The Asian Journal of Technology Management Vol. 9 No. 2 (2016): 109-119

Improvement of Inventory Control Using Continuous Review Policy in A Local Hospital at Bandung City, Indonesia

Fina Hafnika, Desy Anisya Farmaciawaty*, Akbar Adhiutama and Mursyid Hasan Basri
School of Business and Management, ITB, Bandung, Indonesia

Abstract. *This research was aimed to analyze the excess inventories issue in pharmacy and medical equipment unit at a local hospital in Bandung which affected the service level of the hospital. As one of the busy hospital in Java, proven by the higher amount of the patient/year than in other average Java typical hospital, the hospital needs to concern about the pharmaceutical and medical equipment inventories in order to fulfill patients' needs and in the same time keeping the inventory level under control. Therefore, an inventory control evaluation was conducted to determine the appropriate number of inventories and time of order to avoid the excessive goods in central warehouse of the hospital. By using probabilistic inventory model and continuous review policy, the pharmaceutical inventory in the hospital was calculated to compare the ideal and actual amount of the average inventory level (AIL). ABC (Always, Better, Control) classification also classified in this research to identify the proper item which potentially can be reduced from the inventory. From the analysis, we have discovered that the hospital potentially able to reduce almost Rp 830 million or 57% from the overstock inventory level by using continuous review policy as the basis of inventory control calculation system.*

Keywords: *Continuous review policy, inventory control, EOQ, ROP, AIL*

1. Introduction

The local hospital that we studied in this research is a grade 'A' public hospitals, which mean the hospital able to provide services of specialists and subspecialists medical treatment and also was designated by the government as the highest referral hospital. The hospital is indicated as a busy hospital based on the average number of patient visited the hospital. The patient visited number is greater than other typical hospital in Java which has less number of patient/year than the hospital that we studied. The hospital has more physicians than the other typical hospital in West Java, which is 41 physicians. In addition, the hospital has 5 more physicians than the other typical hospital in West Java and 6 more physicians than the other typical hospital in Java.

Health-care service in this hospital is supported by human resources and capacity supports by service level in the calculation of the ratio of the number of nurses with the number of doctors, ratio the number of nurses with the number of hospital beds, and the ratio number of medical technicians with the number of doctors. West Java also has lower resource rather than the studied hospital in our research. According to the data from Ministry of Health Affair, the ratio number of nurses with the number of doctor comparison in the hospital was 3.12 while in Java hospitals typically was 1.77. The ratio number of nurses with the number of hospital beds comparison in this hospital was 1.23 while in Java hospitals typically was 0.73. And the ratio number of medical technicians with the number of doctor comparison in this hospital was 1.10 while in Java hospitals typically was 0.35. The hospital currently endure the excess inventory level in central warehouse, especially in pharmaceutical items and medical equipment inventory. We focus our research in the pharmaceutical items because they represent a great percentage of the costs in the healthcare industry due to the

*Corresponding author. Email: desy.anisya@sbm-itb.ac.id
Received: December 6th, 2016; Revised: February, 15th, 2017; Accepted: March, 13th, 2017
Doi: http://dx.doi.org/10.12695/ajtm.2016.9.2.5
Print ISSN: 1978-6956; Online ISSN: 2089-791X.

significant costs of these products and their storage and control requirements (Kelle, Woosley, & Schneider, 2012), and also by improving the particular inventory provides a great opportunity to decrease the cost of healthcare (Gebicki, Mooney, Chen, & Mazur, 2014). The excess inventory we studied in this case lead to space problems, increase the storage cost, increase waste such as expire medicine, and also increase inventory cost which can be used to invest in other development project or understock items. The lack of budget for understock items and development project caused by high inventory cost could lead to low customer service level. The excess inventory problem occurs because the pharmaceutical and medical equipment unit does not a have system or method to forecast the appropriate inventory level accurately.

