Current Research Journal of Social Sciences 2(3): 181-186, 2010
ISSN: 2041-3246

Submitted Date: March 24, 2010 Accepted Date: April 12, 2010 Published Date: June 15, 2010

Analysis of Performance of Collaborative Information Sharing Cost in Outbound Logistics

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Abstract: The study sought to analyse the performance of collaborative information sharing cost in outbound logistics with emphasis on Order and Information costs, with a view to minimizing cost and enhance efficient ordering and information services in manufacturing companies. The ordering cost is about order entry, order notification and order verification costs, while the information cost is basically information technology investment. The paper adopted case study approach. Twenty (20) 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 Order processing and information investment; indeed, most of the order processing cost components (Entry, Notification, Verification and Information costs) was significant. In other words, order-processing cost has a significant relationship with most of all variables (Dependent and Independents). The paper recommends that companies should adopt management information system that enhances information technology investment as well as training and maintenance of these information devices.

Key words: Analysis, collaborative, cost, information, logistics, performance

INTRODUCTION

Information and Telecommunication Technology (ICT) are fast becoming one of the main drivers of change, posing new strategic challenges. International literature has been reviewed to analyse current and future trends in logistics and Supply Chain Management (SCM) that are connected to dissemination of ICT. The review allows distinguishing the impact of ICT on the overall Supply Chain from the effects of new technologies on the manufacturing companies. Arranging product and customer data helps determine the customers or distributors who are prime candidates for collaboration because they will help the organization minimize inventory levels and increase customer service levels. The criteria for a collaboration candidate include those that have the greatest variance in order quantities and short order lead times. The Coefficient of Variation for Demand (CVD) measures order variability. Distributors of customers with high order variability have more difficulty in forecasting demand, so as good rule of thumb would be to consider distributors with ratio of 0.5 or higher to have erratic ordering patterns. If the variability exists for an entire product and not just for certain distributors, then use the CVD to identify specific high-variance customers. Try to collaborate with high-variance distributors or customers to smooth out demand, but if that doesn't work then increasing reliability will require either increasing inventory or reducing production cycle time (Carlson, 2005).

One of the main areas of interest that has emerged in recent years concerns the effects of ICT on logistics and SCM. In the literature, there are a plethora of research that have analysed general aspects (Long, 2003; Lambert, 2004) and specific effects (Lovorn, 2003; ASCET, 2004) of these technologies in logistics, and SCM considering the wide range of possible effects, the attention in this paper is focused on the supply chain efficiency improvements related to ICT usage be analysed with reference to three functions related to information/order processing and management, Distribution and sharing of Data and information , their transfer and lastly, the processing and utilization of information for supply chain specific technologies used as a support tool for the three functions identified and summarized in Fig. 1 and Table 1.

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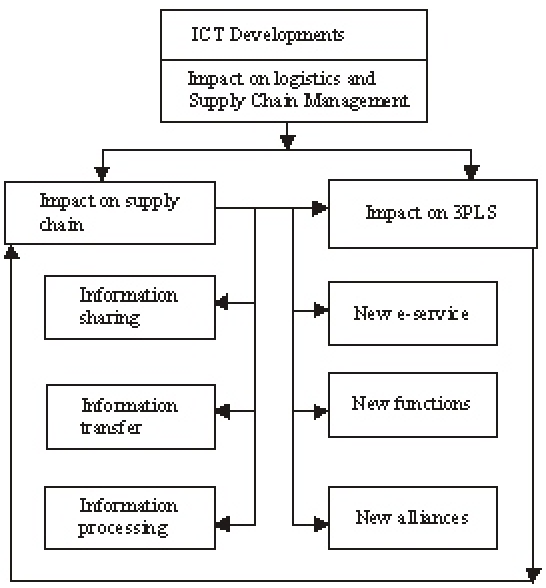
Table 1: ICT and application for SCM

