

INFORMATION AND COMMUNICATION TECHNOLOGY AND SUPPLY CHAIN PERFORMANCE OF MANUFACTURING COMPANIES

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Abstract

This study examined the influence of information and communication technology on supply chain performance of manufacturing companies. Descriptive research design was adopted for the study. Subjects were selected using the purposive sampling technique. The population comprised staff, distributors and wholesalers of selected manufacturing companies totaling one thousand one hundred and twenty-nine (1129). A sample size of two hundred and ninety-seven (297) was used for the study. Data were statistically analyzed with multiple regressions. The result revealed that; barcode scanner, radio frequency identification (RFID) and electronic data interchange (EDI), significantly influenced supply chain performance of manufacturing companies (positively). Hence, we recommended among others that manufacturing firms should employ the use of ICT tools such as barcode scanner, radio frequency identification, and electronic data interchange in their supply chain operations because of the obvious boost on their performance.

Keywords: Supply chain, Barcode scanner, Radio frequency Identification, Electronic data interchange, Corporate Performance.

Introduction

According to Cohen et al., (2002), information and communication technology provides supportive role for supply chain functions to enhance firm's process effectiveness and efficiency. ICT tools facilitate task execution, promote distribution, and enhance decision making so as to attain higher supply chain efficiency and operation (Jack et al., 2006). ICT tools also make business processes transparent to stakeholders and business partners, which in turn builds the confidence of both business partners and stakeholders (Bharadwaj, 2000). Most organizations desire to employ ICT tools to facilitate production; supply chain activity and feedback from customers in order to expand market share and reduce business costs while maximizing profits. Supply chain by way of definition comprises all the functions involved in the movement as well as conversion of raw material and distribution to customers and the flow of vital data and financial transactions (Effy & Andy, 2008). Neely, Gregory & Platts, (2005) defined performance measurement as the process of evaluating the effectiveness and efficiency of activities. Performance of a firm is dependent on whether the firm has the capacity to generate and market knowledge judiciously (Sampson, 2017). The performance of companies is of great relevance to stakeholders, business partners and the society. For depositors and investors, return on investments is very important and a well

performing organisation or business is sure to make high turn-over for their depositors as well as partners (Mirza, 2013). For a firm to increase performance the firms must also be prepared to improve on its capacity (Flynn et al., 2010).

Global Supply Chain Forum (1998) viewed SCM as the combination of vital business functions from the supplier to the end user which ensures availability of goods/services, information for both customers and shareholders. The combined tactic to planning, monitoring and controlling of the flows of goods from vendors to customers, aims at providing services to customers at a reduced cost which also enhances the development of cordial relationship among distribution channel members in order to enhance prompt exchange of information and the organization of business functions. Lyons (1998) postulated that the vital functions of SC can be divided into 8 dimensions which include: suppliers' management, demand forecasting, inventory management, physical distribution procurement, channel selection and management, and warehousing.

The exponential growth in the application of ICT is actually facilitating and performing a very important role as it concerns decision making in the supply chain network for better competitive advantage, effectiveness, efficiency, quality service delivery, inventory control, cost and even risk minimization. For an organization to share information effectively within and outside the organization, information technology is also needed. Firms are adopting virtual supply chain rapidly through Radio Frequency Identification (RFID), Electronic Data Exchange (EDI), Barcode scanner (BS), Decision Support system, Global positioning system (GPS), Enterprises Resource Planning (ERP) package, etc.

ICT plays the following key functions in supply chain performance: (1) It promotes information flow between the firm, stakeholders, business partners and customers. (2) It enhances the spread of real-time information within the supply chain including product planning, scheduling, inventory level, and delivery status which actually empowers firms to take control in the management of its supply chain. (3) It also promotes coordination in the area of scheduling and forecasting process between firms and trading partners, permitting higher inter-organisation relationship. Hence difficulties usually encountered in supply chain operations which are often delayed by distance and time can be minimized (Paulraj et al. 2017).

