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Information Flow Management and the Effectiveness of the Supply Chain of Essential Medicines in the Public Sector. Evidence from Selected Public Hospitals in Uganda: A Downward Perspective

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Abstract: ***This study assessed the relationship between the Information flow management in the public hospitals and the effectiveness of the downward supply chain of essential medicines in the selected 6 public hospitals in Uganda. A cross sectional descriptive and analytical survey was done with both qualitative and quantitative data collected. Two hospitals were regional referral and the four were general hospitals. The major findings of the study were that; sharing planning information, distribution schedules, knowledge of each other stock levels and new demand were statistically significant in influencing the downward supply chain effectiveness. Improved sharing of information that is accurate, timely and complete, development of computerized medicines management systems in the hospitals, Collaborative procurement planning at all levels, Improvement in records and record keeping and enhancement of online communication between the hospitals and the suppliers was significantly influencing the effectiveness of the supply chain***

Keywords: Inventory, supply chain, Information flow, medicines, effectiveness

1. Introduction

Agarwal and Shankar (2002) described a supply chain as an interlinked set of relationships which connects customer to supplier. It involves a series of intermediate stages such as manufacturing, warehousing and distribution. Supply chain management (SCM) involves the management of product, information and financial flow from the source of supplies to the manufacture and assembly of the product right to the delivering of the final product to the consumer. It also includes the management of after sales service and the product returns (Lee, 2000). The objectives of SCM are to increase productivity, reduce inventory and cycle time but its ultimate goal is to increase customer satisfaction, market share, and profits for the entire supply chain in the long run (Wisner and Tan, 2005).

The information dimension encompasses the communication and decision making infrastructure which overlays and is interwoven with the physical dimension. With few exceptions (Jones, 1997), a literature search regarding the specific role of information within the Lean paradigm derives a low yield. However the pivotal role of information was identified during numerous Lean Enterprise Research Centre (LERC) research projects (James *et al*, 1996).

Information flow is an integral aspect of supply chain management (Lambert *et al.,* 1998). The importance of information flow in supply chain was demonstrated by Singh (1996) who proposed that information must be managed at three different stages, before, during and after sales have been made.

Information sharing is essential as it provides the mechanism for coordination and integration of the processes or activities along the supply chain (Lee, 2000; Ramayah and Omar, 2010). Singh (1996) observed that in order to ensure that customer requirements in the supply chain can be fulfilled, it is fundamental to manage the information flow associated with the movement of products (goods or services) to the final customer. Effective flow of product and services is dependent on information sharing among supply chain members (Lee *et al.,* 1997). Firms would be able to respond effectively to changing market demand requirement through information sharing (Mason-Jones and Towill, 1997).

According to (Bowersox *et al.,* 2000; Gustin *et al.,* 1995), information sharing among supply chain partners enables firms to achieve common goals besides enabling the coordination of the supply chain processes (Lee, 2000; Barratt, 2004; Lambert 2004). The level of information sharing across the supply chain can be influenced by the supply network configuration and goal congruence of the supply chain partners (Samaddar *et al.,* 2006).

Information sharing is also particularly important within the internal supply chain. If firms cannot share information internally, it would be difficult to share information externally with their partners (Rupple, 2004). Information can have dual functions; it benefits the supply chain entities and it can contribute to the improvement in organizational performance and competitive advantage (Lee *et al.,* 2006). To optimize supply chain performance, information about forecast, sales, promotional activities must be shared not only among the internal functions but also across the supply chain (Bowersox *et al*., 2000).

The quality and quantity of information are important attributes which need to be stressed in information sharing. Monczka *et al.,* (1998) defines information sharing as the

level of information that is being communicated to the supply chain members or partners which is critical and proprietary in nature.

Effective Information sharing also relates to activities of distributing useful information among people, systems or organizational unit in an open environment. Information sharing should address the following issues; ‗what to share', ‗whom to share', ‗how to share', and ‗when to share' of which if properly addressed would minimize sharing cost, information deficiency or overload and improve supply chain responsiveness, this according to (Sun and Yen, 2005).

