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ASSESSING THE IMPACT OF INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) ON THE PERFORMANCE OF FREIGHT DISTRIBUTION

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ABSTRACT: *The application and development of Information and Communication Technologies (ICT) have already had significant effects on many industries, especially in the field of freight distribution. This paper examines the impact of ICT on the performance of freight distribution in terms of supply chain, logistics and fleet management. A survey was conducted to 77 ICT users from 22 companies consisting of 6 manufacturers, 5 third part logistics, 4 freight forwarders, 5 warehouse operators, 8 wholesalers and retailers. A descriptive statistical analysis was used to analysis the data obtained. One of the major findings of the research is the impact level of ICT use by Freight industries in Lagos and Ogun State which falls into moderate impact on their performance as majority of them only use the low technology for information gathering. It was discovered that the major barrier to use of ICT is the acquisition cost. Government needs to promote a sharing of knowledge about the use and the role of ICT in logistics with logistics firms by facilitating a demonstration of technology solution and expand innovative public and private financing methods in generating finance and building skills for the development of ICT capacity*

KEYWORDS: ICT, Freight, Logistics, Globalization, Internet, 3PLs, 4PL, infomediary

INTRODUCTION

The application and development of Information and Communication Technologies (ICT) have already had significant effects on many industries, especially in the field of logistics. Because of it, the style of business operation, upstream and downstream partnership and customer relationship are changing. According to (Stock, Greis and Kasarda, 1999; Christiaanse and Kumar, 2000) this competitive environment has changed dramatically in past two decades and has become very complex.

Globalization also has an important impact on business environment and on all business organizations, especially in last two decades. For instance e-commerce is growing as the cost of acquiring information and communication equipment fall as well as growth in the number of internet users. Although e-commerce liberates sellers from the need to maintain a store, and buyers from the need to visit one, it requires the delivery of goods from seller to buyer. This has led some to argue that e-commerce will lead to worse urban road congestion as it will increase road freight transportation operations (Visser and Nemoto, 2003). On the contrary Browne 2001 and Taniguchi and Kakimoto 2004 suggests that information and communication technology (ICT) will have a positive effect on freight traffic. For example, once e-commerce has reached a certain level of diffusion there may be reduced use of private vehicles for shopping and and more efficient joint

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delivery systems based on shared operational information that work to prevent an increase in traffic volume (Taniguchi et al 2004).

The usage of this ICT gargets - computers, internet, and information communication systems can be seen in almost every activity in the logistics industry, such as transportation, warehousing, order processing, material management, fleet management and procurement. It is suggested that passing information to all businesses in the supply chains via ICT will improve performances (Disney, Nairn and Poker. 2004).

In such scenarios, ICT is becoming one of the main drivers of changes in the freight movement industry, posing new strategic challenges to logistics companies. For instance, the volume of electronic communication along the supply chain is fast growing together with the electronic of exchanges of transport documentation, invoices, order instructions, payments and tracking (Trilog, 1999). This has created an increasing need to support customers supply chains requirements through an effective use of ICT (Atkinson, 2001)

The use of ICT in the freight industry can lead to substantial cost savings (Stough, 2001). Such technologies are able to improve business processes and interconnections with other trading partners operating in the supply chain. These systems allow the information exchange in real time improving the ability of planning transport and logistics activities and the level of customer service (Clarke, 1998). The result is that the competitive advantage of freight industry increasingly depends on the ability to create value for customers through ICT, since many value adding activities are directly or indirectly dependent on ICT applications (Crowley, 1998).

The objective of this paper is to examine the impact of ICT on the performance of freight distribution in terms of supply chain, logistics and fleet management

Developments in ICT

In recent years, the cost of personal computers and peripherals has dropped sharply even as their processing power and storage capacity have skyrocketed. Likewise, as the growth of broadband and always-on Internet connections illustrates communication fees continue to drop even as connection speeds increase. The lower cost and higher functionality of information and communication systems has had a profound effect in increasing the population of Internet users and fostering the growth of e-commerce.

In the transportation field, Intelligent Transportation Systems (ITS) like car navigation systems and VICS (Vehicle Information and Communication System), which provides drivers with traffic information, have begun to find their way into private vehicles. For commercial vehicles it is now easy to track the location of vehicles and freight using GPS, and apply such information to the optimization of travel routes and freight arrival times. In addition, great promise is also seen for the use of electronic tags (RFID) and Dedicated Short Range Communication (DSRC) systems such as the ETC system used to collect highway tolls.

