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THE RELATIONSHIP BETWEEN REAL-TIME INFORMATION PROCESSING AND SUPPLY CHAIN OPTIMIZATION AMONG SUPERMARKETS IN NAIROBI, KENYA

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Abstract

Though the concept of real-time information processing is spreading across organizations like bush fire, not many companies have embraced its application. The study was conducted to determine: the types of real-time information processing technologies used by supermarkets in Nairobi, Kenya; their benefits; and to establish the relationship between real-time information and supply chain optimization. The research adopted a descriptive cross-sectional survey of the supermarkets. Data was collected through questionnaires, analyzed using SPSS and presented in tables and figures. The study revealed that all the supermarkets use real-time information

processing technology such as: barcodes, mobile phones, internet, RFID, and GPS. The study found two major benefits of real-time information processing: increased supply chain visibility and reduction in labor costs. The findings too indicate mixed relationships between real-time information processing and various supply chain optimization indicators. Whereas there was a significant positive relationship between real-time information processing and inventory turnover, ROSCI and number of warranty claims, there was no significant relationship between real-time information processing and number of customer complaints and number of orders with complaints among others. The study recommends staff training on the use of these technologies and increasing the use of mobile phones, RFID and internet in business.

Keywords: Real-Time Information Processing, Supply Chain Optimization, Supermarkets in Nairobi, Kenya

INTRODUCTION

Firms operating in the current business environment are faced with stiff competition, increased customer demands, and dynamic business environment (Bosire, 2007 and Stuart 2011). Equally, today's Supply Chain Management (SCM) need coordination and integration of activities and resources across firms which spread through decentralized geographical locations and have a high degree of operational complexity (Chopra et al., 2007). Moreover, there is a growing need for supply chains to embrace responsiveness due to more sophisticated and ever-changing customer demands (Dreyer et al., 2008).

According to Folinas et al., (2004), firms are increasingly facing pressure to expand beyond the frontiers of their traditional supply chains as customers demand online order status, trucking capabilities, electronic proof of delay, immediate service based on call centers and online customer service systems, self-service and personalized interactions.

Supermarkets are no exception to these challenges. The nascent industry in Africa is faced with the need to increase sales volume and stiff competition (Olamide et al., 2013). The industry is equally being saturated due to urbanization and need to address newer competition challenges including restaurants and home shopping delivery which ;coupled with changing demographics affect tastes and preferences and consequently per capita spending of its customers (Kumar, 2008).

The solution to these challenges is embracing supply chain (SC) optimization and paradigm shift to real-time information processing (Dreyer, 2008). As Folinas et al., (2004) argues, in the modern business environment SC should be a way for achieving short-term economic benefits and gaining long-term competitive advantages. Hence, any firm that takes

advantage of current environment and implements an end to end supply chain enabled with the best in class real-time information processing technologies will have a competitive edge (Chopra, 2007; Genpact, 2011).

The shift to real-time information processing has a milliard of benefits which include: increased productivity, improved SC visibility, cost reduction, reduction of overall inventory, increased customer service, and increased latency and value of data (Hackthorn, 2004; Hensley, 2010;). SC, therefore, need not only to sense but also respond to changes in real time and use information to drive intelligent tactical decision-making whenever exceptions occur (Stuart, 2011). As Dreyer (2008) posits, accesses to continuously updated real-time demand and event information is a pre-requisite for competitive supply chain planning and control as it enhances visibility into real-time demand information, and is a vital element in the planning and control environment.

Real-time information processing systems are systems characterized by speed of response and are able to quickly respond to circumstantial changes and come up with appropriate feedback (French, 1996). Real-time enterprises, on the other hand, are organizations that enable automation of processes spanning different systems, media, and enterprise boundaries by providing real time information to employees, customers, suppliers, and partners and implementing processes to ensure that all information is current and consistent across all systems, minimizing batch and manual processes related to information. In these systems, the correctness of the system behavior depends not only on the logical results of the computation, but also on the physical instant at which these results are produced meaning that in strict real-time systems a late result is not just late but wrong. Real-time systems are characterized by time, deadlines, fastness, and predictability (Ecker et al., 2009).

The effective working of real-time information processing and integration depends on the installation of key technologies. Different studies show that there exist a number of real-time information processing technologies which include: ERP, RFID, internet, GPS, mobile- phones, barcodes, among others. These technologies have helped firms in inventory management, supply chain integration, supply chain visibility and planning and execution (Ajayi et al., 2010).

Real–time information processing systems should be vigilant systems able to detect changes and enhance managerial visibility from the field to corporate headquarters and help decision makers at strategic, tactical and operational level take action. Its benefits in supply chain management include: errors are caught at point of entry and are fixed, increased employee productivity, better control over inventory and increased inventory turnover, reduced paperwork, reduced bullwhip effect, improved customer relationships and increased customer

satisfaction which collectively help make the supply chain more efficient (Houghton et al., 2002 ; Pisello, 2006; Hensley, 2010; Nishanthet al., 2013).