The deterministic inventory model considered was not the appropriate model to be used by the hospital due to the model was not included the safety stock because it did not consider the lead time. In hospital case, it is necessary to allow the safety stock inventory because hospital is having the vital items that must always be available. Even though the order delivery conducted 3 – 4 times per year, the order delivery schedule can be adjusted depends on the agreement between distributor and the local hospital party. The periodic review policy is not considered in this research due to the limited vendor/supplier capability on items availability and delivery times.

The evaluation of the inventory control in this local hospital should be conducted in order to reduce the large amount of Average Inventory Level (AIL) issue that faced by the hospital, especially in pharmaceutical and medical equipment unit. We can assume that the hospital has greater number of resource and capacity than the throughout typical hospital in Java, Indonesia. Therefore, it needs the evaluation of patient fulfillment needs in medical goods in the hospital. In this research, probabilistic inventory control model will be used and specifically using continuous review policy as the most approachable model to pharmacy unit in the hospital condition. The aim of this research is to verify the excess inventory issue in the local hospital that we studied and determine the potential excessive value of that can be reduced in pharmacy unit. We emphasize more in the excessive inventory issues since most of the inventory in the hospital is in the overstock state.

2. Literature Review

2.1. Definition

Inventory is any items or resources that are stored or stocked by organization. An inventory system is very important since organization needs to set policies, controls, and monitor levels of inventory and determine what levels should be maintained, when stock should be replenished, and how large orders should be in order to keep inventory cost as minimum as possible while maintaining high customer service level (Jacobs, Chase, & Aquilano, 2011). The objective of inventory-control management is to make inventory decisions that minimize the total cost of inventory not to minimizing inventory (Hughes, 1984). According to Bowersox, Closs, and Helferich (1996) high inventory levels result in increased carrying costs but lower the possibility of lost sales because of stock-outs and slowing production, which can result from inadequate stocking. Meanwhile, low inventory levels result in low inventory cost however it would increase the lost opportunity sales.

Therefore, the objective of inventory management is to strike a balance between inventory investment and customer service. To maintain the inventory level, there are some indicators that can be controlled by organization, such as safety stock, reorder point, economic order quantity, and average inventory level. In healthcare area especially in pharmaceutical area, inventory management considered as more complex than other industry application, since there is critical item which perceived need to be supplied very high levels of service and on the other hand, there is a high product value which need for special handling to combat spoilage or obsolescence (Beier, 1995).

2.2. Inventory Control

To be able to control the inventory, we need to know the characteristic of the inventory, whether it is independent demand inventory or dependent demand inventory. In this research we focus on the independent demand. The inventory control model in this research will use the continuous review policy. Continuous review policy requires the inventory reviewed continuously, and place the order when the quantity left reaches the particular point, or reorder point (figure 1). In the healthcare service provider area, applying the inventory management tools need to be conducted regularly to gain effective and efficient management of the provider, along with close supervision on items belonging to important categories (Wandalkar, Pandit, & Zite, 2013). In addition, a good developed SCM system enables healthcare providers to improve the inventory control of pharmaceutical products, which results in decreasing total inventory more than 30% (Kim, 2005).

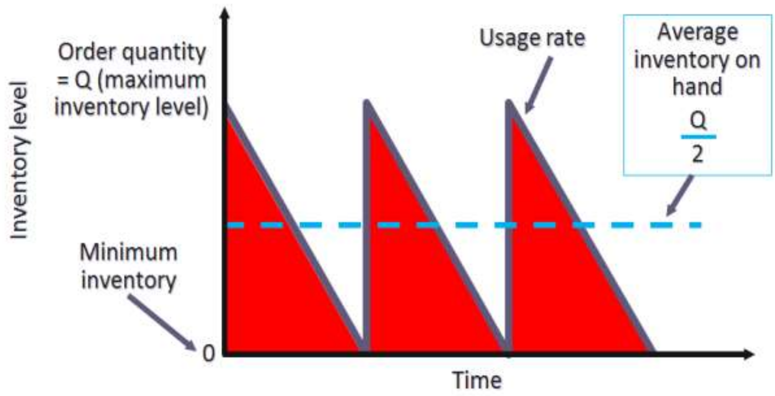

Figure 1. Continuous review policy/Fixed Order Quantity Model (Source: Heizer, 2014)

2.3. Deterministic Model

Deterministic model is widely used as an inventory control technique, one of the technique is the EOQ Model. In deterministic, to calculate the EOQ or the economical quantity to order, we need to assume that the demand for an item is known, constant, and independent from demand of other items; lead time is constant; price per unit product is constant; inventory holding cost is based on average inventory; ordering or setup cost is constant; and no backorder allowed (Jacobs et al., 2011).