Internet-accessible mobile phones have rapidly becomecommonplace and, together with their ability alsoto use e-mail messaging services, are used to find road traffic information. Business uses for such phones include everything from management of a salesperson's schedule to logistics

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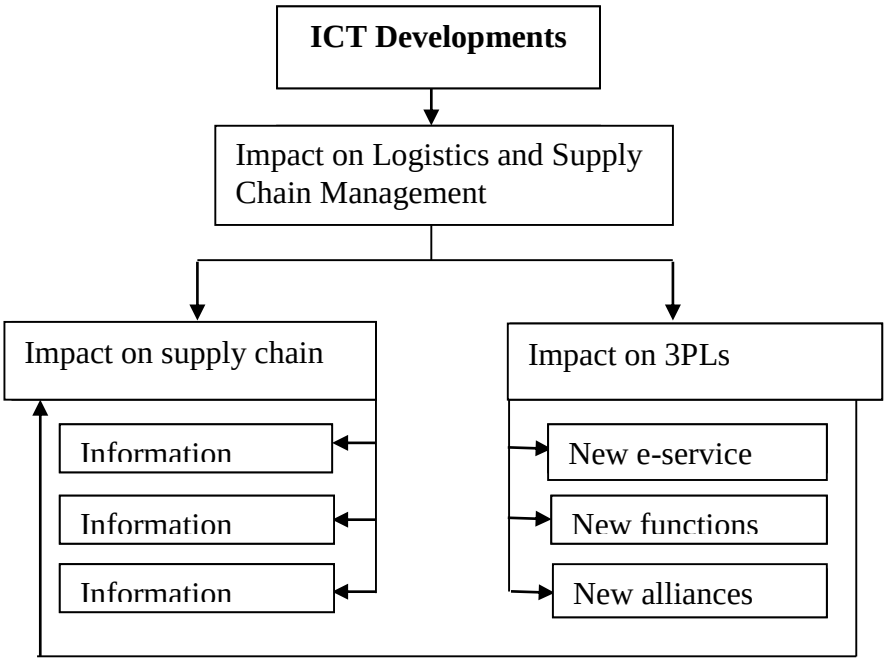
applications like photographing the inside of a shipping container with the internal digital camera and sending the image overseas to show how an item was packaged. In fact, by the end of September 2004 the number of mobile phone users had reached 89 million. The total number of GPS-equipped mobile phones sold through 2003 is estimated to have been roughly 12 million.

A Conceptual Framework for Analysis

There has been a plethora of works in the literature which, from time to time, have underlined the general aspects (Introna, 1993; Hammant, 1995; Crowley, 1998) and specific impact (Peel, 1995; Kia, Shayan and Ghotb, 2000) of these technologies in logistics and SCM. According with the framework reported in the figure 1, the analysis will focus on the effects of ICT on fright distribution as a detailed discussion of the impact of ICT developments on the overall supply chain is beyond the scope of this paper.

Figure 1: A framework for analysing the impact of ICT on logistics and supply chain management



Source: adopted from Evangelista and Sweeney (2003)

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Table 1: ICT and Application for Freight Distribution

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 partners	• EDI • E-mail • Groupware • Internet/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 Evangelista (2003)

Specific Effects of ICT on 3PLs

For manufacturers and retailers, information management has therefore become as critical as the physical movement of goods. As a result, poor ICT resource management by one or more actors in the supply chain can have negative repercussions on the performance of the entire chain in terms of costs, planning ability and customer service (Lee and Billington, 1992). For these companies the selection of 3PLs has an even higher strategic value and the provider's information technology capability represents one of the most important selection criteria. As a result manufacturers and retailers are demanding that all actors in the chain place even more attention to the integration of their business processes through ICT and Internet technologies. Under this strong pressure, 3PLs are attaching increasing importance to ICT in the management of their businesses to the extent that integration and coordination with other actors in the supply chain are becoming a vital elements in the business strategies of such firms. These developments raise two important questions:

- What is the impact of ICT on 3PLs?
- How are ICT and the Internet changing their business model?

The answer to these questions is not straight forward, nevertheless, some effects appear to be emerging and are briefly described as follows.