Supply chain optimization is concerned with decisions about the optimal number of operating facilities and their locations, number of suppliers, the quantity of products to manufacture and the flow of such products to minimize costs. Network optimization models, on the other hand, seek to facilitate optimal material sourcing, processing, activity, material and product flow in the entire supply chain, taking into account forecasts for future requirements (Lyson et al., 2007).

Dealers in information technology and Electronic Components waste billions of dollars a year due to time and cost inefficiencies at different points of supply chains. These inefficiencies are driven by the lack of industry-wide process and data standards that enable end-to-end automation of core supply chain processes such as catalog management, order management, inventory management, and customer service and support (Malcolm, 2000).

Time and cost have also been wasted due to use of manual techniques in data process and information sharing and this directly results into lost or incorrect orders, late deliveries, high clerical and labor costs, excessive buffer and obsolete inventory costs, and ultimately, low customer loyalty and retention (Convery, 2004).

Use of RFID, Mobile Commerce, ERP, internet, barcodes and other technologies to synchronize and integrate activities help to optimize the entire supply chain (Samaranayake, 2009; and Siau et al., 2009).Supply Chain optimization has a milliard of benefits which include: Improved demand visibility reduction in inventory carrying costs, reduction in transport cost, reduction in lead time, reduction in obsolescence costs, making of informed purchasing decisions, reduced product returns, fewer wrong product orders and Clerical costs reduction (Malcolm,2000). The success of these technologies, however, may be hindered if there is lack of training, failure of the technologies and lack of management support (Lyson et al., 2007).

Bore (2007), defines a supermarket as a departmentalized self- service store offering a wide variety of food and household merchandise. Supermarkets are usually driven by the marketing strategy of all under one roof as they stock a wide range of merchandize for their customers.

The supermarket industry is still at its early development stage in most African countries except in South Africa. Unlike the supermarkets in Africa; supermarkets in more advanced economies have developed ways to attract, retain and grow customer value over time (Olamide et al., 2013). Supermarket industry in Kenya dates back to the mid seventies when Uchumi supermarkets opened shop in Nairobi with the industry witnessing rapid growth in the nineties. This rapid growth is attributed to; changes in supply chain management, Foreign Direct

Investment (FDI), urbanization and the rise of the middle class in countries like Kenya and South Africa, (Bosire, 2007; Olamade et al., 2013).

From their initial establishment in urban areas the supermarkets are rapidly spreading in Kenya and eating into the once ecological niche of food retail industry as they spread their wings further into the city suburbs (Neven et al., 2005). Currently there are over one hundred supermarkets in Nairobi, Kenya and they can be classified in terms of their market share as first tier, second-tier and third tier with the first tier comprising of supermarket who are the clear market leaders (i.e. Uchumi and Nakummat) and the second comprises of Tuskys, Ukwala and Metro Cash and Carry (Neven et al., 2004; Bosire, 2007; Bore, 2007).

Supermarkets use various techniques to increase sales volume which include: price appeal, display techniques, self-service, attractive facilities, advertising and promotion, large but well-managed inventories, and diversified lines of merchandise (Belzet et al., 2011).

Problem of Research and Research Focus

The business environment that companies operate in nowadays is characterized with many challenges including: operating in a rapidly changing environment, stiff global competition, rapid technological innovations, limited visibility of supply and demand, limited integration between planning and execution, low data latency and increased planning cycle time (Hugh et al., 2006; Ajayi et al., 2010; Stuart, 2011). These challenges are driving enterprises to adopt the practices of real-time information processing that provide real time information to all SC partners and implement processes to ensure that all information is up-to-date across all systems, minimizing batch and manual processes related to information (Khosla, 2002; Dreyer,2008).

According to Neven et al., (2006), the supermarkets in Nairobi, Kenya, play a key role in offering a variety of goods and services in both the capital and the suburbs. The supermarkets handle a large number of customers, deal with numerous transaction and large volumes of goods with some that are highly perishable. These supermarkets, however, are being saturated due to urbanization and growth of others in residential neighborhoods leading to stiff competition. They also are faced with new competitive threats (restaurants and home shopping). Moreover, changing demographics affect tastes and preferences of their customers and consequently per capita spending (Kumar, 2008). In order to deal with these challenges these supermarkets need to invest in real-time information processing (Dreye2008).