2.4. Probabilistic Model

In the probabilistic model, we have to relax the assumption regarding the constant demand and lead time, since in the real world demand and lead time is uncertain (Heizer & Barry, 2013). To face the uncertain demand and lead time, the management must maintain a good service level which is the complement of the probability of a stock out, since uncertain demand will raise a stock out. We also need to pay more attention to safety stock in order to avoid overstock or stock out. In the probabilistic usually, there are three situations which we need to determine in our inventory model: 1. Demand is variable and lead time is constant; 2. Lead time is variable and demand is constant; 3. Both demand and lead time are variable. In this research, the authors faced the number one situation which demand is variable and lead time is constant.

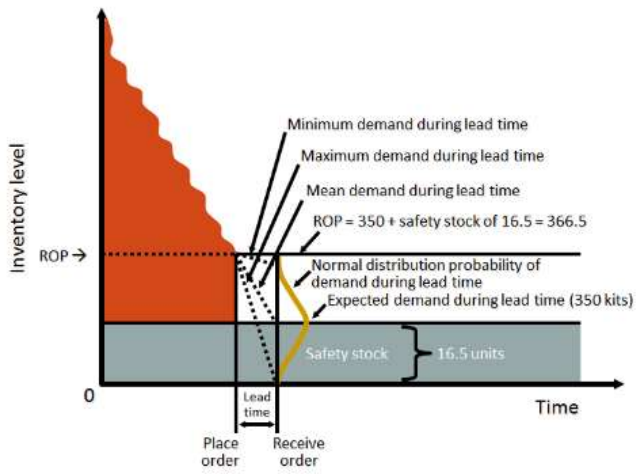

Figure 2. Fixed order quantity model with safety stock

2.5. Inventory Planning

Planning and controlling inventory in healthcare industry still lags behind manufacturing planning and control (Hans, Van Houdenhoven, & Hulshof, 2012), therefore we need to learn from the manufacturing industry in this matter. In manufacturing industry, the ABC inventory classification usually used to control their inventory level. ABC method classify inventory based on dollar volume into three categories, which are high dollar volume (A); moderate dollar volume (B); low dollar volume (C) (Jacobs et al., 2011). The ABC classification use the Pareto Principle, which show that a small number of items account for a small dollar volume and a large number of items account for a small dollar volume.

The purpose of this method is to establish the appropriate degree of control over each item. For A class items, management need to control the inventory much tighter than items in the C class, and provide better forecasting for 'A' class items. The main constraint of applying the ABC method in healthcare industry is that some critical items that may have low usage value will not receive significance attention under this method (Al-Qatawneh & Hafeez, 2011). Therefore, in the healthcare area, the inventory control based on dollar value alone or ABC method is not enough, we need to divide the inventory according to the criticality of the medicine which are vital, essential, and desirable (VED) analysis (Roy, Manna, & Sarker, 2010). However, in this research we focus only with the ABC because of the lack of research resources.

3. Material and Method

The research was conducted using two methods: qualitative and quantitative. The qualitative method is used to gain understanding of the problem, uncover trends of thought and opinions, and helps the researcher to develop ideas to solve the problem. The quantitative method is used to quantify the problem and helps the researcher to understand the problem through numerical data. The qualitative method was performed by observing and interviewing the pharmacy unit meanwhile the quantitative unit was performed by collecting, analyzing, and comparing the result. The pharmacy and medical equipment inventory data was collected from January 2015 until May 2016. The data contains information of 1.164 drugs. The collected data was analyzed using inventory control techniques specifically using continuous review policy, EOQ, ROP, AIL, and ABC classification. Particularly for the ABC classification, calculation was done by using average inventory level in Indonesian Rupiah (IDR). The ABC classification technique, classified three groups of inventory based on cumulative average inventory level cost. class "A" contains 10% of drugs that consume

70% of AIL cost, class "B" contains 20% of drugs that consume 20% of AIL cost, and class "C" contains 10% of drugs that consume 70% of AIL cost.

