig.		.282

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 16.485.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Driver

Tukey HSD[a,b]

impact	N	Subset for alpha = 0.05			
		1	2	3	4
SA	36	1.0000			
A	20		2.0000		
ID	6			3.0000	
SD	26			3.6154	3.6154
DA	49				4.0000
Sig.		1.000	1.000	.172	.629

Means for groups in homogeneous subsets are displayed.

Driver

Tukey HSD[a,b]

impact	N	Subset for alpha = 0.05			
		1	2	3	4
SA	36	1.0000			
A	20		2.0000		
ID	6			3.0000	
SD	26			3.6154	3.6154
DA	49				4.0000
Sig.		1.000	1.000	.172	.629

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 16.485.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

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