Past studies indicate that a number of benefits are accrued from adoption of real-time information processing. Hugh et al., (2006) found out that real-time information processing reduces operations costs and leads to customer satisfaction. However, the study was in the aviation industry and not in the retail industry. Equally, the study does not say whether real-time

information processing leads to supply chain optimization. Meiller (2010), in his studies found out that real-time information processing has also been used in improving tracking of surgical equipment, and managing bottled gas delivery in the Health sector thus reducing related inventory costs and improving accountability. The study, however, is not in the retail industry and concentrated on the use of RFID technology without addressing other types of real-time information processing technologies. Dreyer (2008) looked at the possible benefits of adoption of real-time information processing in the Norwegian food industry and found out that it will lead to increased productivity due to reduction in costs of operations. However, this was on the perceived impact of real-time information processing. Studies in supermarkets in Kenya include: Neven et al., (2005), which looked into the impact of the rise of domestic supermarkets on urban consumers of and supply chains for fresh fruits and vegetables (FFV) in Kenya. Another study by Kimani et al., (2012) compared shopper's perception of retail service quality between supermarkets and small convenience shops.

Generally the studies conducted in supermarkets in Kenya as seen from the studies above do not address real-time information processing and SC optimization and those conducted on real-time information processing are in developed countries and in industries different from the supermarkets. It is on this basis that the study seeks to determine the role of real time information processing and SC optimization in supermarkets in Nairobi, Kenya. The study seeks to answer the following questions: what are the various types of real-time information processing technologies employed by supermarkets in Nairobi, Kenya? What are the benefits of real-time information processing in SC optimization in supermarkets in Nairobi, Kenya? What is the relationship between real-time information processing and SC optimization? The study sought to achieve the following three objectives: first, to find out the forms of real-time information processing technologies used among supermarkets in Nairobi, Kenya; secondly to determine the benefits of real-time information processing among supermarkets in Nairobi, Kenya; and lastly to establish the relationship between real-time information processing and SC optimization among supermarkets in Nairobi, Kenya.

METHODOLOGY OF RESEARCH

General Background of Research

The study adopted a descriptive survey of all the supermarkets operating in Nairobi, Kenya. The survey approach was adopted since it allowed the researchers to collect a large amount of data from a sizable population in a highly economical way. In addition the survey strategy is considered authoritative by people in general and is easy to explain and understand. It also

allowed for collection of quantitative data which was analyzed quantitatively using descriptive and inferential statistics (Saunders, 2009).

Population and Sampling

There are 105 supermarkets in Nairobi, Kenya (The Yellow Pages, 2013).All the 105 supermarkets represent the study population. The size of a sample should neither be excessively large nor too small. It should be optimum such that it fulfills the requirements of efficiency, representativeness, reliability and flexibility Kothari (2004). A sample of 50 supermarkets picked through simple random sampling from a population of 105 supermarkets in Nairobi was used in the study. The use of fifty was based on the central limit theorem which states that the larger the absolute size of the sample, the more closely its distribution will be to normal distribution. A minimum number of 30 or more provides a useful rule of the thumb (Saunders, 2009). Given the number of supermarkets in Nairobi and their expansive geographical locations 50 was representative and economical as it was above the rule of the thumb of 30 cases.

Instrument and Procedures

Primary data was collected by means of closed ended questionnaires. According to Nachimias and Nachimias (1996), answers to closed ended questions can be more elaborate. The questionnaire had four sections, which collected data on: general information of the organization; the forms of real-time processing technology used by supermarkets in Nairobi; information on the benefits of real-time information processing and lastly information on supply chain optimization. The respondents to the questionnaire were procurement and supply chain managers or their equivalents at the head offices of the supermarkets with more than one branch and from the location of those with one branch. The questionnaire were administered on drop and pick later method.

Data Analysis

Data was collected using a self-designed questionnaire which administered then keyed into SPSS package for analysis. To test for reliability, the researcher used the internal consistency technique by employing Cronbach Alpha value of $\alpha>0.75$. In order, to find out the extent to which real-time information processing technologies had been used and the benefits of use of real-time information processing technology, descriptive statistics analysis such as use of frequency distribution, cumulative frequencies and standard deviation were used to analyze quantitative data. Factor analysis was also used in determining the benefits of real-time

information processing. Regression analysis was done to determine the relationship between real-time information processing and supply chain optimization.

EMPIRICAL RESULTS

The data is summarized and presented in form of frequency, percentage and tables interpreted in line with the objectives of the study which included: to find out the forms of real-time information processing technologies used in supermarkets in Nairobi, Kenya, to determine the benefits of real-time information processing in supermarkets in Nairobi, Kenya, to establish the relationship between real-time information processing and SC optimization in supermarkets in Nairobi, Kenya. The respondents were drawn from supermarket in Nairobi, Kenya. All the 50 supply chain managers who were sampled to participate in this study participated giving a response rate of (100%). This response rate indicates that the findings can be used in generalization.