New e-services: One of the first visible effects is the integration of traditional services with "new information services" spurred by the dissemination of the Internet. Although 3PLs have used telecommunication systems and networks for some time,5 the sector as a whole may not be considered a leader in the field of technological innovation (Tilanus, 1997), However, over the last few years firms operating in the sector have made significant progress in the adoption of new

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technologies, particularly those linked to the Internet and e-business. Low-cost access to the Internet and the dissemination of e-business technologies have provided these firms with the potential to satisfy customer demand by using traditional services in conjunction with growing information- based services. Today, the main 3PLs are in a position to provide a variety of information via the Internet and to secure transactions online with customers.

There are firms that initially used their own web sites as electronic service catalogues. Some firms have started to offer tracking and booking services, while others have tried to create a competitive advantage with their web pages by developing signature options unique to their brands. For example, the shipping company OOCL has developed a means of releasing bills of lading over the Internet. In other cases customised portals have been developed to provide support capabilities that can also be tailored to languages other than English. APL is a good example of these advanced applications of Internet portals. However, the rapid development of e-business is expected to give rise to a gradual increase in the functionality of web sites.

New functions: The dissemination of ICT has opened up new opportunities for the development of new roles and functions in the supply chain, i.e. information brokers, or infomediaries. The purpose of these web-based intermediaries is to give added value to the 3PLs through greater efficiency and information transparency. They run web sites - transport e-marketplaces - which bring together buyers .and sellers of transport services, provide the buyer with information and make, communication between the two faster and more direct.

There is also a variety of infomediary typologies in operation on the Internet. Even though it may not be possible to give a comprehensive taxonomy of such typologies, due to the extremely dynamic nature of the sector, a recent study by Regan and Song (2001) has identified at least five different categories, the dividing lines between each being somewhat blurred:

1. Spot Freight Markets: a spot market allows shippers and carriers to post available loads or capacity on the web

2. Auction and Request for Quote (RFQ) markets: an auction space provides automated RFQ and auction capability

3. Exchanges: an exchange nay provide spot market and auction capabilities but must also provide creative e-business solutions for shippers, carriers and 3PLs

4. Applications Service Providers (ASPs): ASPs are developing web-enabling and e-business enabling technology for the logistics industry

5. Purchasing Consolidation Markets: these sites provide an opportunity for member companies (typically small carriers) to purchase equipment and supplies at bulk rates over the Internet.

In reality, the use of web transport portals by 3PLs is difficult to assess due to the lack of consistent data on the overall volume of services sold. This problem is unlikely to be resolved until carriers remove confidentiality constraints on their service rates. These firms, in fact, seem reluctant to use infomediaries since they would be forced to share confidential information which, once disclosed, could be used to gain control of customer relations through, for example, the management of the

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booking process and the rate charged. Actually, a small number of traditional infomediary are using online exchanges to help their shipper clients match with carriers.

A study carried out by KPMG and Benchmarking Partners (2000), on the way in which carriers use the Internet would appear to confirm the above findings (Logistics Management & Distribution Report, 2000). Providers do not foresee that infomediary will have a significant effect on their business, while only 50% of the shippers interviewed replied that they might use infomediaries in the near future.

New alliances: Another feature emerging alongside the Internet and e-business development is the creation of **a new** category of service provider called Fourth Party Logistics Provider (4PL). According to Bade, Mueller and Yond (1999), a 4PL is a supply chain integrator who assembles and manages the resources, capabilities and technology of its organisation with those of complementary service providers to deliver a comprehensive supply chain solution.

The emergence of these providers has been influenced by the lack of adequate technological and strategic capabilities in traditional 3PLs to meet the demand for re-thinking the supply chain strategies of their customers. In order to improve their skills, some 3PLs have started to secure alliances with complementary service providers (Rockwell, 1999). Some of these alliances have been formed with management consulting companies, ICT vendors and financial services providers.

4PLs enable manufacturers and retailers to outsource the entire reengineering of their supply chain processes - from the design, implementation, and finally to the execution of comprehensive supply chain solutions - to a single organisation. Beyond the emergence of 4PLs, an ongoing trend in the international transport and logistics sector involves the formation of alliances with other firms operating in the complementary sectors (Eyefortransport, 2001).

METHODOLOGY

The data used in this study was collected from a survey interview that was conducted in May to August, 2014, this is the months where freight activity is at the pick. Information was solicited on how ICT has impacted on freight movement. Direct interviews with the ICT logistics users were done at their respective offices guided by the self-administered survey questionnaire to ensure highly reliable data and to maximize the data samples. Responses were obtained from 77 ICT users from 22 companies consisting of 6 manufacturers, 5 third part logistics (3pl), 4 freight forwarders, 5 warehouse operators, 8 wholesalers and retailers.