For the safety stock calculation, the number of safety stock was calculated using:

$$SS = z\sigma\sqrt{L}$$

Equation 1. Safety Stock Calculation of Continuous Review Policy

Whereas;
$z =$ Service level constant
$\sigma =$ Standard deviation of demand
$L =$ Lead time

Meanwhile, reorder point (R) was calculated using:

$$R = \bar{d}\text{L} + \text{SS}$$

Equation 2. Reorder Point Calculation of Continuous Review Policy

Whereas;
$\bar{d} =$ Average demand per period

The Economic Order Quantity was calculated using:

$$EOQ = \sqrt{\frac{2DS}{H}}$$

Equation 3. EOQ Calculation of Continuous Review Policy

Whereas;
$EOQ =$ Economic Order Quantity
$D =$ Annual demand
$S =$ Setup cost
$H =$ Holding cost

The Average Inventory Level (AIL) was calculated using:

$$AIL = \frac{Q}{2} + SS$$

Equation 4. AIL Calculation of Continuous Review Policy

This research is conducted in two stage of analysis. The first stage of this research was carried out by observing the historical data (January 2015 – May 2016) and calculated the data using the current policy practiced by the hospital managerial. In, the second stage, the data was calculated using new method proposed by the authors which are the continuous review policy. Afterward, the AIL resulted from the first stage and the second stage is compared each other.

4. Findings

In the hospital, there are 1.455 types of drug and medical equipment and two financial resources: Badan Layanan Umum (BLU) and Rupiah Murni. BLU revenues derived from non-tax revenue's income, meanwhile in Rupiah Murni, the fund is derived from the government budget. In this research, the inventory that will be analyzed is from BLU financial resources because the inventory procurement process in BLU is not bound by strict government regulations regarding the financial accountability and availability ss this would affect the inventory lead time. The historical data is available in 17 months (January 2015 – May 2016). Based on interview with the pharmaceutical production planning and control (PPC) manager of the hospital, the real condition in the hospital especially in pharmaceutical and medical equipment unit is shown below:

Table 1.
Fixed Variable of pharmaceutical and medical equipment goods order

Lead Time	45 days
Holding Cost	25% of unit price
Setup Cost	Rp. 5000
Service Level	95%

Lead time for the pharmaceutical and medical equipment in the hospital is 30 – 45 days due to the goods was ordered from E-Catalog. In this research, we assume that the lead time is 45 days. Refers to Alford and Bangs (1948), *holding cost inventory assume as 25% of unit price, setup cost Rp. 5000 and service level in the hospital is 95%.*
The following table is the examples of calculation of the 9 type random goods.

Table 2.
Calculation Example of 9 Type of Pharmaceutical Inventory

Item	Average (Unit)	Lead Time (Month)	Price (IDR)	AIL Ideal (IDR)	AIL Actual (IDR)
0ALKOHOL 70% 100 ML	2	1.5	4,203.2	88,294.46	59,339.29
0ALKOHOL 70% 1000 ML	10	1.5	18,707.2	377,361.77	768,424.24
0ALKOHOL 95%	37,505	1.5	32.8	7,696,259.64	7,665,792.09
CALSIUM GLUCONAS	0	1.5	7,832	0	86,152
CEFADROXYL SYRUP	26	1.5	3,519.2	218,592.65	482,18809
CEFAT 250 TABLET	22	1.5	2,2209.6	186,812.55	295,973.31
CEFAT 500 TABLET	68	1.5	6,370.4	1,480,676.57	3,138,886.80
CEFAT FORTE SYRUP	2	1.5	54,189.6	341,527.66	383,589.69
CEFAT SYRUP	2	1.5	33,348	272,976.65	171,045.46

The table above shows that the average unit demand of calcium gluconas are zero. It means that there is no demand from the unit to the warehouse for 17 months in a row (January 15 – May 2016). The actual condition in the local hospital indicates most pharmaceutical and medical equipment unit endure the excess inventory. The following table shows the comparison of actual and ideal Average Inventory Level (AIL) of pharmaceutical and medical equipment inventory in the hospital. The detail calculation shown at Appendix A.

