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DETERMINING THE OPTIMAL REPLENISHMENT POLICY FOR K-24 PHARMACY PONDOK PINANG

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Abstract

This research discusses about the regulation of product replenishment in K-24 Pharmacy Pondok Pinang. The main problem is that the total cost to replenish 4 products with highest value is too high. This may because of the existing regulation isn't optimal enough. The amount of stock in an order and the range time between orders is too flexible, and the lead time from ordering to receiving the product is also small, allowing the firm to order new supply almost in any day, without considering the ordering cost. The author decides to determine the optimal regulation for the future of product replenishment system in K-24 Pharmacy Pondok Pinang. Therefore, the author needs to find new strategies to find the right regulation of product replenishment system that can reduce the total cost. The theories used are demand forecasting to find the targeted year's estimated demand, continuous and periodic review policy with the ROP, EOQ, OUL and SS inside it to find whether the product should order with fixed quantity or range of time, business process to know the roles and help the implementation plan. The end of this research shows that K-24 Pharmacy Pondok Pinang should use the continuous review policy as their replenishment policy to minimum their total cost in the next years. Existing regulation is too flexible, the firm can order supplies with any quantity in any time, it may good to avoid lost sales but not for their costs. This research only focus to the inventory management of the 4 chosen product, the year used for observation is from the last 2 years (and 2011), and the variable of inflation and expired date will be ignored. There are changes in system of recording the stock and sales to support the proposed replenishment strategy. The outcome of this research is Replenishment Strategy in form of new Review Policy to apply to the K-24 Pharmacy Pondok Pinang's inventory management that can reduce the total cost. This research has an outcome which is Replenishment Strategy that can reduce the total cost.

Keywords: Inventory Management, Stock Replenishment Policy, Demand Forecast, Pharmacy Category: Performance Management; Operation.

Introduction

Nowadays drugs and medicine are important for human life. It's almost impossible for a man to live without medicines. Because of that, pharmaceutical businesses are now become more valuable. But this business isn't easy to implement. As a drugs distributor that directly associated to public, there are many risks that could be encountered by a drugstore/pharmacy such as compounding errors or mistakes in the drugs dosage that can cause death. Thus the professionalism of the employees had to be tested; it would take pharmacists who were trained for it. The other problem that may be encountered by a pharmacy is the wide variety of drugs nowadays. A drugstore/pharmacy can hold thousand kinds of drugs, so it will need a good storage management

One of a pharmacy business in Indonesia is Apotek K-24. It's a franchise type of business. The first K-24 pharmacy established in October 24, 2002 at Jalan Magelang, Yogyakarta, and has headquarters in Jakarta. It's a 24 hours service drugstore. K-24 pharmacy offers franchise business; it has many branches in Java. One of the branch is K-24 pharmacy Pondok Pinang, it is located at Jl Ciputat Raya no 17 C, Pondok Pinang. The K-24 pharmacy Pondok Pinang was established by an alumni group of SMA 1 Teladan Yogyakarta called KATY '84. KATY '84 is a group that works together to create businesses and generates profit. Mrs. Wrenges Widyastuti is the commissary of K-24 pharmacy

in Pondok Pinang. She is also a member of KATY '84, and also one of the investors.

The problem in K-24 Pharmacy Pondok Pinang that will be discussed in this research is the amount of total cost for the 4 highest value products; they are too high for the commissary Mrs Wrenge Widyastuti in the last two years (2010 and 2011). The 4 valued products are the products that have highest demand and give the most profit to K-24 pharmacy. The firm has their own regulation of ROP and EOQ, but this regulation seems to be not too strict and the ROP & EOQ aren't calculated properly. Small lead time allows the firm to order new supplies almost in any time, making the number of orders and also the annual ordering cost slightly increased, and finally affecting the total cost.

The objective of the research is to decrease the total cost of K-24 Pharmacy Pondok Pinang by making new regulations. The boundaries of the problem to determine the area that need to discuss. With this way, the process of making this research will be simpler, and can be more focused. The boundaries will be shown below:

1. The author will choose only 4 highest value products to discuss.
2. This research only focuses on the firm's inventory management.
3. The years used for observation would be start from the last 2 years (-2011).
4. The price of the products are fixed and not affected by inflation, and the product's expiration date will be ignored because the ED of a drug is very long.