Adoption of Real-time Information Processing Technology

The study sought to know whether different supermarkets in Nairobi, Kenya use real- time processing technologies in their operations. It was found out that all the supermarkets in Nairobi Kenya have adopted real-time information processing technologies to conduct their day-to-day activities such as data processing and supply chain visibility solutions to assist them cope with the changing business environment as well as reduce operation costs as can be seen in table 1. The adoption of real-time information processing technologies by Nairobi supermarkets support Hugh et al. (2006)'s argument that real-time information processing reduces operations costs and leads to customer satisfaction

Table 1: Supermarkets that have adopted Real-time Information Processing Technologies

Response	Frequency	Percent
Yes	50	100.0

The Forms of Real-Time Processing Technology Used By Supermarkets in Nairobi

There are very many forms of real-time information processing technologies that firms can use in their operations. They include: barcodes, RFID, GPS, Mobile phones, ERP, and internet. The respondents were asked to rate the type of real-time information processing technologies used by their supermarkets to conduct their operations. This was on a five point scale where 1=very small extent 2=small extent 3=moderate extent4=great extent and 5=very great extent. The results are as in table 2.

Table 2: Types of Real-time Information Processing Technologies

Real-time Information Processing Technologies	Mean	Std. Deviation
Mobile Phones	4.74	0.49
Barcode	4.18	1.10
Internet	2.50	1.17
ERP	2.08	1.37
GPS	1.90	0 .89
RFID	1.88	1.88

From the findings in table 2; the supermarkets in Nairobi, Kenya, use mobile phones to a very great extent as the real-time information processing technology to conduct their operations (M=4.74, SD=0.49). Barcodes are used to a great extent (M=4.18, SD=1.10), while, the internet is used to a moderate extent (M=2.50, SD=1.17). The GPS and RFID are used to a small extent (M=1.90, MD= 0.89) and (M=1.88, MD=1.88) respectively. This means that barcodes and mobile-commerce are the most common forms of real-time processing technologies in supermarkets in Nairobi, Kenya. This is associated with the fact that mobile phone technology is increasing its presence in the Kenyan markets and is becoming cheaper with each coming year. The mobile phone's flexibility, personalization, localization, ubiquity, and convenience, make it popular in real-time information processing in supermarkets in Nairobi, Kenya. This is in line with Siau (2009)'s argument that mobile phones use applications such as SMS, WAP, blue tooth, GPS, XML, and GPS to send and receive timely business information. The popularity of barcodes is associated with their role they play at the point of sale in supermarkets where retail sales are recorded by scanning barcodes at the checkout tills (Lyons et al., 2006).

Benefits of Real-time Information Processing Technology

The respondents were given a list of 14 variables of real-time information processing and were asked to rank the extent to which they thought their firms realized supply chain visibility benefits as a result of implementing real-time information processing systems. This was on a five point measurement scale whereby 1= very great extent; 2= to a great extent; 3= moderate extent; 4=small extent and 5= very small extent.

From the findings in table 3 the supermarkets in Nairobi to a very great extent have reduced labor cost and reduced rework due to accuracy of data entry through the use of real-time information processing (mean=1.45, SD=1.169). This is in line with Hensley, (2010) and Hugh, et al., (2006) who argue that automating supply chains with RFID; one of the key technologies that enhance real-time information processing not only improves productivity but also reduces labor costs. The supermarkets to a great extent use real-time information processing to mitigates on risks, have capacity to deal with large amount market information,

reduces incorrect invoice payment, reduces stock out costs, increases resource utilization and reduces paperwork among other benefits (mean=2.44, SD=1.67).

To a moderate extent the real-time information processing has led to increased supply chain visibility through making of timely decisions, lessening or prevention of negative performance downstream, increased inventory turn-over, improved inventory forecasting, reduced pull-whip effect, and avoidance of delays in the supply chain among other benefits (mean 2.66, SD=1.78).

Table 3: Benefits of Real-time Information Processing

Benefits	Mean	Std.Deviation
Reduces labor costs	1.44	1.07
Reduced rework due to accuracy of data entry	1.46	1.27
Real-time information processing mitigates on risks	2.23	1.55
Made a firm have capacity to deal with large amount market information	2.24	1.65
Reduces incorrect invoice payment	2.42	1.67
Reduces stock out costs	2.46	1.71
Resource utilization is increased	2.48	1.66
Reduced paperwork	2.48	1.78
Reduces order cycle	2.48	1.75
Real-time information processing has led to reduction of the need to download and upload files on a daily basis	2.54	1.53
Eliminates excess inventory	2.54	1.73
Reduces data and analysis latency	2.54	1.72
Leads to making of timely decisions to lessen or prevent negative performance down stream	2.55	1.73
Increases inventory turn-over	2.56	1.73
Improves overall customer service	2.58	1.70
Improves inventory forecasting	2.64	1.75
Reduces pull-whip effect	2.66	1.69
Tracks and ensures production coordination and avoids delays in the supply chain	2.70	1.68
Maximized return on investment	2.72	1.68
Reduced fulfillment errors, support calls, customer returns backorders, and change orders	2.72	1.74
Inventory carrying costs are reduced	2.76	1.69
Improves distribution and retail channels to more accurately track delivered goods and match supply with demand.	2.77	1.77
Reduces shipping delays	2.86	1.81
Prevented counterfeits into the supply chain	2.90	1.73

The factors in table 3 above were far too many and therefore factor analysis using the principal component analysis and rotational component matrix was used to extract the benefits of real-time information processing technology used in supermarkets in Nairobi and the results are as in table 4 and figure 1.