The study was carried out in some selected areas of Lagos and Ogun States. The choice of Lagos state was born out of the fact that it warehouses both the major Seaport and Airport in the country where greater percentage of freight in the country are generated. Also most companies have there headquarter, manufacturing point/s and warehouses in Lagos and Ogun State. Activities of most of the manufacturing compainies spill over to Ogun State, some of the compainies selected have their manufacturing activities in the state, hence the choice of Ogun State.

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Lagos State lies in the south Western part of Nigeria on the west Coast of Africa. It lies approximately on longitude 2º 42' E and 3º22'E and Latitude 6º22'N (Merem and Twumasi, 2008). The more built up Mainland and Lagos Island, according to Merem and Twumasi (2008), make up the areas refereed to as Metropolitan Lagos, which accounted for about 80% of the population of the state. It includes such residential districts as Ketu, Oregun, Mushin, Itire, Yaba, Ebute-Metta, Apapa, Ikoyi, Victoria Island and Lagos Island. The continual sprawl of the metropolitan area as observed by LAMATA (2007) is responsible for a complete disappearance of the political boundary between Lagos State and neighbouring Ogun State. The total land area of the Metropolitan Lagos at present extends to over 1,068 square kilometres (Merem and Twumasi, 2008)

Descriptive statistical analysis such as mean, standard deviation and percentage was used to analysis the data obtained.

Types and Kinds of ICT Use in Logistics

Table 2 shows the descriptive statistics for the use of each technology from the selected companies. The result shows that largest percentages of technology in use are from the low technology. Cellular Phone has 100% which shows that every freight carrier uses cell phone while 20% uses two-way radio communication and 5% for pager. Fewer firms use high technology for information gathering. This is as a result of the high cost of acquiring these equipments coupled with the absence of government infrastructures to support the use of these technology. Internet with 89% has the widest use in the information processing technology. Some of the identified ICT equipments are not in use in the study area like Satellite Communications (SATCOM), Maintenance Tracking Software (MTS), Radio Frequency Identification, In-Vehicle Navigation Systems and XML (Extended Mark-up Languages)

Table 2: Types/Kinds of ICT Used in Freight Distribution

TYPES/KINDS OF ICT USED IN LOGISTICS	**PERCENTAGE OF RESPONSE (%)**
LOW TECHNOLOGY - INFORMATION GATHERING	
Cellular Phones	100%
Two-way Radios	20%
Pager	5%
HIGH TECHNOLOGY - INFORMATION GATHERING	
Automatic Vehicle Location (AVL)	10%
Satellite Communications (SATCOM)	0%
On-board Computers (OBCs)	3%
Global Positioning System (GPS)	1%
Geographic Information System (GIS)	2%
Radio Frequency Identification	0%
TECHNOLOGY FOR INFORMATION PROCESSING	
Electronic data Interchange (EDI)	2%
Computer-aided Routing (CAR)	1%
Computer-aided Dispatching (CAD)	1%

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Maintenance Tracking Software (MTS)	0%
Internet	89%
OTHERS	
Data Warehouse	11%
Inmarsat	0%
In-Vehicle Navigation Systems	0%
XML (Extended Mark-up Languages)	0%

Source: Author field work 2014

Table 3 shows some major objectives of firms using ICT on freight distribution in Lagos and Ogun States. Increase in revenue has the highest ranking of 1 with reveals the topmost reason of using ICT by firms. Improving quality and efficiency both in services and operation has the ranking of 2 follow by reducing cost with the rank of 3 while faster planning and system integration, improving communication and information exchange with customer and improving communication and integration within organisation has rank of 4, 5 and 6 respectively.

Table 3: Objective of using ICT in Freight Distribution

S/N	Objectives	%	Rank
1	Improving quality and efficiency both in services and operations	87.5	2
2	Faster planning and system integration	76.01	4
3	Increase revenue and income	95.32	1
4	Improving communication and integration within organisation	54.05	6
5	Reducing cost	77.22	3
6	Improving Communication and information exchange with customers	66-99	5

Source: Author field work 2014

Impact Level on the Use of ICT

The following areas were identified from the respondent in response to the questions on areas where ICT has impacted on their operations. 'Produce more business' which has the highest impact with mean of 1.350 followed by 'increase in revenue' with mean of 1.464. Reduce empty miles of travel and communication cost and increase in safety has the lowest impact with mean of 2.182 and 1.909 respectively. Table 2 shows a vivid analysis of this. The table show mean score on each criterion. A five point liker scale was used to describe the impact from ICT use on freight movement. Degree of 1 was assign to large impact, 2 to moderate impact, 3 to small impact, 4 to no impact and 5 to negative impact.