Literature review

Supply Chain Management

A Supply Chain Management is a systemic, strategic coordination of the traditional business function within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performances of the individual companies and the supply chain as a whole^[1]. Supply chain business process integration involves collaborative work between buyers and suppliers, joint product development, common systems and shared information. According to Lambert and Cooper (2000), operating an integrated supply chain requires a continuous information flow. However, in many companies,

management has reached the conclusion that optimizing the product flows cannot be accomplished without implementing a process approach to the business. The key supply chain processes stated by Lambert (2004)^[2] are:

- Customer relationship management
- Customer service management
- Demand management style
- Order fulfillment
- Manufacturing flow management
- Supplier relationship management
- Product development and commercialization
- Returns management

SCM is a system that contains the process of delivering goods from the beginning supplier to the customers; it involves the supplier, manufacturer, retailer and the customers. In this final project, the key of supply chain processes that will be discussed is the Order fulfillment. The first research towards defining order fulfillment strategies was published by Mather (1988) and his discussion of the P:D ratio, whereby P is defined as the production lead-time, i.e. how long it takes to manufacture a product, and D is the demand lead-time, i.e. how long customers are willing to wait for the order to be completed^[3].

Inventory Management

Inventory is always dynamic. Inventory management requires constant and careful evaluation of external and internal factors and control through planning and review. Most of the organizations have a separate department or job function called inventory planners who continuously monitor, control and review inventory and interface with production, procurement and finance departments^[4].

Demand Forecast

Demand forecasting is the activity of estimating the quantity of a product or service that consumers will purchase. Demand forecasting involves techniques including both informal methods, such as educated guesses, and quantitative methods, such as the use of historical sales data or current data from test markets. The indicator of a forecast is its error. One measure of forecast error is the *mean absolute deviation* (MAD) which needs the

absolute deviation in period t (A_t) to determined first by making the absolute number of the error in period t (E_t)

$$|A_t - E_t| \dots \dots \dots (1)$$

MAD is defined to be the average of the absolute deviation of all periods, as expressed by

$$\frac{\sum |A_t - E_t|}{n} \dots \dots \dots (2)$$

The *mean absolute percentage error* (MAPE) is the average absolute error as a percentage of demand and is given by

$$\frac{\sum \frac{|A_t - E_t|}{A_t}}{n} \dots \dots \dots (3)$$

To determine whether a forecast method consistently over- or underestimate demand, we can use the sum of forecast errors to evaluate the *bias*, where the following holds:

$$\sum (F_t - D_t) \dots \dots \dots (4)$$

To see that a forecast is whether over- or under forecasting, we can calculate the *tracking signal* (TS):

$$\frac{\sum (F_t - D_t)}{\sum |F_t - D_t|} \dots \dots \dots (5)$$

If the TS at any period is outside the range ± 6 , this is a signal that a forecast is biased and either underforecasting ($TS < -6$) or overforecasting ($TS > +6$). In this case, K-24 pharmacy may decide to choose another forecasting method [5]

Replenishment Strategy

Replenishment is the movement of inventory from upstream – or reserve – product storage locations to downstream – or primary – storage, picking and shipment locations. The purpose of replenishment is to keep inventory flowing through the supply chain by maintaining efficient order and line item fill rates. The process helps prevent costly inventory overstocking.

Safety Stock

Safety stock (also called buffer stock) is a term used by logisticians to describe a level of extra stock that is maintained to mitigate risk of stock outs (shortfall in raw material or packaging) due to uncertainties in supply and demand. Adequate safety stock levels permit business operations to proceed according to their plans [6]. Safety stock is held when there is uncertainty in the demand level or lead time for the product; it serves as an insurance against stock outs.

