Implementation of Vendor Managed Inventory (VMI) in Managing Inventory of Intra Ocular Lenses (IOL) in an Eye Care Organization

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Abstract

The Indian healthcare industry is a fast growing industry and needs attention for reengineering of many processes. The supply chain process is one of the important processes. But it lacks the attention of stakeholders due to which lack of efficiency of the process leads to direct or indirect impact on the businesses. Vendor managed inventory (VMI) is such a programe or tool that is still less used in the healthcare industry. VMI can help in increasing the efficiency of the supply chain process by delegating the responsibility of inventory management to the suppliers. The purpose of this paper was to measure the effectiveness of VMI over traditional inventory management system of IOLs (lenses that are used in surgeries of eye hospitals). A matrix was also designed to understand the key performance indicators of supply chain to assess the results of implementation of VMI in place of traditional managed inventory. True experimental design of quantitative research with pretest posttest was used to measure before and after impact of VMI on management of inventory of IOLs. A sample size of 14 types of lenses was taken to assess the impact of the VMI technique. Literature review of the traditional inventory management system and VMI was done and data was obtained from an eye care organization of inventory of IOLs to test the hypothesis to measure the effectiveness of VMI over traditional method of inventory management. The results concluded the success of VMI over traditional inventory management based on the performance indicators (OFR/TAT) of the supply chain.

Key words : **vendor managed inventory (VMI), traditional inventory management (TIM), supply chain performance indicators, effectiveness, turnaround time, order filling rate (OFR), accuracy, intra ocular lenses (IOL)**

JEL Classification : C44, E22, E2, I1

Paper Submission Date : May 1, 2016 ; Paper sent back for Revision : July 20, 2016 ; Paper Acceptance Date : October 15, 2016

The healthcare industry in India is in a developing stage and it will evolve gradually. Hospitals play an important role to serve the society with most advanced and equipped healthcare techniques and services. With an increase in the income of the customers, the expenditure power has also increased. When it comes to a supply chain process, it is less evolved in the healthcare industry of India and is treated only as a store function. VMI is not a new concept, but it can be utilized in hospitals as a competitive strength. VMI is a replenishment program in which the supplier has the right to control the level of customer's inventory on the basis of demand orders and forecasts from the customer.

The VMI function is an integrated approach to reduce the complexity of the supply chain process by delegating the responsibility of supplies to the supplier through real time data access and in turn increases the optimization in expenditure (Jayakumar, Jose, & Sijo, 2013). When we discuss about inventory management, then it is affected by several factors. VMI is a tool that can help in managing the inventory and in turn also enhances the efficiency of

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the supply chain function by reducing the stock outs and increases the availability of the material. Rossetti (2008) discussed in his paper that through better inventory management, a hospital can reduce 2% of the overall total expenditure including expenses on supplies. Inventory can serve to fulfill the requirement when it is well managed and there is no position of stock out and over stocking.

Factors that Affect an Inventory are

(i) Lead Time : Lead time is the total time required to perform all the operations processes. In context of a healthcare setup, it starts with the generation of requirement till supply of a product or service to the end user (Treville, Shapiro, & Hameri , 2004).

(ii) Cost of Inventory Holding : It is the cost that broadly contains all the cost of inventory handling, storage facilities, obsolescence, breakage, insurance, pilferage, depreciation, taxes, and cost of capital (Whitin, 1953). This is one of the major factors of concern for an organization.

(iii) Reorder Point : This is the point at which the order of any material is placed to replenish the current stock (Whitin, 1953). Mismanagement of the reorder point can lead to position of stock outs which can further create loss in business due to unavailability of material.

(iv) Material Planning : Material planning is the overall planning of the material to procure/produce, quantity of the material, storing technique, and management of material (Gharakhani , 2011).

(v) Obsolete Inventory and Stock : The inventory that are lying unused or that perhaps is slow moving but consists of a huge cost is obsolete inventory (Grondys, Kott, & Strzelczyk, 2014). This is considered as dead stock of the inventory and increases the burden of cost as well as mismanagement burden on the organization.

(vi) Quantity Discount : The benefits in the cost due to quantity of the material that involves the lot size is termed as quantity discount (Monahan, 1984). Quantity discount not only helps in reducing the cost, but also helps in preventing frequent ordering of fast moving items.

(vii) Variety Reduction : Variety reduction helps in reducing the inventory by reducing the variety of the same items in the warehouse/store (Haleem & Gopalkrishnan, 2015).