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Table 4: Impact Level on the Use of ICT

S/N	Impacts of the use of ICT	Mean	Standard Deviation
1	Increase vehicle turn around	1.594	0.984
2	Improve transport efficiency	1.494	0.847
3	Reduce load-waiting and delivery time	1.545	0.905
4	Increase safety	1.909	1.281
5	Produce more business	1.3506	0.698
6	Increase revenue	1.468	0.766
7	Reduce empty miles of travel and communication cost	2.182	1.626
8	Increase cost of ICT acquisition	1.429	0.829

Source: Author field work 2014

Table 5 highlight what the firms in freight industry perceive as key barriers to ICT adoption and use and major ICT concerns, respectively. As the table shows, high cost posed the biggest barrier to continued adoption of ICT, with about 30% of respondents identifying this as a problem. Surprisingly resistance to change from staff formed the least barriers (4%) to ICT adoption.

Table 5: Barriers to ICT adoption in Freight Industry

S/N	Barriers	Percentage	Rank
1	ICT expenditure too high	30	1
2	Concerns over Security	10	4
3	Lack of awareness about new technology	5	9
4	Accuracy of Information exchange	7	5
5	Resistance to change	4	10
6	Non availability of ICT professional	7	5
7	Fear of distorted of information	6	8
8	Compatibility of ICT/ITS system between companies	7	5
9	Uncertainty over business benefits	11	3
10	Epileptic power supply	13	2

Source: Author field work 2014

After cost the single biggest constraint on ICT investment was epileptic power. Next to this is the uncertainty over potential business benefits from such investment. Accuracy of Information exchange, Non availability of ICT professional and Compatibility of ICT/ITS system between companies got the same percentage of 7% which indicate that all the firms rated equal.

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FINDINGS

The study investigated the dissemination of technology that focuses on the interaction of all the elements in the supply chains as well as its operation and management. It was discovered that the low technology are mostly in use by all the firms while the high technology are really in use. This may be due to high cost of acquisition and epileptic power supply. The study elicited a great deal of material relating to the influence of ICTs in the firm performance, the way ICTs drive or enable improved performance; and whether there are hindrances to effective use of ICTs .

CONCLUSION

Moderate impact of ICT signifies that ICT is re-shaping the logistics system from traditional methods to modern logistics. Specifically, it was supported by the current types of ICT, their uses, and the applications as well the barriers presented. Most transport/logistics firms use ICT as facilitating technologies to gather, process, and use knowledge about the application of technologies that will help in making their business to be more progressive and contribute in

increasing the efficiency of urban goods transport. The survey found far less confidence in the explicit use of ICT for more strategic purposes. At best ICT was used in a defensive or reactive manner in order to help the firm keep up with competitors.

Our survey points to a number of key factors that inhibit the widespread adoption and use of ICT, and these include the cost of technology, uncertainty over the business benefits and impacts, and the lack of relevant internal ICT expertise. Day to day challenges such as dependence on external consultants and vendors and the unreliability of systems, potentially owing to technological obsolescence and technical complexity, were also important constraints on ICT use.

There are two broad key challenges to ensuring the optimal use of ICT by the private side based on this study. First, problem on cost and financing in acquiring the ICT or high capital

which indicates that most firms are lack of financial resources. Sometimes, firms are not aware about the advantages and cost effectiveness of the technology and why it costs a lot for them to acquire it. Second, no public policy exists as well as environment that is conducive to the efficient use of new ICT by the private firms. The use of information and communication technologies in private sector received a small attention and there is no constant monitoring and evaluation on how ICT will be fully utilized in freight logistics from the government side.

RECOMMENDATIONS

Government needs to promote a sharing of knowledge about the use and the role of ICT in logistics with the private sector by facilitating a demonstration of technological solutions, experiments and diffusing best practices that requires national, regional, and international approaches that adapt to the international developments in the industry itself. Expand innovative public and private financing methods in generating finance and building skills for the development of ICT capacities.

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Human and financial capital building should be fundamental elements of the strategies of the public and private sectors in the development of e-logistics. Training and education policies, together with adequate financing are also important for e-logistics to play its full role in the process of regional economic combination.

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