Business Process

A business process or business method is a collection of related, structured activities or tasks that produce a specific service or product (serve a particular goal) for a particular customer or customers. It often can be visualized with a flowchart as a sequence of activities with interleaving decision points or with a Process Matrix as a sequence of activities with relevance rules based on the data in the process. A business process begins with a mission objective and ends with achievement of the business objective. Process-oriented organizations break down the barriers of structural departments and try to avoid functional silos.

Methodology

Preliminary Study

The preliminary study is the first step in this research to determine the topic and to identify the problem that faced by the company. In this step, the author do some research in the pharmaceutical businesses replenishment system such as the common strategy used in keep the business on track. The author uses root cause analysis to determine the cause, the Figure 1 below shown the root cause analysis:

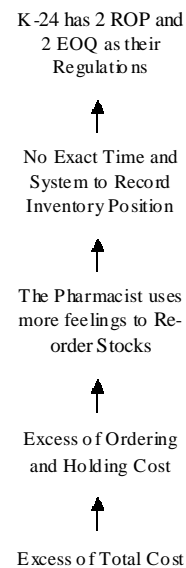


Figure 1. Root Cause Analysis

We can see on the figure above that the first cause of the main problem (excess of total cost) is that the firm has an unreliable replenishment system; they have 2 EOQ and 2 ROP for every product they sell. Moreover, the lead times from every vendor are short, allows K-24 to re-order new stocks in short time.

Problem Identification

The problem identification is really important for the author to determine and describe the exact problem that encountered by the company. The author main concern is about the inventory management for K-24 pharmacy.

Theoretical Foundation

The sources of theoretical foundations in this research are taken from supplement books such as *Operation Management* by Heizer and Render, *Supply Chain Management* by Chopra and Meindl, and from internet, that related to the research.

Data Collection

To obtain reliable data, the author needs to see the field and do some observation. From this trip, the author gets much important information like the preface of the store, the building's exact location and the store environment. But the most important and reliable data are recorded in their administration computer. The data is consists of two kinds:

- **Primary Data**
The author does an informal interview with the administrator (Ms Dian) to collect the information about KATY '84 (the investors) and other additional supportive data that has explained in previous chapter (mostly about company profile).
- **Secondary Data**
Collecting secondary data from K-24 pharmacy is quiet simple; the administration has various recorded data that needed for this research such as the sales data, stocks/remaining inventory data and others like financial record and company profile.

Conclusion and Recommendation

After the result of the analysis has been proved, the author will be able to make conclusion and maybe solution for the case. The author may give the suggestion that could improve the quality of supply chain management in K-24 pharmacy, the solution from data analysis could be implemented to the main problem that encountered by K-24 pharmacy.

Data Analysis

The Firm's Business Process

The business process in K-24 pharmacy divided into 2 processes; stock procurement and sales process. The Stock Procurement (replenishment) Process is start with the needs of new supplies in some products that can be determined by updating the inventory. After the products needed is determined and listed by the Pharmacy Manager, the Financial Division must calculate the fund needed to order the products. Then, the list of product needed will be given to the Assistant Pharmacy Manager, which will contacts the Distributor (supplier) to order the product via telephone. The payment of products ordered won't be done before the Assistant Pharmacy Manager check the quality of the products. If the ordered product's qualified, the Financial Division will transfer the money via ATM, while the products are stored in the inventory locker inside the pharmacy. If it isn't qualified, the product will be sent back to Distributor to be replaced with the new one. The sales process is the firm's process when it deals with the customer. This process starts with the order of the Customer to the Cashier. The Cashier then will inform the order to Pharmacy Assistant. The pharmacy assistant will check if the order needs process or not, if it's so, the Pharmacy Assistant will start the process (mixing, forming the product) while the Cashier asks the Customer to wait. If the order doesn't need process, then the Pharmacy Assistant just need to take the product from the inventory. When the process is done, the Pharmacy Assistant will give the product to the Cashier, and then the Cashier will inform the Customer that the process of making the product is done. After that, the Customer should pay for the product before they get it, and finally the sales will be recorded and sent to the Financial Division..