(viii) Financial Position of Firms : In inventory management, this point is hidden, but its impact on it is equivalent as of the above points. The financial position of a firm states the inventory holding position of the firm and also has an impact on the external lead time.

Rossetti (2008) talked about the main goal of inventory management in his paper, which is to maintain the quality and standard of the service and at the same time, improving the efficiency of the system.

This study is based on the implementation of VMI in the management of inventory for the IOLs, and matrix designed has supported the understanding of the key performance indicators of a supply chain to assess the results of replacement of traditional managed inventory with VMI.

Literature Review

(1) Eye Care and IOLs : The eye is the most important and sophisticated sense organ that we rely on to help us to see the world. Because they are so vital, hence they are well protected. Each eyeball is protected by a bony orbit to

prevent trauma to the eye from larger objects (Lens, Nemeth, & Ledford, 2008). The eye care industry in India is becoming more quality service oriented to patients with increase in the expenditure power of the patients. Still, there is a scope of significant growth in the industry which can help in generating the revenue to increase the market size of the industry.

A research survey of ICMR (Indian Council of Medical Research) for ophthalmic research stated that total load of blindness in the world is 23 million and 9 million in India comprising of three major disorders, namely cataract, glaucoma, and trachoma. Cataract was found to be the cause of blindness in more than 70% of the cases followed by corneal blindness and optic nerve disease, each of which causes one - seventh of all blind eyes and other sites (retina, macula, unknown) account for 15% of the causes.

Lenses are one of the important parts of the eye which are used to transfer light from the cornea to retina for visualization of images. It helps in contracting the size of the object and enables to accommodate itself according to the distance of the object (Lens, Nemeth, & Ledford, 2008).

In eye care hospitals, management of IOLs inventory is an important part and needs to be looked into very carefully. IOLs are implantable lenses that are used to replace the natural lenses of the eyes when they are damaged naturally or accidentally. Scientists originally designed IOLs to treat cataracts so that patients can enjoy vision without glasses or contacts (Schwiegerling, 2006). The global market of IOLs is expanding with the ageing of a more affluent middle class population. The global market of IOLs is expected to reach $3.8 billion by 2019 as mentioned in a report on optical research.

(2) Traditional Inventory Management of IOLs : The Indian healthcare supply chain is less advanced than it is in other parts of the world. Supply chain of Indian eye care is more manpower dependent. Inventory management of IOLs in eye care is based on the "Library system," a system that is more or less similar to that of VMI. The difference in the two is that in the Library system, a vendor is responsible to replenish the inventory stock of the library of IOLs, but real time data of the consumption is not accessible to the vendor, and the vendor needs to be dependent on the information provided by the customer (hospital's purchase or store department) ; whereas, in VMI, real time access to the data is provided to the supplier to fulfill the requirements. Periasamy (2009) discussed that traditional inventory management is all about maintaining the safety stock to provide protection against uncertainty in demand and can also be referred to as "just in case" system. This library system can also be said to be "partial VMI" as management of inventory by supplier is present, but access to real time data of the customer, that is, information sharing is not there in the system.

In the library system, the common power of lenses (the power of lenses that are used frequently in surgeries) are kept in inventory in the warehouse and as soon as the lenses of common power are consumed, the purchase department needs to place the order on time to replenish the library of the lenses. The Figure 1 depicts the process of traditional inventory management, which is a lengthy process and can lead to various issues in the supply chain process of IOLs.