Statement of the problem

Manufacturing industry is among the most crucial industries in Nigeria's economy. Performance of manufacturing firms remains a serious problem in service delivery. The demand for quality service from firms and individuals has triggered the need for quality service delivery and efficiency. The application of ICT in supply chain plays a vital function in actualizing quality service delivery. It is apparent that companies operating in this 21st century that fail to employ Information and communication technology would gradually fold-up in this highly competitive society. Due to the current economic situation caused by the outbreak of Covid-19 pandemic, SMEs are taking advantage of the ease of use of most ICT applications and their comparative usefulness to enhance the skills and expertise of owners/managers to better their businesses. Recently, most manufacturing firms focus on monitoring their vehicles and personnel including drivers, assets, and even sales agents in order to minimize cost and improve productivity and service delivery (Zhirong et al., 2010).

Objectives of the study

The main purpose of this study was to examine the influence of ICT on supply chain performance of manufacturing firms in Cross River State. The specific objectives include:

1. examine the influence of barcode scanner on supply chain performance of manufacturing firms in CRS.

2. examine the influence of radio frequency identification on supply chain performance of manufacturing firms in CRS.
3. examine the extent to which electronic data interchange influences supply chain performance of manufacturing firms in CRS.

Conceptual model

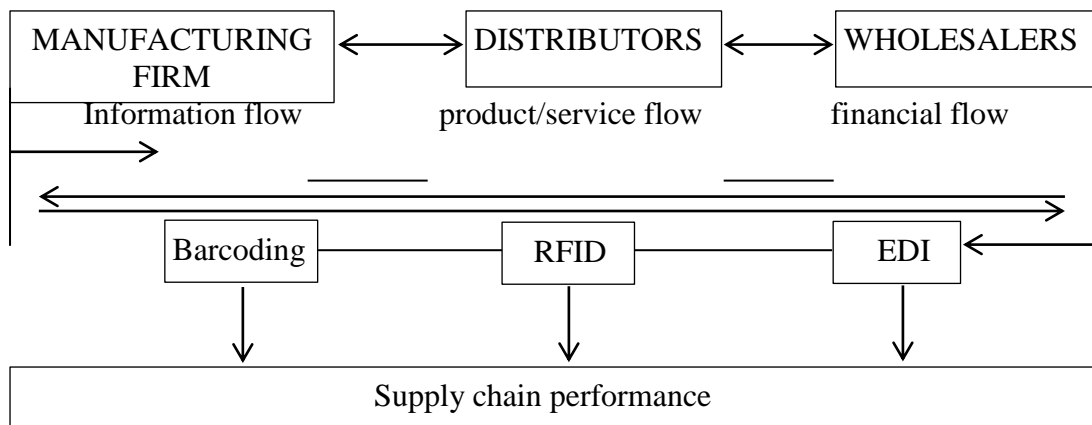


Figure 1: Conceptual ICT and supply chain model.

Source: Adapted from: Source: Coyle, J. J., Bardi, E. J., & Langley, Jr., C. J. (2003). *The Management of Business Logistics: A Supply Chain Perspective*, 7th Edition, South-Western/Thomson Learning, Mason, Ohio.

Literature review

Supply chain refers to a system or network which comprise of supplier, manufacturer, wholesalers, distributor, retailer and customer. It is a relationship or interaction within supply chain members. Supply chain also includes all the activities involved in investigating customer needs, purchase of raw materials, converting them to products, transportation in addition to services in order to satisfy customer wants (Nickels and Wood, 1997). Gbede (2005) SCM majorly is a relationship between channel members targeted at improving process efficiency, and minimize cost in order to enhance quality service delivery to end users. It involves planning and organising of all functions such as sourcing, conversion, purchase, logistics, inventory and other interrelated functions. Essentially, it also involves cooperation and teamwork with channel members such as vendor, middle-men, and customers.

Barcode scanner

A barcode is a graphical field of wide and narrow gaps and bars between bars designed in a parallel configuration, which represents a coded field of information. It is an electronically readable label that can provide information on an item or items such as the origin, destination, type of item and billing information. It can be attached to items/goods or containers of goods (Hensher & Button, 2001).