The Data Analysis

From the observation and interview, the author gets data of 8 products that have the highest sales in the last 2 years in K-24 pharmacy. To obtain the data needed, the author needs to choose 4 products that have the highest sales in the last 2 years and eliminate the others. Those products are Lipitor 20mg, Cataflam 50mg, FG Troches and Incidal OD. Their historical demand data are analyzed in Table I below:

Table 1. Data of Demand in the Last 2 Years of The 4 Highest Value Product

Month & Year	Lipitor	Cataflam	FG Troches	Incidal
January 2010	20	346	828	328
February	33	301	849	358
March	32	334	823	485
April	34	347	998	497
May	43	365	1120	433
June	10	315	1490	488
July	30	382	1025	494
August	61	396	1370	547
September	43	357	1645	699
October	95	383	1440	507
November	66	391	1215	554
December	134	402	1485	682
TOTAL 2010	601	4319	14288	6072
January 2011	43	421	1360	499
February	72	408	1646	528
March	75	447	1759	577
April	75	453	1670	636
May	60	445	1450	687
June	37	469	1740	581
July	136	486	1806	662
August	116	457	1625	697
September	107	477	1664	573
October	141	481	1515	643
November	87	492	1655	661
December	133	549	1786	833
TOTAL 2011	1082	5585	19676	7577
TOTAL 2010-2011	1683	9904	33964	13649

The table above is used to find many variables in the next step in the research. The total demand of Lipitor 20mg in 2010 and 2011 is 1683, Cataflam 50mg is 9904, FG Troches is 33964, and Incidal OD is 13649 tablets. These demand conditions are still low because K-24 Pharmacy Pondok Pinang is just open for 6 months and could be higher in the next year because they indicate an increasing trendline.

Current Replenishment Strategy

From the information the author get from Mrs Dian (the pharmacist), the K-24 Pharmacy Pondok Pinang has no holding cost because the inventory is stored inside the pharmacy, so the author will use 20% of each product's price as their holding costs per year as a fraction of product cost (h). K-24 Pharmacy Pondok Pinang has a regulation for their ROP, but it's not strict. They don't need to meet the ROP to order new supplies; they use more 'feelings' and the previous demand analysis to determine when they need to order new supplies. Here is the regulation for the 4 chosen products:

- Lipitor 20mg – EOQ = 60 tablets, ROP = 20 tablets
- Cataflam 50mg - EOQ = 250 tablets, ROP = 50 tablets
- FG Troches - EOQ = 600 tablets, ROP = 150 tablets
- Incidal OD - EOQ = 200 tablets, ROP = 30 tablets
- In Lebaran event, K-24 Pharmacy will restock one more boxes for each product needed. 3 boxes for Lipitor 20mg, 6 boxes for Cataflam 50mg, 4 boxes for FG Troches, and 8 boxes for Incidal OD.
- If the stock of a product has reach 0 (out of stock), the pharmacist will order as much as the number of boxes the product should be restocked in normal days. (Lipitor = 2, Cataflam = 5, FG Troches = 2, Incidal OD = 4)
- In every order, there is a delivery cost. The cost is different depends on each distributor's regulation, and the pharmacy usually adds IDR 5,000 as the tips for the deliverer.

The ROP above is made based on the historical data of K-24 Pharmacy and feelings. Actually, there are 2 ROP and Q in current condition, but

to order new supplies, K-24 Pharmacy usually use more feelings than their historical demand, making the actual regulation less reliable. So the author simplified it by choosing the highest Q as the regulation in current condition. K-24 Pharmacy Pondok Pinang also has a very short lead time (lead time = 1 day). This may because K-24 Pharmacy is a franchise company, so it has a trusted distributor (listed in chapter 1). So, because the lead time is very short, the demand during lead time may also small. The author now will compare the total cost of the current system with the proposed system (new replenishment policy) and the best result will be implemented to the future, which will be estimated by forecasting later. The Table II below is the total cost of the 4 highest value product in current condition:

Table 2. Total Cost of The 4 Products with Current System's Regulation

Product Name	Total Annual Cost (2010)	Total Annual Cost (2011)	Total Cost (2010, 2011)
Lipitor 20mg	8,983,095	16,102,480	25,085,575
Cataflam 50mg	17,191,204	22,188,860	39,380,064
FG Troches	11,895,044	16,265,488	28,160,532
Incidal OD	13,336,880	16,627,580	29,964,460

As we can see, the product that has the highest total cost of 4 products above in every year is Cataflam 50mg with IDR 17,191,204 in 2010, and IDR 22,188,860 in year 2011, so the total cost of Cataflam 50mg in the year 2010 and 2011 is IDR 39,380,064 which is the highest total cost between the other products. These costs can be reduced using the proposed strategy.

