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Pharmaceutical Inventory Management Issues in Hospital Supply Chains

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Abstract The primary focus of the healthcare sector is to provide patients with the best quality of care. While the healthcare cost is keep on growing, effective healthcare supply chain should be achieved to reduce some unnecessary costs. To address this issue, this study aims to examine inventory management practice in one of Indonesian public hospital and focus on the role of inventory to drive hospital supply chain performance. Three major issues regarding inventory management practice has been identified such as overstock, unjustified forecasting technique and lack of IT support. Proposed (s,Q) policy using continuous review can reduce by 50% total inventory value on hand of oncology medication. Among several forecasting technique that's presented, Holt's model appears to be the best adapted for oncology medication. Future study is needed to simulate the outlook condition using proposed policy. By implementing a new inventory policy that cope all the constraints and problems will help hospital to manage its pharmacy inventory in effective and efficient way.

Keywords Inventory Management, Oncology Medication, Public Hospital, Indonesia

1. Introduction

Today's healthcare organizations have evolved into highly complex organizations. As healthcare costs are growing rapidly, both practitioner and academicians seek for some ways to overcome that problem. While cost of healthcare is keep on increasing, healthcare organizations is required to provide the high quality of care. By increasing the efficiency of supply chain, healthcare cost savings could be achieved[1]. It also mentioned, based on previous studies 30-40% of hospital expenses are spent in terms of logistical activities. As in[2], several studies showed with implementing effective supply chain management (SCM) practices can reduce significant healthcare cost.

According to[3], supply chain macro process is classified into three major parts, such as customer relationship management (CRM), internal supply chain management (ISCM) and supplier relationship management (SRM). This study will discuss about the internal supply chain management in the hospital, which the major aim is to fulfil patient demand produced by the supply chain management process in a timely manner with the lowest possible cost.

This study aims to present a case study of Indonesian public hospital and focus on the role of inventory in hospital supply chain and proposed how the managers can use inventory to drive supply chain performance.

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In the next section, we reviewed some literature of hospital supply chain particularly in hospital pharmacy inventory settings that guided our study. Then, outline of the methodology that used in data collection is presented. The next sections present the case data analysis and discuss some main issues regarding pharmaceutical supply chain inventory. Finally, potential improvements are detailed.

2. Hospital Pharmacy Supply Chain

Hospitals are complex organization providing a multitude of service to patient, physicians and staff. These services include pharmacy, laboratory, surgery, dietary, linen, housekeeping, administration and others. Moreover, each area has specific and often unique material and supply need[4]. The hospital product line consists of high cost and low cost items as well as perishable and durable goods that are consumed in large and small.

Pharmaceutical components characterize as a large amount of hospital's operating expenses. Several researchers pointed out that inventory costs in the healthcare sector are substantial and are estimated between 10% and 18% of total revenues[5]. Any measures to control expenditures in this area can have significant impacts on the overall efficiency of the organization.

The importance of effectively managing the pharmaceutical flow in internal chain has been emphasized by many practitioners and academicians. Hospital supply chain, in terms of pharmaceutical products is providing the supplies of medicine for the patients and it's critical in ensuring high standard care[6]. Many challenges come up in handling

hospital pharmacy. First, pharmaceutical industry is influenced by strong institutional and regulatory pressures. The regulatory pressures affected in determining accurate demand forecast. Second, hospitals are operationally different with another business, because it's extremely difficult to make a forecast about the patients and their consumption of drugs. Third, hospital pharmacy mainly holds a large amount of safety stock to cope with uncertainty demand, which resulting in a high operational cost and have to deal the drug expiry problems[7]. Also, several reasons why pharmaceuticals deserve extraordinary consideration in controlling inventory, such as: medicine are developed, manufactured and distributed according to strict regulatory requirements and it makes fundamental differences between medicines and other consumer products; medicines are most often selected by a physician for a specific patient and reimbursed in whole or in part by a third-party insurer or state[8].

2.1. Role of Inventory in Hospital Supply Chain

American Production and Inventory Control Society (APICS)[9] define inventory management as the branch of business management concerned with planning and controlling inventories. The major aims of hospital inventory management and healthcare supply chains research is to reduce healthcare cost without sacrificing the quality of service to the patient by improving efficiency and productivity of healthcare system[10].

Inventory management has a significant role in the supply chain. Among various SCM issues, inventory management is a greater extent relevant to the entire supply chain. Inventory management has been recognizes as one of the most important functions that has huge impact on their overall performance[11]. Supply chain inventory management is focused on end-customer demand and aims at improving customer service while lowering relevant cost[12].