Barcode comprises of width lines in a vertical/horizontal direction in which data can be saved in optical or magnetic form as part of communication structure. Firms use it in supply chain to computerize tracking and tracing of products at each stage of the product and distribution process. It also offers timely and accurate information necessary to eliminate mistakes (Ellram et al., 1999) since it comes in coded format and readable by a machine. Pilfering which occurs regularly in organisations that produces consumer goods resulting to gross inefficiencies such as poor customer service, excessive inventory, misguided capacity

plan, porous production plan, deficiency in transportation, revenue lost, is removed totally through the application of barcode and scanner.

EAN which stands for European Article Number and was developed in the year 1976 to achieve the desires of grocery business. The EAN code is an advancement of UPC (Universal Product Code) of USA. Because of the low cost and high convenience for product identification, the barcode system is very common in the manufacturing industry.

According to Rajiv (2019) the following are the impact of Barcode system on supply chain and logistics activities.

- 1) Procurement function: The components developed by vendors are allotted barcodes which in it carries information such as name of the item, manufacture date, batch number, serial number, order number etc. The details contained in the barcode helps to identify and track the product. In a typical warehouse, when products are received from conveyor, the products are usually scanned using the hand-held scanner. Immediately the product is scanned, the details decoded therein are immediately transferred to the central computer which is further used for real time inventory update.
- 2) Processing function: At the point of order processing, the details of the barcode helps to store, and identify the product based on the imputed date of arrival. This process makes material storage, retrieval and dispatch very easy using the concept of first-in-first out.
- 3) Production function: The identification and tracking of semi-finished product and finished product becomes very easy because of the act of barcoding all the items.
- 4) Distribution function: At the point of distribution, barcode also assist immensely in the identification and tracking of the finished goods even while on transit to the end users.

Radio Frequency Identification

RFID is a system which uses tags capable of emitting and receiving in the form of a unique serial number through radio signals and also on scanners that accepts the information transferred by the tags and transmit the data to the remote server system for further analysis and evaluation. Barcode and Radio Frequency Identification technology are based on Auto ID but in barcode, a barcode readable device is used to scan the printed label through an optical laser or imaging system while in RFID, the device used to scan actually scans a tag through the use of radio frequency signals. By using RFID system, the activities of supply chain can be enhanced in terms of customer needs visibility, accurate and reliable order forecast, efficient business process, reduction in operating cost, improvement in productivity, identification of fake items, theft prediction and better tracking (Attaran, 2007).

Radio Frequency Identification comprise authentication and verification (Coronado et al., 2004), it also enhance forecasting, planning capabilities and reduces channel volume (D'Avanzo et al., 2004). Organisations also uses RFID for warehouse management (Attaran, 2007), as a matter of fact, Wal-Mart decided to put a deadline for vendors to start using RFID tags on their operations (Coronado et al., 2004). RFID enables vendors to effectively manage defect product, return of faulty products and product recall (Sabbaghi & Vaidyanathan, 2008). The adoption of RFID by organisations is actually increasing rapidly in supply chain network lately (Jedermann et al., 2009).

The technology of RFID is also applicable in both logistics and supply chain activities. This development has actually made most firms to attach RFID tag transponder. Some transponders look like a smart card, plastic coin, or label. They have to be scanned with

RFID scanner which can be fixed at the point of loading. This scanner can detect parcels through the information stored on the transponders and other informations such as temperature, weight, and construction date. RFID can only be relevant in supply chain when the system has been configured to use barcode and RFID reader (Sabbaghi et al., 2008).

RFID is one of the latest security device used in most organisations because of its relevance in the supply chain. The use of RFID enables a firm to avoid item duplication, as the tags are exclusive and authentic. It also eliminates fraud in the supply chain to a great extent.

Electronic Data Interchange

EDI was first postulated in 1970 and became popular in 1980. EDI has been applied widely by organization in their supply chains to enhance exchange of information and facilitate transaction. EDI can be defined as the exchange of structured information for automation execution between computer-to-computer. Supply chain members use EDI to exchange vital information regarding their business operations. These type of cordial relationship is usually established between firms that have outstanding and very cordial long-term business relationship..