Proposed Replenishment Strategy

The proposed replenishment strategy is to change the current review policy with the new 2 review policy, which are the Continuous and Periodic review policy. The Continuous review policy determines the fixed quantity of product the firm must order in flexible range of time. The Periodic review policy is the opposite of Continuous review policy; it determines the fixed range of

time to order new supplies with flexible quantity of product. The Table III below is the comparison table between the current system and the two calculated proposed replenishment strategy in the year 2011:

Table 3. Total Cost of The 4 Products with Continuous Review Policy

Product Name	Current System's Total Cost	Total Cost using Continuous review policy	Total Cost using Periodic review policy
Lipitor 20mg	16,102,480	16,072,990	16,489,057
Cataflam 50mg	22,188,860	22,167,660	22,433,196
FG Troches	16,265,488	16,252,928	16,547,320
Incidal OD	16,627,580	16,463,180	16,766,024

After using the proposed review policy and get the result as listed in the Table III above, we can compare their total cost in year 2011 with the current system's total cost. The continuous policy's total cost seems to be smaller than the others and the priodic policy is seems to be higher than the others. So the firm should use continuous review policy and avoid using periodic review policy.

Demand Forecast

In this section, the author will explain about the forecast for the highest value products in year 2012. The forecasts implemented on every product will depend on the condition of the demand history in the last 2 years. The author may use more than one forecast method options (depends on the condition) and only choose the method with best result (has the least error). The indicator to choose the right method is the number of Track Signal (TS); it must between range of +6 and -6. There are 3 methods used for the demand forecast, Linear Regression, Moving Average, and Simple Exponential Smoothing. The result shows that the Linear Regression is the best method with the least error and has all the TS point between +6 and -6. The result of the forecast will be shown in the Table IV below:

Table IV. Forecasted Demand in Year 2012 Using Linear Regression Forecast Method

Period (Month)	Demand (Unit)			
	Lipitor	Cataflam	FG Troches	Incidal OD
1	124	520	1886	734
2	129	529	1924	747
3	133	538	1962	761
4	137	546	1999	774
5	142	555	2037	787
6	146	563	2075	800
7	150	572	2112	813
8	155	581	2150	827
9	159	589	2188	840
10	163	598	2225	853
11	167	606	2263	866
12	172	615	2301	879
TOTAL	1771	6806	25116	9676

From the table above, we can see that the forecasted demand will increase significantly, especially for the product Lipitor 20mg, on this year, this product has more total demand (1771 tablets) than the total demand in the 2 previous years with 1683 tablets.

Implementation of the Chosen Strategy to the Forecasted Demand

In this section, the author will implement the chosen strategy, which is continuous review policy, to the forecasted demand using chosen method, linear regression. The Table V is the estimated total cost calculation in year 2012:

Table 5. Total Cost of The 4 Products in The Forecasted Year Data

Product Name	Total Material Cost	Total Ordering Cost	Total Holding Cost	Total Cost (2012)
Lipitor 20mg	25,830,035	156,000	218,775	26,204,810
Cataflam 50mg	26,652,996	160,000	176,175	26,989,171
FG	20,4	140,	146,	20,70

Troches	19,308	000	700	6,008
Incidal OD	20,706,640	140,000	149,800	20,996,440

The total cost above is the total cost estimated in year 2012 using Continuous review policy and Linear Regression as the forecast method. The yellow cells contain the total costs for the 4 chosen products in targeted year (2012). We can see that the total cost of Lipitor will increased significantly from the previous years and approaching the total cost of Cataflam 50mg. This condition indicates that Lipitor 20mg can be the product with the most growth in year 2012.