Appendix A.
Calculation Example of 9 Type of Pharmaceutical Inventory

Item	AIL (Rupiah) Ideal	Actual	Gap	Status
0ALKOHOL 70% 100 ML	88,294	59,339	-28,955	Understock
0ALKOHOL 70% 1000 ML	377,362	768,424	391,062	Overstock
0ALKOHOL 95%	7,696,260	7,665,792	-30,468	Understock
CALSIUM GLUCONAS	0	86,152	86,152	Deadstock
CEFADROXYL SYRUP	218,593	482,188	263,595	Overstock
CEFAT 250 TABLET	186,813	295,973	109,161	Overstock
CEFAT 500 TABLET	1,480,677	3,138,887	1,658,210	Overstock
CEFAT FORTE SYRUP	341,528	383,590	42,062	Overstock
CEFAT SYRUP	272,979	171,045	-101,933	Understock

Table 3.
Average Inventory Level Comparison

Item	AIL (Rupiah) Ideal	Actual	Status
0ALKOHOL 70% 100 ML	88,294	59,339	Understock
0ALKOHOL 70% 1000 ML	377,362	768,424	Overstock
0ALKOHOL 95%	7,696,260	7,665,792	Understock
CALSIUM GLUCONAS	0	86,152	Deadstock
CEFADROXYL SYRUP	218,593	482,188	Overstock
CEFAT 250 TABLET	186,813	295,973	Overstock
CEFAT 500 TABLET	1,480,677	3,138,887	Overstock
CEFAT FORTE SYRUP	341,528	383,590	Overstock
CEFAT SYRUP	272,979	171,045	Understock

The table above shows that calcium gluconas in the hospital warehouse has a value of Rp. 86,125 whereas the ideal condition is Rp. 0. This condition occurred because there was no demand for calcium gluconas in three months in a row but the pharmaceutical and medical equipment unit still has the stock available in the warehouse. Because the demand is zero for three months in a row, this items can be classified as a deadstock item (referred to Regulation of Health Ministry of Indonesian Republic No. 58/2014). Alcohol 70% 100 ml item value in the hospital warehouse has a value Rp. 59,339 whereas the ideal condition is Rp. 88,294. This condition occurred because of alcohol 70% 100 ml has greater demand than the available stock in the warehouse. This condition for alcohol 70% 100 ml, alcohol 95%, cefat syrup, and similar case in different item, can be classified as understock item. For the alcohol 70% 1000 ml item value in the local hospital warehouse has a value Rp. 768,424 whereas the ideal condition is Rp. 377,362. This condition occurred because of alcohol 70% 1000 ml item has less demand than the available stock in the warehouse. This condition for alcohol 70% 1000 ml, cefadroxyl syrup, cefat 250 tablet, cefat 500 tablet, cefat forte syrup, and similar case in different item, can be classified as overstock item. Several item has actual condition Rp. 0 whereas the ideal condition also Rp. 0. This condition occurred because of that item has no demand and no stock in the warehouse, the PPC only has the list of the item but the item has no changes either on the stock and the demand. This can be classified as discontinued item. From figure 3, we can see that there are 926 items (64% of total items) was discontinued items, 45 items (3% of total items) was deadstock items, 325 items (22% of total items) was overstock, and 159 items (11% of total items) was understock items in pharmaceutical and medical equipment unit of the hospital.