Table 4: Befits of Real-time Information Processing

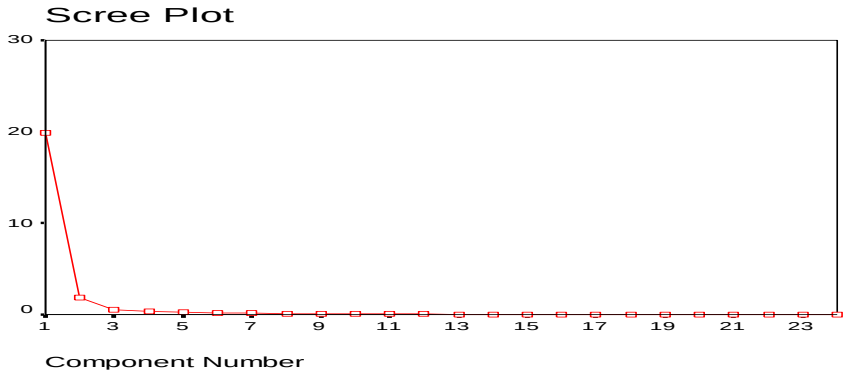
Component	Initial Eigen values			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	19.889	82.872	82.872	19.889	82.872	82.872
2	1.885	7.853	90.725	1.885	7.853	90.725
3	.562	2.342	93.067			
4	.372	1.551	94.618			
5	.256	1.067	95.684			
6	.204	.850	96.535			
7	.161	.670	97.204			
8	.130	.541	97.745			
9	.120	.502	98.247			
10	.102	.426	98.673			
11	.084	.349	99.022			
12	.067	.279	99.301			
13	.044	.181	99.482			
14	.042	.174	99.656			
15	.028	.117	99.773			
16	.023	.094	99.867			
17	.017	.069	99.936			
18	.006	.024	99.961			
19	.005	.021	99.982			
20	.003	.012	99.994			
21	.001	.005	99.998			
22	.000	.001	99.999			
23	.000	.001	100.000			
24	.000	.000	100.000			

Extraction Method: Principal Component Analysis.

Two benefits of real-time information processing were extracted using the principal component analysis method.

The extraction criteria was Eigen values > 1 as can be seen from table 4. Each of the extracted benefits shares a proportion ≥ 7.5 % of its variance with the rest of the other benefits. This shows that the benefits extracted accounted for highly significant variability in the behavior of the major variable which was in this case the benefits of real-time information processing technology in supermarkets in Nairobi, Kenya. Cumulatively, the extracted benefits account for 90.725 % of the variability in the main construct as summarized in table 4

Figure 1: Screen Plot



The screen plot from figure 1 shows that two benefits extracted had highly significant variability in the behavior of the major variable which was in this case the benefits of real-time information processing technology in supermarkets in Nairobi, Kenya. Cumulatively, the extracted benefits account for 90.725 % of the variability in the main construct.

Table 5: Benefits of Real-time Information Processing Rotated Component Matrix

	Component	
Benefits of Real-time Information Processing	1	2
Improves inventory forecasting	**.982**	.026
Eliminates excess inventory	**.978**	.030
Leads to making of timely decisions to lessen or prevent negative performance down stream	**.976**	.046
Reduced fulfillment errors, support calls, customer returns backorders, and change orders	**.975**	-.006
Increases inventory turn-over	**.974**	.039
Improves overall customer service	**.973**	.035
Resource utilization is increased	**.972**	.003
Tracks and ensures production coordination and avoids delays in the supply chain	**.972**	-.022
Maximized return on investment	**.971**	-.052
Reduces order cycle	**.970**	.006
Reduces incorrect invoice payment	**.957**	.021
Reduces pull-whip effect	**.957**	-.033
Reduces data and analysis latency	**.953**	.053
Inventory carrying costs are reduced	**.951**	-.004
Reduces shipping delays	**.948**	-.033
Improves distribution and retail channels to more accurately track delivered goods and match supply with demand.	**.941**	-.078
Prevented counterfeits into the supply chain	**.931**	-.072
Reduced paperwork	**.916**	.083
Reduces stock out costs	**.912**	.084
Real-time information processing has led to reduction of the need to download and upload files on a daily basis	**.845**	-.227
Made a firm have capacity to deal with large amount market information	**.845**	-.328
Real-time information processing mitigates on risks	**.762**	-.540
Reduced rework due to accuracy of data entry	.482	**.814**
Reduces labor costs	.433	**.855**