Conclusion and Recommendation

Conclusion

K-24 Pharmacy Pondok Pinang's replenishment strategy isn't optimal enough; the variable used to order new supplies is only based on the previous periods and determined by feelings, which is unreliable.. The author created 2 strategies (Continuous and Periodic review policy) that involve important variable to determine the optimal costs that will be used to calculate the total cost. After the author gets the result from each strategy's calculation, then the result will be compared. The author also made 3 forecast methods of the demand for the targeted year based on the previous years (2010 and 2011) and chooses the method with the least errors, which is the Linear Regression method. Please note that the forecast method used is depends on the data in the previous years For example, in 2013, the method used to forecast the demand in 2014 may be different, it depends on the actual data in the previous year. The strategy with the least total cost will be chosen and will be implemented to the demand data in the forecasted year. Finally, the author has found the best result for K-24 Pharmacy Pondok Pinang; it is the continuous review policy, which means the quantity of product ordered should be fixed, with ROP as the point to re-order.

Recommendation

The only recommendation to reduce total cost of the 4 products is to implement the continuous review policy. The policy would probably make the firm to check their inventory every day, so a new system of sales record should helps the replenishment strategy.

Implementation Plan

After creating the new review policies, K-24 Pharmacy Pondok Pinang may implements the strategy by following the implementation plan. The Figure 2 below is the implementation plan offered by the author:

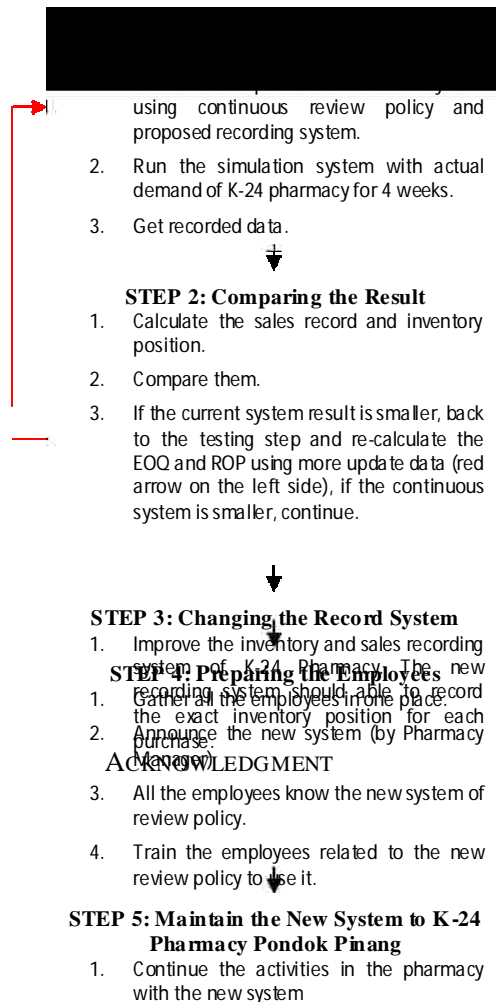


Figure 2. The implementation plan for K-24 Pharmacy Pondok Pinang

The implementation plan is divided into 5 steps. The first step is the testing process, in this step there is a new system that not conducted with current system, this new system must using proposed policy but facing actual demand, and the result is the data of sales and inventory with new policy. The second step is to compare the result recorded with current condition and the result with new system, if the new system has worse result, then the firm must re-calculate the variable of ROP and EOQ with more update data

and tests it again, if the result is better, continue to step 3. In the step 3, the firm must change the system, using the continuous review policy with calculated ROP and EOQ, and the system should have the inventory position record. After the system changed, the firm must get all the employees announced about the new system, in this 4th step, the employees also should get trained and applied the system more than 1 week. The last step is to maintain the regulation in the firm, if there is big loss in a period, the firm must re-calculate the ROP and EOQ and fix the forecast data with more update demand data.

Future Research

For future research, the author recommends to expand the research on the explanation of assumed variables like lead time and the h for the holding cost. The author also recommends to expand the research on implementing the proposed strategy; the simulation system in the first step would be complex to explain.

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