Function	Activity	ICT Technology
Sharing of data and information	Access and use of data and information by supply chain partners	-Databases -Datawarehouse
Information transfer	Communication of Information between supply chain partner	-EDI -E-Mail -Groupware -Inernet/WEB
Information use for supply chain planning	Data and e-document processing in decision making and operations planning of the supply chain	-Advanced AI -CAD -CAE -ERP -MRP -Multimedia -Traditional AI

Source: Adapted from Gilmour (1997)



Source: Adapted from Carlson (2005) and Collins (2005)

Fig. 1: Framework for analyzing the impact of ICT on Logistics and SCM

Information sharing: It is an essential prerequisite for securing information accessibility to all supply chain partners involved in logistics operations. The creation of distributed databases accelerates the development of relationships with other operators in the Supply Chain. In addition, the availability of consistent information improves decision-making process for operators. Data sharing has always been important in the transport and logistics of manufacturing companies. Access to and availability of information in intermodal transport, for instance, contribute to substantially reduced processes and thus time savings in freight transfer from one mode of transport to another and minimize errors in drawing up freight documentation, thereby increasing overall transport efficiency.

Information transfer: It is probably the most relevant function in the SCM concept, because it takes place through several technologies ranging from the most recent e-business applications or extranet, Electronic Data Interchange (EDI) systems, to the most traditional communication technologies such as telephone, telex or fax. EDI is the most investigated technology in SCM literature. The widespread dissemination of the internet and e-business technologies allow to a large extent overcoming problems relating to systems and applications interoperability. This allows extending the use of these technologies, including EDI, to smaller companies since internet application technologies require relatively low implementation costs and show a high flexibility in information transfer (Somuyiwa, 2010; Stair and Reynolds, 2001).

Extent of the use of it devices in order processing and information cost: This refers to how companies have made products and services available to customers. It also involves how various types of information technology devices are made available in each of the studied companies. The identified technologies are computer systems, electronic data transfer, electronic data interchange, magnetic ink character reader, local area network, wide area network and Electronic Resource Planning. Similarly, on the cost side, tangible, direct costs are straightforward, but there are some intangible and indirect costs that can be overlooked. The tangible costs include the direct costs of the IT product and ongoing service and maintenance, plus estimates for consulting fees, staff training and change management, staff and resources assigned to the project, and opportunity costs. However, many estimates mean many places for poor budgets. Many IT projects come in significantly over budget because managers:

- Overlook major cost items such as operational support cost
- Use estimates that assume everything will go according to plan
- Purposely underestimate costs to secure project approval

The three basic categories of costs are capital expenditures, one-time project expenses, and ongoing support activities. Capital expenditures are amortized over the expected life of the technology. If this amortization period exceeds the actual product life, the costs will be underestimated. One-time project fees often contain hidden costs such as fees to investigate alternative systems, training travel and lodging, data conversion and normalization, or lost productivity time when employees go through a learning curve. Ongoing support costs include annual license fees and maintenance fees for vendor support costs include upgrades, taxes on fixed assets and IT support staff. Analytical software may have additional cost such as the cost of generating mathematical or simulation models once software is installed (Bowersox *et al.*, 2002; Davenport, 2002; Lambert, 2004).

It is perhaps not advisable to underestimate the cost of reallocation employees to an IT project. Just because a salaries employee is a sunk cost does not mean that this cost should be ignored in the justification. Employees should be used when the savings from long-term maintenance using experienced staff are greater that the savings of using an already seasoned consultant. A final cost to consider is the cost of not implementing the project. However, in practice, many manufacturing companies have found it difficult to realize the suggested benefits of information sharing and the adoption rate of collaborative forecasting remains low. It is in the light of this that the paper attempts to examine the implication of the above fact on the manufacturing companies. Similarly, the pare is set to test hypothesis that order processing is not strongly influenced by the rate of information technology investment

MATERIALS AND METHODS

Study area: The study was carried out among the manufacturing companies in South-Western part of Nigeria that lies between latitude 6^0N and $8½^0$N of the equator and longitude 3^0E and 5^0E 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 Square Kilometres. 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 (Somuyiwa, 2010).