For instance, some distributors could decide to supply certain information directly to their vendor that would elicit automatic re-stocking of sold items in the warehouse. The implication of establishing such cordial relationship with a trading partner is to build a solid sales pattern capable of promoting the process of demand forecast. Since there exist no need for manual collation of information, EDI provides numerous benefits, for instance, it enhances prompt transfer of information regarding product, price and even sales. Moreover, EDI can also be used to generate invoices, shipping details, confirmation of dispatch, and bills of lading when necessary and on time (Rushton et al., 2000).

Electronic data interchange is one of the first major technology breakthroughs in providing commercial link between companies. The data exchanged through EDI can be processed without any form of human interference (Sanchez & Perez, 2003) between the supply chain members and commonly referring to the use of EDI message format ANSI X.12 and EDIFACT. EDI has been used to replace mail, fax and even courier. It was introduced to reduce paper work within the supply chain network to share vital information (Garcia-Dastugue & Lambert, 2007), regarding inventory control, accounting, order processing, better customer service, transportation, production, cost, competitive advantage within the supply chain network.

The establishment of electronic data interchange connections with suppliers has created close partnerships between suppliers and customers (Puschmann & Alt, 2005). It is used to transmit documents through a third party “network” that communicates from the computer of one organisation to the computer of another, directly or indirectly (Reynolds, 2001). EDI is now the most commonly used connectivity medium in the supply chain. EDI also enhances accuracy and speed in order entry as well as order transmission (Lambert et al., 1998).

According to Ross (2003) EDI is an extranet system with a jointly established and applied set of information transfer format usually applied through a network known as private value-added. There are two typical type of EDI data transfer. One form of EDI data transfer is computer-to-computer and the other is via Third-Party Linkage. Computer-to-computer allows the transfer of agreed-upon documents from company A computer (vendor) to company B computer (trading partner). The documents may include sales orders payments, which updates directly to the databases of both parties involved. Greenstein and Feinman (2000) identified that the most widely recognised importance of EDI include:

1. Reduction in order placement process to the time the order is actually received from the vendor.
2. Reduces possible errors in data entry
3. Reduces costs.
4. Increases re-stocking speed and information processing by customers.
5. Increasing communications and networking among supply chain partners.
6. Accelerating information flow

Although EDI can provide benefits to the supply chain, there are also disadvantages because EDI is costly and consumes time especially during decoding. Organisations must also accept to use a known format. Although both the Internet and EDI provide communication relating to logistics activities, the application between the two is slightly different. The Internet is commonly used when performing non-financial transactions such as placing purchase orders, marketing, or customer service. When performing financial transactions such as accounts payable, billing or fund transfers, enterprises tend to use EDI rather than the Internet ((Reynolds, 2001).). This is mainly attributable to the relative security of EDI and its standardised formats. EDI is better suited to financial transactions between multiple parties and financial institutions.

Developments in information technology such as POS readers, identical product codes and EDI have promoted product handling, inventory control, and order processing as well as scheduling and distribution routing (Kotler, 2003). Sophisticated barcodes, RF tags, EDI, etc. have enabled companies to reduce uncertainty (Coyle et al., 2003).

Methodology

The study adopted survey and descriptive design. This is because the researcher intends to sample the opinion of respondents as it concerns the application of ICT tools in the supply chain of manufacturing firms in Cross River State. The population of the study comprised staff, distributors, and wholesalers of the manufacturing companies in Cross River State. A total number of 295 staff and 320 distributors and wholesalers was drawn from Lafarge cement Plc, while 230 staff and 284 distributors and wholesalers was drawn from Niger Mills, Calabar. A sample size of 297 was however drawn from the population using the Taro yamane formula.

Theoretical framework

Technology-Organization-Environment model (1990) was propounded by Tornatzky and Fleischer. TOE models the effect of technology on organization and the ecological framework on the practice of embracing and implementing technology by a firm (Drazin, 1991). Technological framework describes the external and internal automation that an organisation uses presently and the recent technologies that are obtainable in the market but not yet employed by the organization. Organizational framework describes the firm's organogram, human resource and size of the firm. Environmental framework however refers to factors that are beyond the regulation of the firm such as environment, supply chain members, and competitors.