Benefit No. 1: Improved Inventory Management and Increased Supply Chain Visibility

Improved Inventory Management and Increased Supply Chain Visibility is one of the greatest benefits that supermarkets in Nairobi, Kenya have accrued through the use of real-time information processing technology in their operations (82.872 %). This means that through the use of real-time information technology in their day-to-day business, the supermarkets were able to improve inventory management and SC visibility. The supermarkets were able to achieve this through improved forecasting, elimination of stock-outs, reduction of inventory carrying costs, increased inventory turnover and prevention of counterfeits in the supply chain. This is in tandem with Pisello (2006), who posits that accurate and real-time visibility in the whole supply chain assists to improve inventory forecasting, manage just-in-time workflow and eliminate excess inventory costs and minimizes inventory errors.

The supermarkets managed to improve supply chain visibility leading to prevention of negative interference downstream, reduced fulfillment errors, reduced order cycles, reduced bull-whip effect, and hence matching of demand with supply. The findings were in agreement with research by Symbol Group (2005), which concluded that inability to see information in real-time leads to huge costs along the whole supply chains in form of stock-outs, carrying costs of overstocking, incorrect payments of invoices, slow acknowledgement and reporting of shipment and lost sales which in the affects productivity. The use of real-time information processing, equally led to mitigation of risks, reduced the need to download large amount of data, reduced paper work and reduced delays in the supply chain. This supports the argument by Hensley (2010), that by isolating potential issues as they occur, timely decisions can be made to lessen or prevent negative performance impacts from occurring downstream.

Benefit No.2: Reduction in Labor Costs

Another important benefit gained through the use of real-time information processing in supermarkets in Nairobi, Kenya, was reduction of labor costs (7.853%). This is achieved through reduced rework and reduction in number of employees. The application of real-time processing technologies led to reduced number of human resource to deal with data and reduction in number of stages in processes. This led to an overall reduction in labor costs thus making a company to save on labor costs and at the same time freeing others for other productive activities. The findings are in line with Convery (2003); and Hugh, et al., (2006) who found out that real-time information processing reduces handling labor and cost avoidance and reduces accounts receivable disputes which in turn lead to annual write-down cost avoidance (Pisello,2006; Hugh, et al., 2006).

Supply Chain Optimization

In this section respondents were asked to give some information that could assist in the computation of supply chain optimization of their firms. All the 50 respondents gave information on 5 indicators that were used to measure supply chain optimization in their supermarkets for a period of 5 years. The mean was then calculated by looking for the annual averages. The findings were as in table 6.

Table 6: Supply Chain Optimization Indicators

	ANNUAL AVERAGE					
SC Optimization Indicators	**2008**	**2009**	**2010**	**2011**	**2012**	**Average**
ROSCI per year in million shillings	5.1	5.3	5.9	6.5	6.9	5.9
Inventory Turnover per year	40	42	46	50	54	46
Number Of Customer Complaints per year	1342	1282	1230	1205	1150	1242
No. Of Warranty Claims per year	1077	1001	958	920	862	964
No Of Orders With Complaints per year	726	698	698	723	914	752

There were five indicators that were used to explain SC optimization. They include: inventory turn-over, ROSCI per year, customer and order complaints per year, and warranty claims per year. The relationship between real-time information processing and supply chain optimization were regressed on the above said indicators.

The Relationship between Real-time Information Processing and Supply Chain Optimization

Multiple regression analysis was then used to find out the relationship between real-time information processing and supply chain optimization. The five indicators were therefore regressed.

Real-time Information Processing and Inventory Turnover

Regression analysis was conducted with the independent variables being Global positioning systems (GPS), Barcodes, Mobile phones, Internet, and Radio Frequency Identification (RFID). Inventory turn-over was the dependent variable.

The correlation between inventory turnover and real-time information processing was relatively high. The result indicates that the regression model predicts inventory turnover significantly well $F(5, 4) = 5.94$, $p < 0.005$, $R = 0.636$ $R^2 = 0.405$, R^2 Adjusted= 0.337. The model therefore explains 40.5 % of change in inventory turnover using the five independent variables GPS, Barcodes, Mobile phones, Internet, and RFID.

The analysis further shows that GPS (Beta= -.116, t (9), = -0.557, p=0.580) and Barcodes (Beta= 0.015, t (9) = 0.120, p=0.905) did not significantly predict the value of inventory turnover. However, internet (Beta=. 427, t (9) =3.147, p= 0.003), Mobile-phone (B=.110, t (9) = .852, p=0.009), and RFID (Beta= .436, t (9) =2.353, p= 0.002) significantly predicted the value of inventory turnover.