The ability of firms to gain competitive advantage and to ensure product availability in supply chain is determined by how information is used in the supply chain (Mason-Jones and Towill, 1997)

Information has little value if it is not shared among the supply chain partners. Trust among the supply chain partners seems to have influence on the information flow in supply chain. However, due to lack of trust, certain information may be withheld from supply chain partners. Relationship among supply chain members, which is based on trust and commitment, would facilitate information sharing among supply chain partners (Moberg et al., (2002). In support of this, Kwon and Suh (2004) noted that information sharing reduces the level of behavioral uncertainty, which lead to improvement in the level of trust.

High level of information sharing and information quality is influenced by successful partner relationship (Monczka et al., 1998; Mason-Jones and Towill, 1997). However, the confidentiality of the information or privacy may influence the level of information sharing in the supply chain (Li et al., 2006). Consequently supply chain partners need to decide on the types of information that need to be shared. Supply chain partners should be aware of the information which is deemed relevant that must be shared with the supply chain partners for the successful functioning of the supply chain.

Oluka *et al,* (2010) observed that despite Uganda's commitment to improve drug access and availability, actual realization remains low and structural bottlenecks in the have not been identified and documented. Structural bottlenecks at each stage of the supply have not been systematically identified and documented as a starting point. The findings from the cross sectional survey conducted on 240 respondents in four malaria prone districts indicated that hospitals were mainly affected by lack of credible and accessible drug consumption information, poor planning, forecasting and logistics. Health Centre IVs mainly faced inadequate procurement skills and consumption information. Health Centre IIIs encountered poor procurement practices and logistics

2. Methodology

The study adopted a descriptive and analytical cross sectional survey, with mixed research methods approach, (Onwuegbuzie & Johnson, (2006); Greene (2006); Greene, Caracelli, and Graham (1989); Gray (2004). Principal Component Analysis was carried out on the indicators using both Factoring out principle component and Varimax Rotation the survey assessed in detail the information flow management as a key component of the medical store management in relation to the effectiveness of the supply chain of medicines in the selected hospitals. Both quantitative and qualitative data collection methods were used. Standardized checklists, interviewer guide and questioners were used to collect data. A total of 6 purposively selected hospitals were studied with all (30) pharmacy, medical stores and hospital heads as purposively as respondents.

3. Results

Demographic characteristics of the respondents

The study was conducted in six hospitals; these were Abim, Atutur, Kawolo and Bwera General Hospitals and Fort Portal, Soroti Regional Referral hospitals. Of the 38 purposively selected respondents only four persons did not respond to the study giving a response rate of 92.1%. However, of the 35 who responded only 30 provided both qualitative and quantitative information and the other 4 provided only qualitative information. Of the 30 who responded 11 (36.7%) were from the Regional Referral Hospitals and the 19 (63.3%) were from the General Hospitals and the highest number of persons who were handling medicines were under others 10 (33.3%) under these are the volunteers, nurses and non-qualified persons. This observation raises concerns to whether these persons are competent enough to handle medical stores as they are not qualified and lack basic knowledge in handling medical stores. On the aspect of experience, the highest percentage of 46.6% had worked in their current jobs for more than 11 years .However; majority 57.1% had not gotten any related training in the last 6 months

Level of information sharing

Generally 40% of the respondents were in the disagreement about the sharing of business unit's proprietary information, whereas another 40% generally agreed. However, 20 % of the respondents did not know as to whether this information was being shared or not and yet they are actually members of the downward supply chain. Similarly as to whether the supplier informs the hospitals in advance of the changes in supplies related issues, 53.3% of the respondents agreed, 36.7% disagreed and only 10% did not know. This lack of sharing information in advance as regards creates a gap in planning for any probable delays that may occur in the supply chain. Some hospitals may not be able to put in place contingency measures in place to bridge the gaps that the changes in supply may incur.

As regard as to whether hospitals and their suppliers share information which might be useful for each other to establish supplies, 66.6% of the respondents agreed, 30% were in disagreement and only 3.4% did not know. As to whether the supplier provides advance notices to the hospitals 53.3% agreed and 46.7% disagreed. Overall the apart from sharing of the distribution schedules which most respondents agree, there a balance of views on the level of information sharing that could be contributing to the ineffectiveness of the supply chain. There is need therefore to enhance this sharing of

information that is vital for ensuring the availability of essential medicines and health supplies.