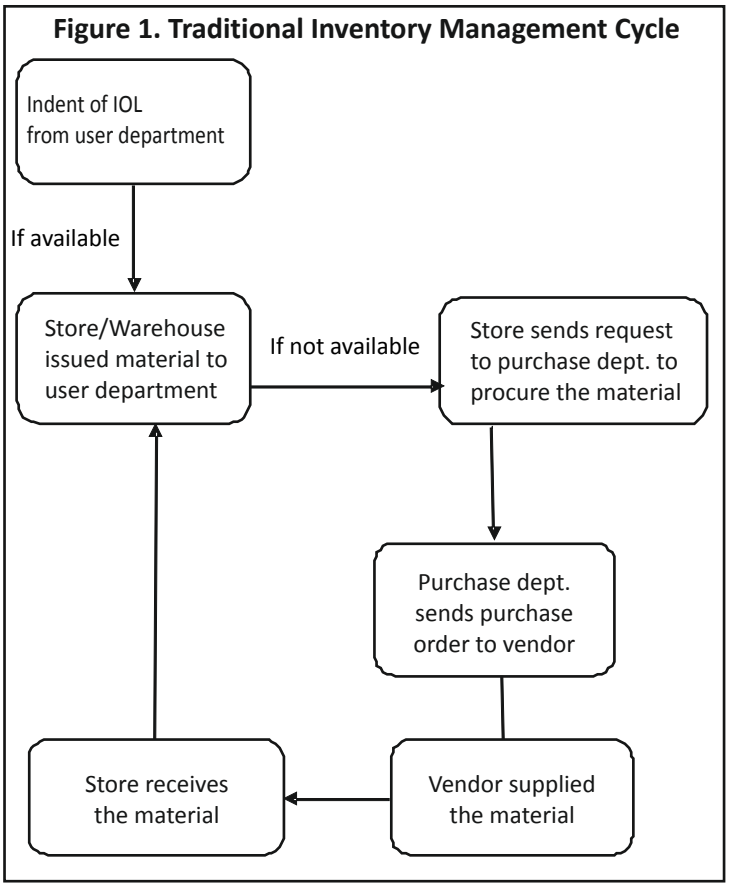
Hoya (a multinational lens manufacturing organization) has adopted advanced supply chain management system for the supply of lenses. With the help of the RFID (radio frequency identification device) system, a barcode attached to a product is scanned and recorded in the system which can help in keeping an eye on the inventory of the lenses. As soon as the inventory is consumed, the system will automatically create an order as per the reorder level and send the information to the vendor to replenish the inventory of the warehouse so that there will not be any shortage of lenses, and the same can be timely supplied to a customer.

As per ICMR (Indian Council of Medical Research), on an average, in India, approximately 3-4% of eye surgeries are cancelled due to:

(i) Delay in transport of lenses,

(ii) Breakage of the lenses at the time of surgery,

Figure 1. Traditional Inventory Management Cycle



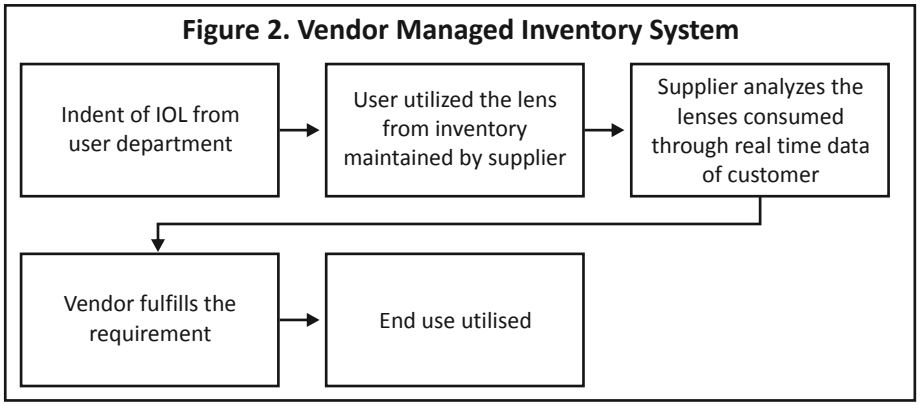
(iii) Delay in ordering of the lenses that leads to unavailability of the same,

(iv) Financial challenges (delay in payments, invoice submission, etc.).

(3) Vendor Managed Inventory (VMI) : There are different definitions and elaboration of VMI in different books and articles, but in the healthcare industry, specifically in the hospital sector, the definition of the same would become slightly different. As in a hospital's setup, one needs to deal with patient care, and hence, the availability of the stock and quality of the material is necessary.

The availability of the right product at the right place at the right time is a must and a supplier must respond spontaneously to a hospital's request (Turhan, 2012). VMI stresses upon the responsibility of the vendor of inventory management (Zachariassen, Henning, & Burklan, 2014). Raveendran and Faisal (2015) discussed that the traditional system of managing an inventory has given way to more advanced systems like just in time (JIT) ; postponement or delayed configuration ; flexible manufacturing system (FMS) ; quick response logistics (QRL) ; 3PL 4PL (third party & fourth party) logistics ; collaborative planning, forecasting, and replenishment (CPRF) ; and vendor managed inventory (VMI). The Figure 2 is a diagrammatic representation of the vendor managed inventory system that is much simpler and faster that the traditional system of inventory management.

The concept of VMI was adopted by the retail and manufacturing sector in the early 1990's, but since then, the concept has not been widely accepted in India and has been sparsely accepted by the Indian healthcare industry, and the scenario of acceptance in the Indian hospital sector is almost nil. The reasons for failure of VMI adoption include confidentiality of information sharing, risk of control of cost by the customer, and increased supplier's administrative costs.