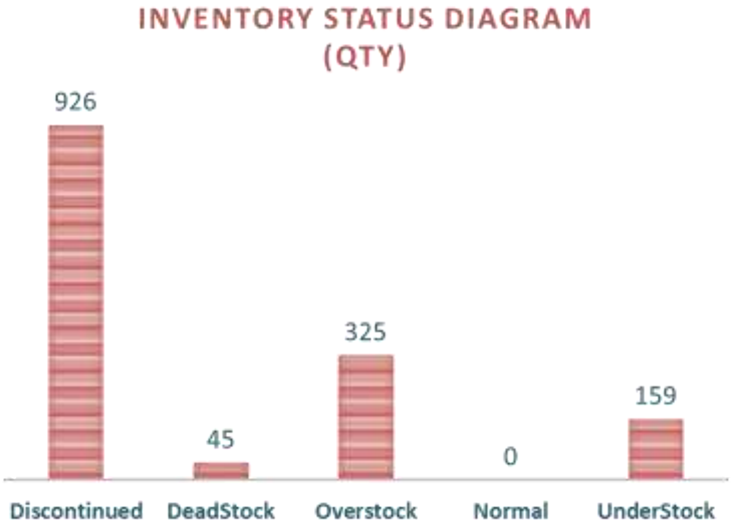

Figure 3. Number Goods of Each Status

Based on value of money (Indonesian Rupiah/IDR) in each inventory status, the actual condition of pharmaceutical and medical equipment unit in the hospital, spent Rp. 1,861,797,072 in warehouse, but the ideal condition, the hospital supposed to spend only Rp. 1,143,230,159. From the total average inventory level comparison, the hospital, specifically in pharmaceutical and medical equipment unit, potentially save Rp. 829,655,791 (56.93%) of inventory value exclude the deadstock inventory. The comparison is shown in table 4 and 5 below.

Table 4.
Value of Money Actual and Ideal Condition Comparison

Status	IDR		
	Actual	Theory	Gap
Total AIL	1,861,797,072	1,143,230,159	718,566,912
Deadstock	164,304,768	0	164,304,768
Overstock	1,457,388,980	627,733,190	829,655,791
Understock	240,103,323	515,496,970	(275,393,646)

Table 5.
Total Quantity Each Category

Items	
Status	**Quantity**
Deadstock	45
Overstock	325
Understock	159
Total	529

Figure 4. Value of Money Actual and Ideal Condition Comparison Based on Status

Figure 5. Five Highest Gap of Value of Money Goods

Figure 5 shows the five highest gap average inventory level in pharmaceutical and medical equipment unit in XYZ Hospital.

The highest gap number value of money items is *stelaris combines posterior vitrec* which is spend more value Rp. 97,435,975, avastin injeksi spend more value, Rp. 32,372,989, blades No. 15 Rp. 29,083,440, lucentis Rp. 27,875,047, and cefazolin injeksi ginerik Rp. 21,012,552. All of those five items classified as overstock category in pharmaceutical and medical equipment calculation in this analysis.

In order to simplify the system to efficiency the excess inventory that proven by the comparison of AIL actual and ideal above, it will be better if the inventory item classified by ABC (always, better, control) class. As it has shown in the table 6, the ABC classification of the pharmaceutical and medical equipment inventory in the hospital referred to that percentage.

Table 6.
ABC Analysis Class Percentage

Class	*Items (%)*	*Value (%)*
A	*10%*	*70%*
B	*20%*	*20%*
C	*70%*	*10%*
Total	*100%*	*100%*

(Source: MJAFI, Vol. 63, No. 4, 2007)

The first stage to classify the inventory items was sort the list of actual AIL (in Rupiah) from the largest to the smallest. Then calculate the value of actual AIL per item until reach the specific value that refers to the table 7 percentage each class. Table 8 shows the A, B, and C class of pharmaceutical and medical equipment items based on the value of actual AIL. In this classified analysis, the item which classified are 484 items which is the total items of pharmaceutical and medical equipment list minus the discontinued and deadstock items (1455 – 926 – 45 = 484). The ABC classification that analyzed include 484 items which is only the overstock and understock items in pharmacy unit of the local hospital.