Technology-Organization-Environment model offers a systematic arrangement of inducing factors that firms have used in existing studies on adoption of technology (Liu et al., 2011). Songer et al. (2001) also introduced a fourth dimension called economic factors into the model which suggest that an organization may consider using a particular technology if the price is affordable. A very high cost technology would directly affect a firm's decision of adopting it because of the high cost of maintaining such technology and the possible risk that

may come with it. Based on the above, this study inculcated the fourth variable into the model of manufacturing firms.

Technology acceptance model

TAM was postulated by Davis (1989). It is based on perceived ease of use and perceived usefulness. TAM is used to explain the use of information system. This model happens to be one of the most is one of the most widely used and modest theoretical model of the use of technology and users acceptance. The model is self-explanatory and very easy to understand; hence it is viewed as one of the most widely used models across various disciplines. It identifies why a particular model may be rejected and adopt proper strategies. Davis et al. (1989) defined adoption of model as: the application of hardware and software technology in a firm to improve productivity, processing speed, competitive advantage, and ensure prompt information availability. TAM assesses the user acceptance of emerging information technology. It is more specific and applies only to the use of information and communication technology.

TAM has a questionable exploratory worth. It lacks the power to predict and explain phenomenon. It is trivial and lack practical applicability. TAM creates an impression of progress in the accumulation of knowledge. The probability of perceived ease of use to be a basis of attitude and usage intention is less likely. The model also lacks objectivity, accuracy and applicability that would make it a deep-rooted theory for information system environment.

According to Davis (1989) PU and PEOU influences the behaviour of consumer towards the use and acceptance of information and communication technology in a firm. PU is the extent to which consumers trust that using information and communication technology would augment expectation. PEOU is the extent to which consumers believe that using information and communication technology would be convenient and less stressful. The TAM has been widely used in different studies and proven to be reliable and effective in explaining information and communication technology acceptance and usage (Venkatesh & Davis, 2000).

Test of hypotheses

1. H_0 Barcode scanner does not significantly influence supply chain performance of manufacturing firms in CRS.
2. H_0 Radio frequency identification does not significantly influence supply chain performance of manufacturing firms in CRS.
3. H_0 Electronic data interchange does not significantly influence supply chain performance of manufacturing firms in CRS.

Table 1

Regression model summary showing the influence of ICT on supply chain performance

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.795 ^a	.632	.625	6.04805

- a. Predictors: (Constant), Barcode scanner, Radio frequency identification, Electronic data interchange

Table 2
ANOVA^a showing the influence of ICT tools and supply chain performance of manufacturing firms in CRS

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	17325.823	5	3465.165	94.731	.000 ^b
	Residual	10095.780	276	36.579		
	Total	27421.603	281			

a. Dependent Variable: Performance

b. Predictors: (Constant), Barcode scanner, Radio frequency identification, Electronic data interchange,

Table 3
Coefficients^a showing the influence of ICT on supply chain performance

Model		Unstandardized		Standardized	T	Sig.
		Coefficients		Coefficients		
		B	Std. Error	Beta		
1	(Constant)	101.760	2.332		43.642	.000
	Barcode scanner	.893	.105	.319	8.511	.000
	Radio frequency identification	1.384	.128	.514	10.789	.000
	Electronic data interchange	.458	.128	.182	3.578	.000

a. Dependent Variable: Performance

Interpretation of result

The multiple regression analysis conducted above was to examine the influence of ICT on supply chain performance of manufacturing firms in Cross River State. Table 1 above summarizes the statistics and the results of the analysis as shown in table 2 and 3. The tables produced a correlation coefficient (R) .795^a, and R² of .632 the implication of the coefficient of determination (R²) is that the predictor variables (Barcode scanner, Radio frequency identification, and Electronic data interchange contributed 63% to the overall regression model, while the remaining 37% per cent was influenced by exogenous factors not considered in the study. Going further, the result implies that Barcode scanner (B =.319, Sig =.000 < P=.05), Radio frequency identification (RFID) (B =.514, Sig =.000 < P =.05), and Electronic data interchange (EDI) (B =.182, Sig =.000 < P =.05) have significant influence on supply chain performance of manufacturing firms in Cross River State. The implication of the above result indicates that the individual contribution of the predictor variables as indicated by the Beta values reveals that Radio frequency identification (RFID) (B =.514, t =10.789 P <.05) contributes the most to the regression model as followed by Barcode scanner (B =.319, t =8.511, P <.05), and lastly Electronic data interchange (EDI) (B =.182, t = 3.578, P < .05). Based on the above, the alternative hypotheses of hypotheses 1, 2, 3 are accepted because their p - value is less than .05 while their respective null hypotheses are rejected.