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. It is interesting to note that all these can be attributed to the economic activities, which targentially determine the rate of the distribution of these products.

Data set for this paper was sought from Twenty (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 above, 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

OPc = Order entry cost + Order notification cost + Order verification cost + Training cost+ Maintenance cost + IT Investment cost

Equation:

$$OPc = a+b_1(E) +b_2(V) +b_3(N) +b_4(T) +b_5(M) +b_6(I) + e \quad (1)$$

Where;
a = constant
OP = Order processed in a year
E = Order entry cost
V = Order verification cost
N = Order notification cost
T = Training cost
M = Maintenance Cost
I = IT investment cost

$\beta 1, \beta_2, \beta_3, \beta_4, \beta 5, \beta_{6,}$ are the associated output elasticities and e represents the error term.
Also for estimation purposes, the above function was linearized by taking logarithms of Eq. (1) and adding an error term.

This is done by using a system of five equations, one for each year:

$$Log(OP_{01}) = {}_{01} + {}_1Log(E_{01}) + {}_2Log(V_{01}) + {}_3Log(N_{01}) + {}_4 Log(T_{01}) + {}_5Log(M_{01}) + {}_6Log(I_{01}) + {}_{01} \quad (2)$$

$$Log(OP_{02}) = {}_{02} + {}_1Log(E_{02}) + {}_2Log(V_{02}) + {}_3Log(N_{02}) + {}_4Log (T_{02}) + {}_5Log(M_{02}) + {}_6Log(I_{02}) + {}_{02} \quad (3)$$

$$Log(OP_{03}) = {}_{03} + {}_1Log(E_{03}) + {}_2Log(V_{03}) + {}_3Log(N_{03}) + {}_4Log (T_{03}) + {}_5Log(M_{03}) + {}_6Log(I_{03}) + {}_{03} \quad (4)$$

$$Log(OP_{04}) = {}_{04} + {}_1Log(E_{04}) + {}_2Log(V_{04}) + {}_3Log(N_{04}) \; {}_4Log(T_{04}) + {}_5Log(M_{04}) + {}_6Log(I_{04}) + {}_{04} \quad (5)$$

$$Log(OP_{05}) = {}_{05} + {}_1Log(E_{05}) + {}_2Log(V_{05}) + {}_3Log(N_{05}) + {}_4Log (T_{05}) + {}_5 Log(M_{05}) + {}_6Log(I_{05}) + {}_{05} \quad (6)$$

Where OP, E, V, N, T, M, I were defined in Eq. (1)

This model was used to determine the relationships among components of IT investment and Order processing in total logistics cost.

In view of all these, the study examined the extent to which Information cost has affected the value of order processing. In order to analyze the effect of the IT investment on the order processing of Total Logistics cost, some of the components of order processing were considered. This study made use of data collected from year 2002 to 2006 on each company Information cost / IT expenditures, broken out by categories including order entry cost, order verification cost, order notification cost and training costs (how much the company is spending on maintaining existing systems relatively to response of order processed in a year).

A simple bivarate correlation between IT investment and order processed of the firm was measured from the Cobb-Douglas production function using quantity of order processed as output. The independent variables are maintenance of IT system, order entry cost, order verification cost, order notification cost and training cost of new IT system. T-statistics, R-Square and coefficient of determination were used to determine which of the independent variables is most significant.

RESULTS AND DISCUSSION

The model and equations were developed for the study through the same Cobb-Douglas function. This model was used to determine the relationships among components of IT Investment and Order processing in Total logistics cost, while the variables were defined in Table 2, while values for average of order processing and information components cost are contained in Table 3.