2.2. Inventory Control

Inventory control is the process of managing inventory in order to meet customer demand at the lowest possible cost and with a minimum investment[13]. Several objectives in inventory control such as minimize inventory investment; determine the appropriate of customer service level; balance supply and demand; minimize ordering cost and holding cost; also preservation of inventory control system.

Among various inventory control model, Economic Order Quantity (EOQ) which developed by F.W Harris in 1915 has been the most commonly used in practice. He mentioned that EOQ derives the optimal lot size for purchasing by minimizing the total operating cost. EOQ formula helps inventory manager to determine how many optimum products to buy[4]. However, the classical EOQ model assumes such as: constant demand, constant lead time, fixed order cost per order, instantaneous replenishment, no stocks out allowed, no demand uncertainty and quantity discount aren't available[14]. In order the above assumptions do not reflect in all situations, EOQ model must be modified in a real inventory system analysis.

Replenishment process also one of common practices in inventory control. Replenishment divided two types, which is continuous review and periodic review[3]. Continuous review placed the order when the inventory declines to the re-order-point (ROP). While periodic review placed the order at regular periodic intervals. ROP also used in inventory control to seek suitable level for replenishment.

Another model in controlling inventory is safety stock. Safety stock must be considered where there is an uncertainty in demand; also safety stock is needed during the replenishment lead time when there is a mismatch between actual demand and expected demand[4].

In order to reduce cost and improve service level, hospital is considered to implement various innovative supply chain strategies. Based on the literature, the standard or conventional supply chain was replaced by a number of initiatives that have been undertaken such as just-in time (JIT)[15], stockless inventory[16] and vendor managed inventory (VMI)[17].

3. Method

This study is carried out as a case study analysis. Case study analysis involves in-depth and contextual analyses of matters relating to similar situations in other organization[18]. Also, case study analysis is used in understanding certain phenomena and generating further theories for empirical testing.

Both of qualitative and quantitative data were collected. Qualitative data were gathered through observations and interviews. We conduct direct observation to know about the existing inventory system in hospital pharmacy inventory. By doing observation, we record the behavioral patterns of people, objects and occurrences related to hospital pharmacy inventory. Semi structured interviews were carried out with various hospital staffs, such as supply chain professionals, pharmacist, IT managers, customer service and nurse. The purpose of these interviews are to achieve a clear understanding of the problems experienced within the hospital setting, collect information about the supply chain process and also discuss possible solutions to the problems.

Data analysis was completed in order to illustrate the potential advantages and disadvantages of the proposed solutions to the inventory issues that present in the hospital. Data analysis was also examined the benefits of inventory reductions and various cost

4. Problem Description

The scope of analysis of this study is the pharmaceutical inventory in one of public hospital in Indonesia. For confidentiality reason, the hospital cannot be mentioned. This hospital is classified as a national hospital, which is

directly under supervisory Indonesian Ministry of Health. Also, this hospital becomes the highest referral hospital in Province.

Hospital has various types of drugs in its inventory with different characteristic. To make it easier in analysis, drugs sampling is done. Oncology medication drugs are chosen as drugs sampling because of its huge value. Oncology medication also suggested by the principal pharmacist as the representative of drugs inventory problem in this hospital. A little improvement in oncology medication inventory control can have a significant impact in efficiency of the hospital.

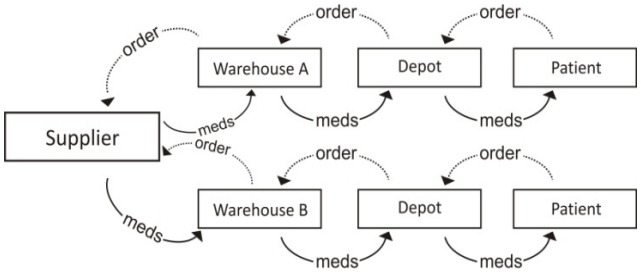

Figure 1. Overview Pharmaceutical Flow

Figure 1 presents the overview of the pharmaceutical flow system in this hospital. As shown below, the system of interest of this study is focus on the internal chain of the hospital. This hospital adopted multi-echelon inventory system, which has two medical warehouses with 20 depots throughout the hospital. Warehouses A serves depot for government insurance holders for poor citizens, while warehouses B serves depot for civil-servant insurances holders, private insurance holders and regular patients. Regular patients are the patient that they are paid the medication by their self.