Table 1: Level of Information sharing between hospitals and NMS

Variable	Indicator/ response	Frequency(f)	Percentage (%)
We and our supplier share business units proprietary information	1. Strongly Disagree	3	10.0
	2. Disagree	9	30.0
	3. I don't know	6	20.0
	4. Agree	6	20.0
	5. Strongly agree	6	20.0
	Total	**30**	**100**
Our supplier informs us in advance of the changes in supplies related issues	1. Strongly Disagree	3	10.0
	2. Disagree	8	26.7
	3. I don't know	3	10.0
	4. Agree	10	33.3
	5. Strongly agree	6	20.0
	Total	**30**	**100**
We and our suppliers share information which might be useful for each other to establish supplies	1. Strongly Disagree	1	3.3
	2. Disagree	8	26.7
	3. I don't know	1	3.3
	4. Agree	10	33.3
	5. Strongly agree	10	33.3
	Total	**30**	**100**
We exchange core supply processes and knowledge with our supplier	1. Strongly Disagree	3	10.0
	2. Disagree	7	23.3
	3. I don't know	6	20.0
	4. Agree	11	36.7
	5. Strongly agree	3	10.0
	Total	**30**	**100**
We and our supplier share information even without specified agreement	1. Strongly Disagree	5	16.7
	2. Disagree	10	33.3
	3. I don't know	1	3.3
	4. Agree	11	36.7
	5. Strongly agree	3	10.0
	Total	**30**	**100**
Our supplier provides advanced notices to us about our supplies	1. Strongly Disagree	8	26.7
	2. Disagree	6	20.0
	3. Agree	9	30.0
	4. Strongly agree	7	23.3
	Total	**30**	**100**
Our supplies share distribution schedule with us	1. Disagree	5	16.7
	2. Agree	14	46.7
	3. Strongly agree	11	36.7
	Total	**30**	**100**

Source: Primary data

Hypothesis test results

The ***chi square test*** was used at 5% level of significance, to test whether the variables of interest for each set of hypothesis had a significant relationship with the outcome variable or not. Further tests were also done to determine the extent to which the significant variables were responsible for the variations in the outcome variable. This was done for each variable at a time, in the absence of a confounding factor.

The outcome variable that was taken to be the best presenter of any confounding factors among the group of variables that moved out to measure effectiveness of supply chain was variable *"no out of stock of essential medicines in the hospitals"*

The hypothesis tested was to determine whether there is ***"no significant relationship between the information flow management systems and the effectiveness of the supply chain of the essential medicines".***
No out of stock of essential medicines in hospitals" was taken as the best measure of the supply chain effectiveness.

Table 2: Information on changes in supply and ~~no~~ out of stock of essential medicines

Variable	Indicator	*"No out of stock of essential medicines in the hospitals"*					
		**Satisfactory	**Unsatisfactory	Total	O.R	χ^2	P-***value***
Our suppliers informs us in advance of the changes in supply related issues	Agree**	9	9	18	6.0	15.30	0.005
	Disagree**	2	10	12			
	Total	11	19	30			

R^2=0.521

When variable, —our supplier informs us in advance of their changes in supply related issues", was found to be significantly associated with variable *"no out of stock of essential medicines in the hospitals"*. This is because χ^2=15.296 was greater than the test value of 3.864 and the p-value of 0.005 being less than 0.05.

The odds ratio of 6 implies that hospitals that are informed of the changes in supply related issues are six times more likely to have medicines in stock than those that are not informed by the suppliers. This could be, as result of the information, contingency measures can be put in place to cater for the gaps that may be created by the change, and those hospital with no such notifications are usually taken unaware. Considering the coefficient of determination in a model fitted for this variable, one can conclude that if this variable is left to vary the outcome variable *"no out of stock of essential medicines in the hospitals"* alone, we can say confidently say that 52.1**%** of the variations that will be observed in the outcome variable, will be as a result of its dependency on suppliers informing hospitals in advance of their changes in supply related issues (Table 2)

Ntayi *et al.*, (2008) observed that collaborative linkages consists of three dimensions, namely information sharing, decision harmonization and better coordination, all resulting in order fulfillment and assurance that deliveries are made on time facilitated by information technology facilities. And according to (Lee *et al.* 1997; Whipple *et al.* 2002), Information sharing enables chain members to create better performance in terms of reduced stock outs. The more firms share information, the more efficient the supply chain (Ramdas and Spekman, 2000). Ntayi (2008) argues that collaborative planning of activities reduces the gap between delivery requirements and actual delivery, thereby improving customers' perceptions of fulfillment performance. The findings above are therefore in line with the earlier observations made by different scholars. So it is therefore important that business organizations in this case the hospitals and NMS enhance their level of information sharing in order for the supply chain to as effective as possible.