In this section the study seeks to identify the most proximate determinants through the software that incorporated cost of order processing, and information in outbound logistics, given the relative importance of order processing and information cost in down stream logistics. Substantially such determinants constitute crucial variables or guides that can be manipulated to increase customer satisfaction or to at least ensure competitive advantage through order processing and information investment.

Table 2: Variables labels and definition

Variables	Description
OENC	Order Entry Cost
ONOC	Order Notification Cost
OVEC	Order Verification Cost
TRGC	Training Cost
MANC	Maintenance Cost
ITIV	Information Technology Investment

Source: Field survey (2009)

Arising from the study's model that form the basis for the software designed for the analysis of the data, it is clear that plausible factors governing information investment and order processing are several, multifaceted and complex as identified above. The modeling in this section is intended to ascertain the correctness of those premises in the context of the information investment and order processing in manufacturing companies.

One of the most noticeable features in Table 4 is the existence of high correlation co-efficient of greater than ±0.7 (order processed) among independents variables such as Order Notification Cost (ONOC), Maintenance Cost (MANC), IT Investment (ITIV) and Order Verification Cost (OVEC). This suggests that there is a strong relationship between Order processed cost and information cost. Again, virtually all these independents variables are significant at 0.05 and/or 0.01 level of significance. Furthermore, Order Processing Cost (ORPR) may also be a useful surrogate for Order Entry Cost (OENC), Order Notification Cost (ONOC), and Order Verification Cost (OVEC) while Information cost can act as surrogate for Training Cost (TRGC), Maintenance Cost (MANC) and IT-Investment Cost (ITIV). Of importance among the independent is the maintenance cost (0.626) that is significant as well as has considerable high correlation value with all other independent variables. This predicates on the fact that, as much as Information Technology (IT) investment is becoming new among manufacturing companies, these companies, tend to spend more on maintenance because of low and constant training of staff as a result of high job mobility in the country. Again, IT-Investment (ITIV) is significant and has correlation value of 0.727 with ORPR (order

Table 3: Average of order processing and Information components cost Records (Millions N') (2002-2006)

Companies	ORPR	OENC	ONOC	OVEC	TRGC	MANC	ITIV
ForeDaiPlc	68	0.9	.8	1	4.8	1.8	6.8
LiveFedPlc	167	1.4	1	1.1	5.2	2.4	8.8
OktOilPlc	94.2	1.4	1	1.1	4.3	2	7.2
GuinesPlc	32.6	1.9	2	3.8	19.6	10.6	17
IntBrewPlc	4.9	.9	.8	.6	5	2.3	8.8
NigBrewPlc	39.7	3.2	2.3	1.6	16	10.4	3.2
NigBottPlc	91.3	2.4	2.2	1.5	15.4	16	14.8
ConBrewPlc	5.01	1.2	.8	1	4.42	2.8	8.3
7upPlc	75.4	1.3	1.2	1.6	5.9	9.2	13.8
NasacoPlc	90	1.3	.9	1.3	3.7	6	7.8
UniDisPlc	55.4	1	.9	1	5.2	5	6.8
DanSugPlc	81.2	2.1	1.2	1.6	7.5	9.2	16.4
BigTretpPlc	92	1	.8	.7	4.3	1.48	6.2
TateIndPlc	95.7	1	1	.8	1.4	4.8	8.9
CadburyPlc	221.8	2.5	1.9	2	11.8	10	18.4
NestlePlc	303.8	2.7	2.1	2	13	11.5	14.8
UTCNigPlc	32.1	.8	.7	.8	1.3	3	8
WAMCO Plc	74.6	1.1	1	1.2	1.1	2.1	8.2
DanFloPlc	181.6	2.2	1.5	1.8	13.4	15.8	14.6
FlourMilPlc	164.2	1.6	1.5	1.8	16.4	11.8	12.6

Source: Field survey (2009)

Table 4: Correlation coefficients of the explanatory variables and dependent variable of order processing and information cost