Third-party managed inventory used to be adopted in this hospital. However since the new regulation from Indonesian Ministry of Health No.68 Year 2010, hospitals have to manage all main activity in the hospital by their own, including pharmaceutical inventory management. Based on that situation, the existing condition of the hospital is back to the traditional supply chain where the hospital is fully managed their inventory. Currently, hospital is using base stock (S) policy with periodic review replenishment for control its inventory. Every depot places an online order to the warehouse once a week. The quantity of order is based on mean demand last week plus 10%-20% buffer stock. Urgent orders can be placed if there's a critical situation at the depot.

From the data gathered from the hospital, three main issues has been identified regarding pharmaceutical supply chain management and affect patient service performance. These issues have been recognized through triangulating findings based on different data collection techniques. These issues are:

a. Overstock. Warehouse carried out too much inventory.

b. Unjustified demand forecasting technique.

c. Lack of IT support and some organizational factors due to the changing systems from third-party managed inventory.

5. Discussion

5.1. Inventory Control

As mentioned above, this hospital is using base stock (S) policy to control their inventory. Under this policy inventory is replenished up to the base stock point S, every time the inventory is reviewed. Average inventory level (AIL) using existing policy during period January – June 2012 is described below.

Table 1. Existing Policy

Product	AIL
Avastin 100 INJ	16
Herceptin 400 INJ	6
Mabthera 500 INJ	9
Glivec 100 MG	315
Tykerb 250 MG	1149
Xeloda 500 MG	4543

A different policy should be investigated to find an appropriate policy in controlling the inventory. Basic inventory (R,S) and (s,Q) policy are proposed to improve the efficiency of drugs inventory. Periodic review (R,S) policy controls that every review interval (R) units of time is ordered to raise inventory position to the order up to level (S). Given the lead time is three days, review interval is one week and customer service level (CSL) is 95%, average inventory level is calculated below.

Table 2. (R,S) Policy

Product	μ D	σ D	ss	S	AIL
Avastin 100 INJ	18	10	10	16	12
Herceptin 400 INJ	16	3	3	8	5
Mabthera 500 INJ	13	5	5	9	6
Glivec 100 MG	375	254	241	366	285
Tykerb 250 MG	464	122	116	271	170
Xeloda 500 MG	2237	515	489	1235	750

(R,S) policy is calculated using this following formula:

(1) $ss = F_s^{-1}(CSL)\ X\ \sigma_{R+L}$

(2) $S = D_{R+L} + ss$

(3) $AIL = \frac{1}{2} DR + ss$

(s,Q) policy is proposed using continuous review. A fixed quantity Q is ordered whenever the inventory position drops to the re order point (s) or lower.

Table 3. (s,Q) Policy

Product	μ D	σ D	ss	s	Q	AIL
Avastin 100 INJ	18	10	5	7	4	7
Herceptin 400 INJ	16	3	2	3	2	3
Mabthera 500 INJ	13	5	3	4	2	4
Glivec 100 MG	375	254	132	170	108	186
Tykerb 250 MG	464	122	63	110	195	181
Xeloda 500 MG	2237	515	268	492	683	609

(s,Q) policy is calculated using this following formula:

(1) $ss = F_s^{-1}(CSL)\ X\ \sigma_L$

(2) $s = D_L + ss$

(3) $Q = \sqrt{\frac{2DS}{hC}}$

(4) $AIL = \frac{1}{2}Q + ss$

Table 4. otal Inventory Values (in IDR)

Product	Existing	(R,S)	(s,Q)
Avastin 100 INJ	69,875,900	52,406,900	30,570,700
Herceptin 400 INJ	106,952,900	89,127,400	53,476,500
Mabthera 500 INJ	129,469,300	86,312,900	57,542,000
Glivec 100 MG	60,374,900	54,625,000	35,649,900
Tykerb 250 MG	83,870,738	12,409,100	13,212,000
Xeloda 500 MG	130,834,400	21,600,000	17,539,200

Based on the calculation above, we can see the differences of total value using proposed inventory policy and existing policy. Existing policy carries higher amount inventory on hand than two proposed inventory policy. However proposed inventory (s,Q) policy carries on less inventory than (R,S) policy. Thus, it is better to adapted the (s,Q) policy for oncology medication.