Need for the Research

From the literature review section, it is clear that the concept of VMI is not new and has been successfully adopted in various industries, for example, Walmart (retail industry), GSK Pharmaceuticals (pharmaceuticals industry), Tata Motors (manufacturing industry), and many others, but it is also clear that this concept has not been adopted yet by the hospital industry in India due to its own specific nature and complications. So, this study will help in filling the gap and stresses upon the need of an advanced concept for inventory management - VMI in eye care hospitals in India. The hospital industry has its own unique nature, and the management of inventories also needs to be looked into critically because patient care and quality of service is essential in the industry. This research will help in identifying the supplier's and management's perspective regarding the implementation of the said concept.

Research Method

The study is based on true experimental design of quantitative research and a sample of 14 types of lenses was taken to measure before and after effect of VMI implementation on inventory management of IOLs. Data, with due permission, was obtained from an eye care hospital in which the OFR (order filling rate) and TAT (turnaround time) data was provided for the IOLs for two different periods, that is, from July-September 2015 and October-December 2015, one without implementation of VMI and then with VMI implementation. Research tool used is pretest posttest to conduct a comparative analysis of before and after effect of VMI implementation. The statistical tool used is dependent/paired *t*- test, which helps in testing the null hypothesis. Also, the use of IOLs in eye care and the importance of its inventory management is discussed.

Data Analysis

In this paper, the performance and success rate of VMI of IOLs is measured through dependent *t*-test by testing the hypothesis that is based on the indicators mentioned in the matrix that will help in evaluating and comparing the data. The matrix will provide indicators to measure the performance and efficiency of traditional management of inventory with "VMI".

↳ **H0 :** There is no significant difference between the efficiency of performance indicators of a supply chain, that is, OFR before and after implementation of VMI.

↳ **Ha :** The efficiency of performance indicators of a supply chain, that is, OFR is more after the implementation of VMI than it is in traditional inventory management.

The Figure 3 represents the key performance indicators of the supply chain which are elaborated further in the paper. The Figure shows critical indicators that have an impact on the process of supply chain management.

The Table 1 represents the standard measures of the indicators that should be present for it to reach the optimum level of efficiency. Definitions for each indicators are also indicated below :

(i) TAT (Turnaround Time) : TAT taken in the study is 1 day for the IOLs to reach the end user from the time of generation of the requirement.

(ii) OFR (Order Filling Rate) : The ideal OFR should be 100% for IOLs.

(iii) Accuracy : The measure of correctness of an item delivered should be 100% ideally as per the norms of an organization.

With reference to the Table 1, the accuracy and OFR should be 100%, it is for the reason that the surgery of a patient is highly dependent on IOLs and it is necessary that the product delivered should be accurate as demanded because the surgery is dependent on the accuracy as well.

The Table 2 represents the TAT for the lenses required and lenses supplied for the period from July-September to October-December 2015.

The comparative tabular analysis (Table 3) shows the total number of intended quantity with respect to the supplied quantity of lenses during the period from July-Sept 2015 and Oct-Dec 2015. The Figure 4 is the graphical representation that helps in understanding the comparison made in Table 3, which shows the total

Figure 3. Supply Chain Performance Indicators

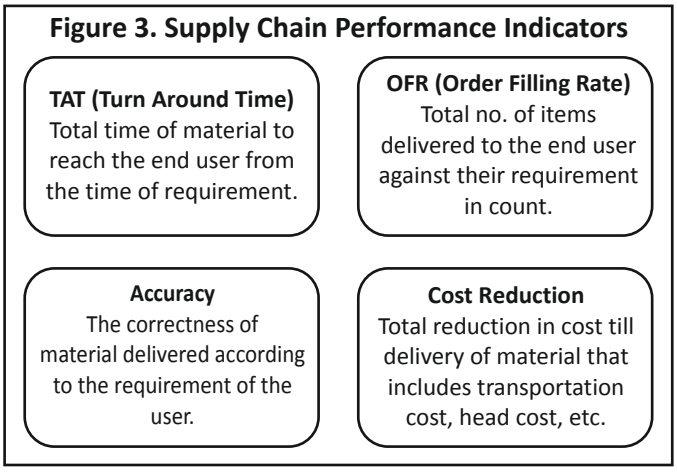


Table 1. Categorized Standard Key Performance Indicators

Items	TAT	OFR	Accuracy
IOL	1 DAY	100%	100%
OT/OPD Consumables	3 DAYS	100%	90-100%
Pharmacy	3 DAYS	100%	90-100%