Summary of findings

The main concern of this study was to examine information and communication technology and supply chain performance of manufacturing firms in Cross River State, Nigeria. In doing this, the study tries to ascertain how barcode scanner, radio frequency identification, electronic data interchange, enterprise resource planning, and global positioning system affect the performance of manufacturing firms. To achieve the purpose of the study, five research questions were posed to guide the study and were translated to the following null hypotheses and tested at 0.05 level of significant:

- 1 Barcode scanner does not significantly influence supply chain performance of manufacturing firms
- 2 Radio frequency identification does not significantly influence supply chain performance of manufacturing firms
- 3 Electronic data interchange does not significantly influence supply chain performance of manufacturing firms
- 4

Relevant literature of many authors and empirical works from researchers were reviewed in line with the study variables. The study adopted both descriptive and survey design. The population of the study comprised staff, distributors and wholesalers of manufacturing companies in CRS. A sample size of 297 was derived from the population with the use of Taro Yemane formula and purposive sampling. To gather relevant data for the study, a questionnaire titled “Information Technology Questionnaire” (ITQ) and Performance Questionnaire (PQ) was drafted by the researcher to elicit information from respondents and was subjected to validation and reliability test. Multiple Regressions and One-Way ANOVA were used to test each hypothesis at 0.05 level of significance. The result revealed the following;

1. There is a significant influence of barcode scanner on supply chain performance of manufacturing firms.
2. Radio frequency identification has significant influence on supply chain performance of manufacturing firms
3. There is a significant influence of electronic data interchange on supply chain performance of manufacturing firms

Conclusion

The following are the conclusions drawn from this study “information and communication technology and supply chain performance of manufacturing firms in Calabar, CRS, Nigeria”: There is a significant influence of barcode scanner on supply chain performance of manufacturing firms in CRS. The relevance of barcode scanner in today’s world has prompted many companies to employ it in their supply chain operations. This is because from the findings of the study, barcode scanner enhances prompt information, asset visibility, and eliminates human error among others. Barcode scanner therefore makes it very easy for manufacturing firms to communicate with channel members, access information about products and control inventory for the purpose of achieving the organization’s objectives.

Radio frequency identification has significant influence on supply chain performance of manufacturing firms in CRS. Since supply chain implies the process through which goods and services are delivered to consumers, some channel members especially distributors and wholesalers who buy goods in very large quantity most times prefer to keep in touch with their goods even while on transit. The act of determining the state and position of a product by channel members, increasing confidence, eliminates fear, and promotes the concept of Just-In-Time.

There is also a significant influence of electronic data interchange on supply chain performance of manufacturing firms in CRS. EDI plays a vital role in today's supply chain management as it reduces processing cost and error in producing manual documents and data entry. Some supply chain members in the quest to increase process effectiveness and efficiency go as far as installing software in their computers in order to facilitate communication, monitor inventory and even generate invoice, bill and receipts immediately payment is made and confirmed.

Recommendations

The following recommendations are made based on the findings above;

1. That, manufacturing firms should employ the use of ICT tools such as: barcode scanner, RFID, and EDI in their supply chain operation because of the obvious influence on performance.
2. Supply chain members who are yet to employ the use of information and communication technology tools in their operations should endeavor to do so, hence this study has revealed that there exist a significant relationship between ICT tools such as barcoding, RFID, EDI and supply chain performance of manufacturing firms.
3. Top management/board of directors, distributors and wholesalers should endeavour to provide necessary facilities that will facilitate the adoption of information and communication technology in their supply chain operation and also organize seminars at intervals to enlighten staff on the use of ICT.

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