5.1. Demand Forecasting

In order to develop an appropriate inventory control, demand forecasting is highly needed. The major forecasting techniques in healthcare settings such as historical data analysis which employ analysis from previous data to determine future demand[19]. Although to do forecasting the accurate demand for drugs is difficult[6]. One of the problems regarding this situation is difficultness to have a correct data for drugs consumption. Moreover, different drugs brand preference of physicians creates additional uncertainties for predicting the demand .To cope this thing, demand patterns analysis can be done firstly then the mathematical modelling for accurately describe and simulate those patterns[20]. Table 4 shows the general nature of mean daily demand of oncology medication across all depots from warehouse B from January – June 2012.

Table 5. Mean Daily Demand of Oncology Medication

Demand Level	Description	Total	%
High Moving	Above 10 items / day	18	5
Moderate	5-10 items / day	12	4
Slow Moving	Less than 5 items / day	314	91

Adaptive forecasting technique is used such as moving average, simple exponential smoothing, trend-corrected exponential smoothing (Holt's model) and trend-seasonality -corrected exponential smoothing (Winter's model). Measures of forecast error are used to find a suitable technique for oncology medication, such as mean absolute deviation (MAD), mean absolute percentage error (MAPE) and tracking signal (TS).

Table 6 shows TS range for every product is in between -6 to 6, it means that all the forecasting technique is acceptable. However, Holt's model has the smallest MAD and MAPE for all products, except for Avastin. MAD represents the average of the absolute deviations over all periods while MAPE represents the average absolute error as a percentage of the demand. It can be conclude, Holt's model is an appropriate technique for oncology medication demand forecasting. It explains that oncology medication demand has level and trend in the systematic component.

Table 6. Oncology Medication Demand Forecasting

Product	Forecasting Method	MAD	MAPE (%)	TS Range
Avastin 100 INJ	Moving Average	11	155	-1 to 1.24
	SES	8	112	-2.66 to 0.54
	Holt's Model	8	80	-1.29 to 1
	Winter Model	6	68	-2.08 to 1
Herceptin 400 INJ	Moving Average	4	27	-0.8 to 2
	SES	3	17	-2 to 2.85
	Holt's Model	3	18	-2 to 1.75
	Winter Model	3	19	-2 to 1.23
Mabthera 500 INJ	Moving Average	5	31	-2.61 to 1
	SES	3	26	-0.67 to 2
	Holt's Model	3	17	-2.07 to 2.06
	Winter Model	3	21	-1.47 to 2.62
Glivec 100 MG	Moving Average	156	104	-1 to 3.41
	SES	194	107	-1.44 to 1
	Holt's Model	192	103	-1.16 to 1
	Winter Model	220	119	-1.52 to 1
Tykerb 250 MG	Moving Average	142	39	-1 to 1.47
	SES	96	24	-3 to 0.64
	Holt's Model	74	18	-1.32 to 2
	Winter Model	92	24	-3 to 0.78
Xeloda 500 MG	Moving Average	394	15	-1 to -3.75
	SES	379	17	-0.97 to 4
	Holt's Model	151	7	-1.63 to 1.58
	Winter Model	402	18	-0.96 to3.4

5.3. Reengineering System

Reengineering is not just automating the existing system, but it is about changing the existing system and then automating the new system[21]. A research has been conducted in India, shows that by reengineering the inventory system lead to several cost savings and improvement[22]. Several things could be done in order to deal with the lack of IT in hospital, such as the replacement of existing spreadsheets by implementing a software tool in order to record and monitor drugs distribution flow in the hospital, building integrated software that linkage between the hospital inventory system and the inventory management. The shaping of organizational structure is also considered. Top management support, role of pharmacy director is also needed. Since hospital is more heavily rely on different coalitions of stakeholders with different interest and responsibilities. Regarding the scope of this study is about inventory and operational management, this issue need to be examined further and analysed separately.

6. Conclusions

Results found the existing system of inventory management in one Indonesian of public hospital is not that much efficient. Complex situations of a changing new

system from third-party managed to own managed inventory made further obstacles in managing its inventory. Historical data inventory showed that hospital still holds too large amount of inventory on hand. With the same customer service level, (s,Q) proposed policy can reduce by 50% total inventory value on hand of oncology medication. Several forecasting techniques have been undertaken to seek the most suitable forecasting technique for oncology medication. Holt's model turns to be the best technique for oncology medication because has the smallest error compared to another.

By managing inventory effectively savings could be achieved in total inventory cost. Exploring factors that might affect hospital inventory management are needed in the next study. By examining the contextual side of hospital, a new inventory model will be build to cope with all the constraints and problems that will help hospital to implement a new model to manage hospital pharmacy inventory in effective and efficient way. Further study will be done by simulating inventory policies with forecast demand to find an appropriate inventory control model for the next period.

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