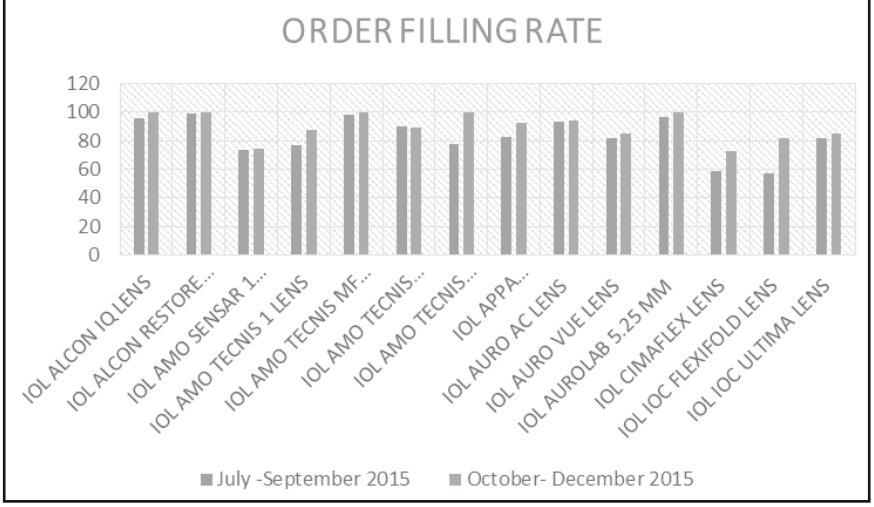
Table 2. TAT for July- September 2015 - October-December 2015

Month	Total no. of Lens Intented	Total no. of lens issued within 1 Day	Percentage of TAT
July-Sept 2015	171	161	94.15
Oct-Dec 2015	336	329	97.92

Table 3. Comparative Table of Intended Quantity to Issued Quantity from July- September to October-December 2015

	July -September 2015			October- December 2015		
Name Of Lenses (IOL)	**Sum of Indent QTY**	**Sum of Issue QTY**	**OFR (in %)**	**Sum of Indent QTY**	**Sum of Issue QTY**	**OFR (in %)**
IOL ALCON IQ LENS	25	24	96.00	3	3	100.00
IOL ALCON RESTORE MF LENS	54	53	98.15	2	2	100.00
IOL AMO SENSAR 1 LENS	127	93	73.23	23	17	73.91
IOL AMO TECNIS 1 LENS	30	23	76.67	311	271	87.14
IOL AMO TECNIS MF LENS	66	65	98.48	3	3	100.00
IOL AMO TECNIS TORIC LENS	10	9	90.00	9	8	88.89
IOL AMO TECNIS TORIC MF LENS	9	7	77.78	4	4	100.00
IOL APPA SUPRAPHOBE LENS	35	29	82.86	26	24	92.31
IOL AURO AC LENS	31	29	93.55	16	15	93.75
IOL AURO VUE LENS	226	184	81.42	26	22	84.62
IOL AUROLAB 5.25 MM	56	54	96.43	5	5	100.00
IOL CIMAFLEX LENS	12	7	58.33	36	26	72.22
IOL IOC FLEXIFOLD LENS	28	16	57.14	65	53	81.54
IOL IOC ULTIMA LENS	78	64	82.05	34	29	85.29

Figure 4. Graphic Representation of Comparison for Intended Quantity to Issued Quantity (in %)



number of intended quantity with respect to the supplied quantity of lenses for the afore-mentioned period. This graph shows the OFR (order filling rate) which shows the total no. of lenses supplied against the total no. of lenses required.

The dependent *t* - test is used to test the null hypothesis and uses input data of OFR to provide the results. The Table 3 and Table 4 show the percentage of OFR before implementation of VMI and after its implementation. The output table (Table 5) shows that the 2 tailed significance of the test is 0.007, which is less than 0.05 significance value. Hence, there is a significant difference in OFR (order filling rate) of IOLs before VMI implementation (M = 83.0500, SD =13.70339) and after VMI implementation (M = 89.9764, SD = 9.71327) ; t (13) = - 3.178, p = 0.007.