	OENC	ORP	ONOC	OVEC	TRGC	MANC	ITIV
OENC	1.000	0.526*	0.709**	0.691**	0.772**	.626**	.692**
ORPR		1.000	0.578*	0.583*	0.356	.546*	.727**
ONOC			1.000	0.774**	0.782**	.763**	.663**
OVEC				1.000	0.605**	.779**	.691**
TRGC					1.000	.740**	.661**
MANC						1.000	.680**
ITIV							1.000

**: Correlation is significant at the 0.01 levels, *: Correlation is significant at the 0.05 levels
Source: Output of SPSS Analysis, Based on field survey, (2009)

Table 5: Multiple regression generation model for components of order processing/information cost

	B	SE of b	Beta weight	t-value	Sig.
OENC	61.591	19.771	0.519	5.848*	0.000
ONOC	99.319	31.137	0.734	6.344*	0.001
OVEC	189.624	62.754	1.124	7.882*	0.021
TRGC	-21.289	6.390	-0.881	-4.767**	0.034
MANC	18.590	5.369	0.625	2.166*	0.000
ITIV	-13.532	4.514	-0.392	-3.287**	0.016
Constant	-52.985	13.945		-3.810**	0.001

ORPR = -52.985+61.591 (OENC)+99.319 (ONOC)+189.624 (OVEC)–21.289 (TRGC) + 18.590 (MANC)–13.532 (ITIV)+e
Multiple R = 0.8779, R^2 = 0.7707 or 77.1%, Adjusted R^2 = 0.6910, F-values = 2.757**, *: Significant at 0.05, **: Significant at 0.01
Source: Output results of Cobb-Douglas function based on field survey (2009)

Table 5: Analysis of variance

Model	Sum of square	df	Mean square	F-value	Sig.
Regression	54911.979	6	9151.996	2.757	0.011
Residual	43153.016	13	3319.463		
Total	98064.995	19			

Source: Output results of Cobb-Douglas function based on field survey (2009)

processing cost). The implication of this is that, the higher the IT-Investment, the more the orders of prospective customers are processed and this in turn will enhance competitive advantage that logistics is known for. Again, the stepwise regressions contained in the software and as presented in Table 5 and 6 were employed to ascertain the level of contribution of each of these variables.

Clearly, from Table 5, it may be surmised that the independent variables jointly account for as high as about 77.1 percent of the order processed in down-stream logistics of manufacturing companies. The ANOVA, as presented in Table 5 indicating F-value as 2.757 and significant at 0.05 and for 0.01 level of significance. Indeed, this is more than the contributions of warehousing and inventory cost to the total logistics. This negates the hypothesis that order processing is not strongly influenced by the rate of Information Technology investment. Hence, alternate hypothesis of Order processing is strongly influenced by the rate of Information Technology investment is accepted. This is due to the results of R^2 (77.1%) and F-value (2.757). The import of this is that order processing and information cost is gaining more prominence among manufacturing companies in developing economy like Nigeria.

CONCLUSION

The study revealed strong relationship among components of order processing and information costs. Suffice it to stress that, the more IT investment, the more order processed and the more customer gets satisfied. However, the study showed that there was more cost on maintenance of IT and Training of staff, as a result of job mobility among manufacturing companies. It is interesting to note that all the independents variables accounted for over 70% of level of explanation of order processing in the downstream logistics.

The relative importance of information cost in the total logistics cost has been identified and analysed with a view to examining the efficiency and effectiveness of associated information sharing cost in downstream logistics, as well as to determine the rate at which information and technology investment is influenced by order processing. It is obvious, based on the analysis that the trend is becoming new among manufacturing companies in Nigeria. Closely akin to this is the fact that training and maintenance cost are two major areas in which information cost is incurred. This is as a result of alien attributes of these information devices, consequently, personnel need to be trained and devices need to be maintained. Nevertheless, the model found all components to be significant and adequate to predict order processing and information cost at down stream logistics.

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