However, Eisen Alexander *et al.,* (2005) noted that many times because of the nature of supply chain dynamics, managers often do not have insight into the ripple effects of their decisions. Effects also can easily get lost in the overwhelming flood of data that crosses the supply chain managers' desk daily, weekly, or monthly. A rapidly changing supply chain with a continuous change of partners leads to different sets of decisions than a stable chain with long-term contracts
But overall they agree that sharing information in the supply chain enhances its effectiveness

Table 3: Sharing supply planning information and —o out of stock of essential medicines

Variable	Indicator	*"No out of stock of essential medicines in the hospitals"*					
		**Satisfactory	**Unsatisfactory	Total	O.R	χ^2	P-***value***
We and our supplier share information which might be useful for each other to carry out supplies planning	Agree**	6	14	20	1.7	14.79	0.007
	Disagree**	2	8	10			
	Total	**8**	**22**	**30**			

R^2=0.61

Sharing of information for supplies planning between the hospitals and the suppliers was found to a significant factor in influencing the variable *"no out of stock of essential medicines in the hospitals"* since the χ^2=14.79> 3.864 and p-value of 0.007< 0.05.

Considering the coefficient of determination, one can also conclude that if this variable was left to vary *"no out of stock of essential medicines in the hospitals"*, 61% of the variation in the outcome variable *"no out of stock of essential medicines in the hospitals"*, if left alone will be due to its dependency on sharing information for supplies planning between the hospitals and the suppliers. A hospital which was sharing information for supplies planning with the suppliers was 1.7 times more likely to have medicines as compared to those hospitals that were not sharing such information with their suppliers. This also means that hospitals that were not sharing information with suppliers that was useful to carry out supply planning were more likely to encounter out of stock of essential medicines (Table 3).

For proper planning to be done accurate, complete, relevant and timely information is required. The findings of this study are in line with the observations that were made by (Samaddar *et al.,* (2006); Lambert (2004) who highlighted the role of information in ensuring an effective supply chain. It therefore important that parties in the supply chain share relevant information, as this will enhance the effectiveness of the supply chain.

Table 4: Sharing of distribution schedules and no out of stock of essential medicines

Variable	Indicator	*"No out of stock of essential medicines in the hospitals"*					
		**Satisfactory	**Unsatisfactory	Total	O.R	χ^2	P-***value***
Our supplier shares distribution schedules with us	Agree**	16	10	26	1.6	23.329	0.003
	Disagree**	2	2	4			
	Total	**18**	**12**	**30**			

R^2=0.972

Variable, —haring distribution schedules with hospitals, was found to be significantly associated with variable *"no out of stock of essential medicines in the hospitals"* as its χ^2-value =23.329 > 3.864 and p-value =0.003 < 0.05.

Considering the coefficient of determination of 0.972 (97.2%) one can say that if variable —sharing distribution schedules is left to vary variable *"no out of stock of essential medicines in the hospitals"* alone, then we can say that

97.2% of the total variation that will be observed in the variable *"no out of stock of essential medicines in the hospitals"*, will be as a result of its dependency on sharing of distribution schedules between the hospitals and the suppliers. Hospitals that were sharing distribution schedules with suppliers were 1.6 times more likely to have their essential medicines in stock all the time as compared to those hospitals that were not sharing such distribution schedules with suppliers (Table 4)

Distribution schedules are innovations from the supplier to ensure a cost effective delivery of essential medicines and health supplies. It is structure in a way that health facilities in on direction or region are grouped together and put under one route.

Table 5: Knowledge of inventory levels and ~~–n~~o out of stock of essential medicines

Variable	Indicator	*"No out of stock of essential medicines in the hospitals"*					
		**Satisfactory	**Unsatisfactory	Total	O.R	χ^2	P-*value*
We and our supplier know each other inventory level quiet well	Agree**	6	6	12	3.5	22.368	0.034
	Disagree**	4	14	18			
	Total	10	20	30			

R^2=0.709

Variable ~~–s~~upplier knowing each other's inventory levels quiet well" was found to be a significant factor in explaining variable *"no out of stock of essential medicines in the hospitals"*, since its chi square value is 22.368 which is greater than the test value of 3.864 and the p-value =0.034< 0.05

Looking at the coefficient of determination, on can be 95% confident that, in the absence of all the rest of the variables in the model, 70.9% of the variation observed in the variable out of stock of essential medicine will be as a result of its dependency on suppliers knowing each other's inventory levels quiet well. Health facilities that were in the know of the supplier's inventory level quiet well as well as the supplier knowing their inventory levels were 3.5 times more likely to have their essential medicines in stock all the time (Table 5).