These findings are consonant with studies by Harrington (2013) and Siau, (2009) that found out that the use of real-time technology improves inventory management. The findings about the internet and mobile phones point to the rise in popularity of the two technologies and is in agreement with Mendelson, (2000) who says that with the advent of E-Business, many firms are using the Internet to integrate with their suppliers, customers and trading partners and Siau, (2009), who argues that mobile-commerce has the potential to improve customer service, create new distribution channels, enhance responsiveness, and facilitate inventory management. The findings about the GPS and barcodes, however, are not in agreement with most studies that show that the two enhance inventory management (TFHA, 2000; and Lyson et al., 2006).

Real-time Information processing and ROSCI

Regression conducted with return on supply chain investment (ROSCI) as the dependent variable and GPS, Barcodes, Mobile phones, Internet and RFID the independent variables found that correlation between ROSCI and real-time information processing was relatively high .The result indicates that the regression model predicts ROSCI significantly well F (5, 4) = 4.459, $p < 0.002$, R = 0.580, R square=0.366, R^2 Adjusted= 0.261.The model explains 33.6 % of change in ROSCI using the five independent variables GPS, Barcodes, Mobile phones, Internet, and RFID. This implies that there is a relatively strong relationship between real-time information processing and ROSCI. Thus, the use real-time information processing increased return on supply chain investment by 33.6%.

The analysis found out that GPS (Beta= .167, t (9), = .760, p=0.452), Barcodes (Beta= 0.005, t (9) = 0.041, p=0.119) and RFID (Beta= .311, t (9) =1.589, p= .119)), did not significantly predict the value of ROSCI. However, internet (Beta=. 408, t (9) =1.379, p= 0.005) and Mobile-phone (Beta=.416, t (9) = 1.582, p=0.002) significantly predicted the value of ROSCI.

The findings are in agreement with many studies that have shown a correlation between real-time information processing and supply chain performance. The studies, for example are in line with Hugh et al., (2006) who says that real time information processing maximizes return on investment.

Real-time Information Processing and Number of Customer Complaints

Regression on the number of customer complaints as the dependent variable and independent variables being GPS, Barcodes, Mobile phones, Internet and RFID was also conducted. From the results the correlation between number of customer complaints per year and real-time information processing was slightly low .The result suggest that the regression model does not predict number of customer complaints significantly well $F (5, 4) = 1.609$, $p < 0.178$, $R = 0.39$ $R^2 = 0.155$, R^2 Adjusted= 0.058. The model explains for 15.5 % of change in Number of Customer Complaints using the five independent variables GPS, Barcodes, Mobile phones, Internet, and RFID. The results are not significant since $p> 0.005$. This implies that there is no significant relationship between real-time information processing and number of customer complaints.

This analysis shows GPS (Beta= .074, t (9), = -.299, p=0.766), Barcodes (Beta= -.155, t (9) = -1.066, p=0.292), internet (Beta=. 081, t (9) =.051, p= 0.619) and Mobile-phone (Beta=.230, t (9) = 1.498, p=0.141) and RFID (Beta= .347, t (9) =1.573, p=0 .123)), did not significantly predict the value of number of customer complaints. Thus real-time information processing does not necessarily lead to decrease in number of customer complaints. This is contrary to the expectations that real-time information processing leads to elimination of supply chain issues in real-time and availing of products at point of demand at the time of demand and gives customers an exciting experience (Pisello, 2006). The fact that real-time information processing has no significant relationship with customer complaints is an indication that there are other factors not studied that could be reducing number of customer complaints

Real-time information Processing and Number of Orders with Complaints

When the number of orders with complaints was regressed as the dependent variable and independent variables being GPS, Barcodes, Mobile phones, internet and RFID results indicated that the regression model does not predict number of orders with complaints significantly well $F (5, 4) = 0.972$, $p > 0.005$, $R = 0.315$ $R^2 = 0.100$, R^2 Adjusted= -.003. The model explains 10 % of change in Number of orders with Complaints using the five independent variables GPS, Barcodes, Mobile phones, Internet, and RFID. This implies that real-time information processing does not necessarily translate to decline in number of customer complaints. This is contrary to assertion that real-time information processing leads to elimination of supply chain issues quickly and avails products at point and time of demand giving customers an exciting experience (Pisello, 2006)

The analysis further shows that GPS (Beta= -.290 , t (9), =1.134 , p=.263), Barcodes (Beta= -.019 , t (9) =.127 , p=.900), internet (Beta=. 107, t (9) =.643, p= .524) and Mobile-phone

(Beta=.201, t (9) = .267, p=.212) and RFID (Beta= .290, t (9) =1.134, p= .263)), did not significantly predict the value of number of customer complaints

Relationship between Real-time and Number of Warranty Claims

With warranty claims as the dependent variable and independent variables being GPS, Barcodes, Mobile phones, Internet, and RFID the results were shows that the correlation between the numbers of warranty claims and real-time information processing was high. The results indicate that the regression model predicts number of orders with complaints significantly well F (5, 4) = 3.908, $p < 0.005$, R = 0.555 $R^2 = 0.308$, R^2 Adjusted= 0.229. The model explains 30.8 % of change in number of warranty claims using the five independent variables GPS, Barcodes, Mobile phones, Internet, and RFID. The results are significant as $p < 0.005$.This implies that there is a relatively strong relationship between real-time information processing and number of warranty claim. Real-time information processing, therefore, leads to a drop in number of warranty claims.