Table 4. Input Data for Paired Sample *'t'* - Test

Name of lenses	Before VMI OFR (in %)	After VMI OFR (in %)
IOL ALCON IQ LENS	96	100
IOL ALCON RESTORE MF LENS	98.76	100
IOL AMO SENSAR 1 LENS	73.23	73.91
IOL AMO TECNIS 1 LENS	76.67	87.14
IOL AMO TECNIS MF LENS	98.48	100
IOL AMO TECNIS TORIC LENS	90	88.89
IOL AMO TECNIS TORIC MF LENS	77.78	100
IOL APPA SUPRAPHOBE LENS	82.86	92.31
IOL AURO AC LENS	93.55	93.75
IOL AURO VUE LENS	81.42	84.62
IOL AUROLAB 5.25 MM	96.43	100
IOL CIMAFLEX LENS	58.33	72.22
IOL IOC FLEXIFOLD LENS	57.14	81.54
IOL IOC ULTIMA LENS	82.05	85.29

Table 5. *t*-Test for Paired Sample of Lenses

Paired Samples Statistics

	Mean	*N*	Std. Deviation
Before VMI implementation	83.0500	14	13.70339
After VMI implementation	89.9764	14	9.71327

Paired differences

Mean difference	Std. Deviation	*t*-value	*df*	2-tail significance
-6.92643	8.15406	-3.178	13	0.007

From the above-mentioned results, it can be concluded that the null hypothesis is rejected as the p-value < $\bar{\alpha}$. The results suggest that VMI implementation has a better effect on OFR (order filling rate) than the traditional inventory management system. The difference in OFR and TAT before implementation of VMI and after implementation of VMI shows an increase in the efficiency of the supply chain process. The paired t-test shows the p - value, which is less than the significance value, and leads to the rejection of the null hypothesis.

↳ **Accuracy and Surgery Cancellation :** The overall observation of the study for accuracy is 100% accurate delivery of products before and after implementation of VMI. As far as cancellation of surgeries is concerned, the cancellation of surgeries due to unavailability of the lenses decreased by implementation of the VMI concept and more in-depth studies are required to assess overall surgery cancellations and business assessment.

Discussion and Conclusion

A paired sampled t - test was conducted to compare the effect of VMI implementation on OFR before its implementation (M = 83.0500, SD =13.70339) and after its implementation (M = 89.9764, SD = 9.71327) conditions; t (13) = -3.178, p = 0.007. The results suggest that VMI implementation has a better effect on OFR (order filling rate) than traditional inventory management, and the null hypothesis is rejected.

It is concluded that although our current healthcare system and hospitals are using the traditional system, but the traditional system has a number of shortcomings which impacts the whole business and system of the hospitals. From the literature review, it is clear that VMI has been a part of various industries, but still, the Indian healthcare industry has not adopted VMI. The study provides a tool to managers that will help in smoothening the complex issues of supply chain management. It will also help in reducing the burden of process complexity with orientation towards automation.

From the data analysis and results of this study, it is clear that there is a comparative decrease in the TAT (turnaround time) and increase in the OFR (order filling rate) from one period to other. As seen in the months from July to September 2015, with the use of traditional managed inventory, the TAT and OFR are approximately 95%, but with implementation of VMI, it increases up to 98%. As far as accuracy is concerned, it is 100% in both the periods.

Researchers have conducted studies on VMI implementation and its impact on process improvement in several industries. Benson and Kenneth conducted a study on the retail industry (as cited in Irungu & Wanjau, 2011) and concluded that the stocks and management of inventory improved for a retail store after implementation of VMI.

Limitations of the Study and Scope for Future Research

The study lacks the discussion of one of the major issues, which is lack of mutual trust between the parties. It is hard to have trust on a third party and provide them the real data of the organization, which creates difficulty in implementation of VMI. The study also does not focus on the costs involved in the implementation of VMI. Need of managing the vendors who are excluded from the VMI programe is also not discussed in the study, which can be a problem in implementation of the program. These points can be addressed in future studies.

In this paper, the focus is on the improvement of efficiency of various indicators of inventory management and supply chain. Some aspects are not highlighted here like the division or categorization of the material as per its criticality to be included in the VMI concept. As in a hospital setup, every item cannot be included in VMI, so it is necessary to categorize the items accordingly. Also, trust management and vendor relationship management in the context of the hospital scenario can be studied in future studies, which can help in providing solutions for sharing of data with other parties and makes the management of a hospital much more comfortable in taking decisions.

Acknowledgment

We would like to thank the esteemed eye care organization, Eye Q Hospital for providing data for inventory of IOLs without which this study and data analysis would not have been possible.

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