Table 7.
Pharmaceutical and Medical Equipment ABC Classification

Class	Number of Items	AIL (IDR)
A	58	1,187,136,415
B	99	338,764,439
C	327	171,591,450

Table 8.
Pharmaceutical and Medical Equipment ABC Classification

Class	Number of Items	AIL (IDR)
A	58	1,483,920,518
B	99	423,455,549
C	327	214,489,312

The classification by using ABC method will indicate which items that spent a large value of the actual AIL and the hospital potentially to reduce the inventory budget by reduce the number of 'A' class of inventory item in the hospital.

5. Conclusion

From the research, it can be seen that the hospital has potentially to saved Rp. 829,655,791 (56,93%) from the overstock cost of pharmacy unit. The excess inventory occurred effected by the hospital do not have system inventory control. This research assumes that the most approachable method to be used by the hospital is probabilistic inventory control model because the deterministic inventory model does not consider the lead time and the demand assumed as constant demand. Probabilistic inventory model divided into two policies, and also the most approachable policy to be used by pharmacy unit in the hospital is continuous review policy. Because by using the periodic review policy, the calculation led the hospital to spent large inventory rather than by using continuous review policy. This statement proven by the research conducted by (Ma & Lei, 2013) in comparison of continuous review policy and periodic review policy table.

References

Al-Qatawneh, L., & Hafeez, K. (2011). *Healthcare logistics cost optimization using a multi-criteria inventory classification*. Paper presented at the International Conference on Industrial Engineering and Operations Management, Kuala Lumpur.

Alford, L. P., & Bangs, J. R. (1948). *Production handbook*: Ronald Press Co.

Beier, F. J. (1995). The management of the supply chain for hospital pharmacies: a focus on inventory management practices. *Journal of Business Logistics, 16*(2), 153.

Bowersox, D. J., Closs, D. J., & Helferich, O. K. (1996). *Logistical management* (Vol. 6): McGraw-Hill New York, NY.

Gebicki, M., Mooney, E., Chen, S.-J. G., & Mazur, L. M. (2014). Evaluation of hospital medication inventory policies. *Health care management science, 17*(3), 215-229.

Hans, E. W., Van Houdenhoven, M., & Hulshof, P. J. (2012). A framework for healthcare planning and control *Handbook of healthcare system scheduling* (pp. 303-320): Springer.

Heizer, R., & Barry, R. (2013). *Operation Management, Sustainability and Supply Chain management* (Vol. 11): Pearson, UK.

Hughes, T. F. (1984). Objectives of an effective inventory control system. *American Journal of Health-System Pharmacy, 41*(10), 2078-2085.

Ministry of Health Affair of Indonesia: *http://www.buk.depkes.go.id* accessed from *http://rumah-sakit.findthebest.co.id/l/2169/RS-Mata-Cicendo, [accessed in July 2016].*

Jacobs, F. R., Chase, R. B., & Aquilano, N. (2011). Operations and supply chain management. Vol. Global ed: The McGraw-Hill/Irwin series operations and decision sciences. New York: McGraw-Hill.

Kelle, P., Woosley, J., & Schneider, H. (2012). Pharmaceutical supply chain specifics and inventory solutions for a hospital case. *Operations Research for Health Care, 1*(2), 54-63.

Kim, D. (2005). *An integrated supply chain management system: a case study in healthcare sector*. Paper presented at the International Conference on Electronic Commerce and Web Technologies.

Ma, J., & Lei, T. (2013). *EOQ-based Inventory Control Policies for Perishable Items: The Case of Blood Plasma Inventory Management*. Paper presented at the IIE Annual Conference. Proceedings.

Roy, R. N., Manna, S., & Sarker, G. N. (2010). Applying management techniques for effective management of medical store of a public sector undertaking hospital. *Indian J. Prev. Soc. Med, 41*(1&2).

Wandalkar, P., Pandit, P., & Zite, A. (2013). ABC and VED analysis of the drug store of a tertiary care teaching hospital. *Indian Journal of Basic and Applied Medical Research, 3*(1), 126-131.