The analysis indicates that GPS (Beta= -.593, t (9), = -2.646, p=0.011), Barcodes (Beta= -.125, t (9) = -.950, p=0.347) and Mobile-phone (Beta=.037, t (9) = .266, p=.792), did not significantly predict the number of warranty claims. However, RFID (Beta= .747, t (9) =3.743, p= .001) and internet (Beta=. 427, t (9) =1.959, p= 0.002) significantly predicted the number of warranty claims. The findings, therefore, show that real-time information processing reduces number of warranty claims. This may be associated with the reduction of errors in service delivery and is consonant with Pisello,(2006) and Hugh, et al., (2006) who found out that real-time processing technologies reduced production-related exceptions such as reworks order and fulfillment errors, support calls, customer returns, backorders, change orders, production stops, production expediting and changeovers, transportation errors and recalls, reduced incidents and handling costs in annual error handling labor and cost avoidance and reduces accounts receivable disputes which in turn lead to annual write-down cost avoidance.

CONCLUSIONS

The study found out that all the supermarkets in Nairobi, Kenya use real-time information processing technology with most of them having used the technology for a period of over four years. The most commonly used forms of real-time information processing technology emerged out as the use of mobile phones that are used to a very great extent. This is attributed to the flexibility of the mobile phones. The use of barcodes came second as their use was rated as to a great extent. This could be attributed to the fact that bar codes are used very much at the

point of sale. This is followed by the internet that is used to moderate extent. The GPS and RFIDs are used only to a small extent.

The results indicate that two major benefits are accrued from the use of real-time information processing by supermarkets in Nairobi, Kenya. The greatest benefit of real-time information processing was found to be Improved Inventory Management and Increased Supply Chain visibility. The second benefit was found to be reduction in operational labor costs. The supermarkets managed to improve inventory management and supply chain visibility through: prevention of negative interference downstream reduced fulfillment errors, reduced order cycles, reduced bull-whip effect, improved and reduced shipping delays, better tracking of goods in transit and hence matching of demand with supply. Labor costs were found to be reduced by the supermarkets through: reduced rework and reduction in number of employees.

The overall results also showed varied findings concerning the relationship between real-time information processing and the different supply chain optimization indicators. The study found out that there is a significant relationship between real-time information processing and inventory turnover and ROSCI and number of warranty claims. The results indicate that real-time information processing increases both inventory turnover and return on supply chain investment (ROSCI) while reducing number of warranty claims.

The study however found no significant relationship between teal-time information processing technologies and two supply chain optimization indicators including: number of orders with complaints, and number of customer complaints. This indicates that the said factors are more influenced by other factors not studied than real-time information processing.

Following the study findings it is possible to conclude that all supermarkets in Nairobi, Kenya use real-time information processing technologies to conduct their operations. This is true from the number of respondents who said they use real-time information processing technology. The study also concludes that more than half of the supermarkets in Nairobi use barcodes and mobile phones. This may be associated with the lower costs of these gadgets and the flexibility of use of mobile phones with relation to other technologies. It is also apt to conclude that in as much as real-time information processing may impact positively on supply chain optimization, other factors do affect optimization. This is true from the fact that a number of supply chain optimization indicators analyzed did not show significant relationship. Another conclusion is that GPS is not a significant independent variable in real-time information processing given that in almost all regressions analyzed it was not significant from the t-test of real-time information processing. It will also be concluded that the supermarkets in Nairobi, Kenya use real-time information processing majorly on inventory management and supply chain

visibility solutions. This is given that the factor analysis found that this accounted for over 80% of all the components analyzed.

RECOMMENDATIONS AND SUGGESTIONS FOR FURTHER RESEARCH

The supermarkets in Nairobi, Kenya should consider training their staff on use of the real-time information processing to be able to reap maximum benefits of real-time information processing. This is due to the fact that most supply chain indicators did not show significant relationship with real-time information processing technology. The study also recommends the increase in the use of mobile phones, RFID and internet since they had significant relationship with inventory turnover, ROSCI and number of warranty claims.

The study indicates that GPS is not a significant independent variable in real-time information processing among the supermarkets in Nairobi, Kenya. It will be important to conduct a study to find out why? Study should also be conducted in other sectors to see whether the same trend holds water. Other studies should also be conducted to find out the relationship between training of employees on the use of real-time information processing technology and supply chain optimization. This will bring out the relationship between technological training and supply chain optimization.

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