Table Error! No text of specified style in document.**:** Exchange of pricing strategies and no out of stock of essential medicines

Variable	Indicator	*"No out of stock of essential medicines in the hospitals"*					
		**Satisfactory	**Unsatisfactory	Total	O.R	χ^2	P-*value*
We exchange pricing strategies with our suppliers	Agree**	2	4	6	0.1	15.916	.019
	Disagree**	20	4	24			
	Total	**22**	**8**	**30**			

R^2=0.542

As shown in table 6 exchanging pricing strategies between health facilities and suppliers, was found to be significantly associated with variable *"no out of stock of essential medicines in the hospitals"* since the chi-square value of 15.916 is greater than the test value of 3.864 and same conclusion was arrived at by considering the p-value of 0.019 which is less than 0.05.

In addition the coefficient of determination shows that, if we are to let this variable ~~—e~~xchanging pricing strategies between health facility and supplier" alone to vary the outcome variable, then we can be 95% confident that 54.2% of the total variations in the *"no out of stock of essential medicines in the hospitals"*, will be due to its dependency on variable ~~–e~~xchanging pricing strategies between hospitals and suppliers. In terms of the odds ratio, hospitals that were exchanging such pricing strategies with the supplier were 0.09 times less likely to encounter out of stock of essential medicines.

Table 7 Supplier knowledge of demand and ~~–n~~o out of stock of essential medicines

Variable	Indicator	*"No out of stock of essential medicines in the hospitals"*					
		**Satisfactory	**Unsatisfactory	Total	O.R	χ^2	P-*value*
Our supplier knows our demands very well	Agree**	2	6	8	3.3	19.024	0.0024
	Disagree**	2	20	22			
	Total	4	26	30			

In the table 7, variable, supplier knowing the new demands of the hospital very well, was proved to be significant in explaining the outcome variable *"no out of stock of essential medicines in the hospitals"*. This is shown by the chi-square value of 19.024 which is greater than the test value of 3.864 and p-value of 0.0024 which is less than 0.05. And the hospitals, whose suppliers knew their new demands, very well, were 3.3 times more likely to have their essential medicines stocks in stock.

Multivariate Analysis

In order to assess the relationship between the medical stores management practices which was the independent variable and the effectiveness of the supply chain of essential medicines which was the dependent variable, all the factors of the three constructs that were significant at bi-variate level were subjected to a multivariate analysis using **logistic regression model**. A Back Ward Stepwise Logistic

Regression was used to control for all probable confounding variables in the test.

Table 8: Information Flow Management and the Effectiveness of the supply chain

Variable	Indicator	Adjusted OR	95% CI Adjusted OR	P-*value*
Supplier and the health facilities sharing information which might be of use for each other to establish supplies planning,	Agree* Disagree*	5.2	3.20 – 8.63	0.0005**
Suppliers knowing the hospital new demands	Agree* Disagree*	1.5	1.29 – 2.54	0.005**
Our supplier /customers sharing distribution schedules	Agree* Disagree*	1.4	1.02- 1.93	0.002**
We and our supplier know each other inventory level quite well	Agree* Disagree*	3.8	2.10 – 6.34	0.004**
Exchange of pricing strategies,	Agree* Disagree*	0.7	-0.20- 0.30	0.002**
Our supplier know our demands very well	Agree* Disagree*	3.2	2.31 – 6.90	0.000**

Overall impression/ conclusion

From the above tests, one can conclude that there is a significant relationship between the information flow management systems and the effectiveness of the supply chain of the essential medicines as all the aspects tested have showed that. Therefore hospitals should ensure that the information sharing with the supplier is enhanced as this has been proven to influence the effectiveness of the supply chain.

4. Recommendations

- Improved sharing of information that is accurate, timely and complete
- Development of computerized medicines management systems in the hospitals
- Collaborative procurement planning at all levels
- Improvement in records and record keeping.
- Enhancement of online communication between the hospitals and the suppliers

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