Comparison Continuous and Periodic Review Policy Inventory Management System Formula and Enteral Food Supply in Public Hospital Bandung

Santi Setyaningsih and Mursyid Hasan Basri

***Abstract*—Inventory management system hospital is one of the things that need to be considered to satisfy the needs of the patient. Not only medicine but also food in hospitals is a product that has a storage area and the system needs to be set in order to provide added value to the hospital especially in nutrition installation department. This study aims to look at the comparison of the use of basic inventory policy in formula and enteral food supply. The results show that all of formula and enteral food supply under study really fit to use periodic review policy to calculate inventory management system because the demand of these products is not really high compared to the other food supplies. Besides, this research tries to looking for a period of inventory management system maintenance so that it can found the minimum cost incurred or the period which still tolerable for tracking inventory management system itself.**

***Index Terms*—Formula and enteral food supply, inventory management system, public hospital, supply chain management system.**

I. Introduction

Perishable products can be divided into two parts. Those are time dependent and time independent products. The examples of time dependent perishable product are green vegetables, fruits, milk, flowers, meat, New Year greeting cards, Christmas trees and more, because it has a short life in its use. While the examples of the time independent perishable product are fashion products, mobile phones, personal computers, and others, because it was useful for customers in a significant period of time but have much less economic value. Inventory management system for perishable products more difficult than a non-perishable product, due to the short life cycle, low salvage value, long supply chain with the fragmentation of supply chain ownership, as well as the uncertainty of supply, demand and dynamic pricing [1].

Effective and efficient of inventory management system can affect supply chain management significantly to improve cycle service levels and reduce costs [2]. Stanger, *et al*. [3] conducted research on inventory management system of perishable products. The purpose of the research was to identify how the perishable products can drives good management in SCM (Supply Chain Management). There are 6 recommendations for managers to be able to increase the performance of the perishable product. Tiwari [4] conducted a study in bread product that only needs a shelf life of one day. The focus of this study is the management of perishable product inventory in the store with high volume. The result of the study was expected to increase the yield advantage of the effectiveness of the solutions which developed in this research. In contrast to those researches, the products examined in this research are formula and enteral food supplies which classified as perishable product and this research will make comparison between inventory policies and it will see which policies that appropriate to implement for the product under study.

This research focuses on the inventory management system of perishable products, enteral and formula food supply. The objective is to find the best policy of inventory management in order to manage the product under study and also wants to find the fit period time to manage that inventory system itself.

The paper is organized as follows: Section II is concerned with literature review on the supply chain management system, inventory management system and perishable product in inventory management system to identify the existing gaps of literature; Section III presents the research methodology and explanation of current situation. In Section IV is concern with the calculation of inventory management system policy. Finally, Results of the calculation and highlight on areas of future research are discussed in Section V and VI.

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II. Literature Review

A. Healthcare Service Supply Chain Management

The service sector is becoming increasingly important worldwide. Value added means enhancements supplementing a product or service by a company before the product is offered to customers. The service sector has been growing at about ten times the rate of non-service sectors [5]. Samuel, *et al*. [5] defined service process as one where the main contribution is welfare of others and provides an intangible commodity.

From all of these explanations, many service sectors that can be studied in the future. However, the healthcare is one of the services sectors which should serve as an important facility for the research. The healthcare business is provided by a variety of product and service enterprises including medical consumables, pharmaceuticals, catering, laundry

cleaning, waste management, home-care products, information technology, vehicle fleet management and general supplies [6]. Healthcare is a special facility, because it is a 24 hours a day, 7 days a week facility and furthermore, a mistake in a hospital can cost the life of a human being. Based on the explanation of Lennerts, *et al*. [7] hospitals also must constantly update their equipment to meet state of the art standards and if possible to go beyond this service level and offer cutting edge technologies at exorbitant prices.

Kumar, *et al.* [6] describes the advantage of reengineering in the healthcare supply chain, noting that the healthcare industry has historically viewed itself as being operationally different from other businesses. This is due to healthcare providers' belief that, unlike managers in manufacturing industry, they cannot control or project their production schedules. The healthcare industry's supply chain management problems do not only end up with poor inventory control, and stem from years of outdated supply chain strategies.

It can conclude an agreement statement of the descriptions that have been described, that the supply chain management was conducted in different way to the healthcare service compare to the manufacturing. The difference lies in the consumption of the customer, giving rise to problems in inventory management. Therefore, it need for the research using simulation that will provide solutions in case of certain problem.

Kumar, *et al.* [6] states that healthcare supply chains have evolved from mass to focused marketing and the facilities in future must concentrate on single integrated supply chains. But there were some previous researches that refer to the SCM at the hospital that was not focused on of the marketing research which one of them was conducted by Xiong and Pokharel [8] who mapped the logistics activities in Singapore Hospitals. It defines various types of activities handled by a logistics division. Inventory management policy and the use of information and communication technologies (ICT) for logistics purposes are also discussed. The study identifies the nature of strategic alliances in Singapore's health care industry. The details of those terms contained in the SCM logistics.

In addition it has conducted research on the healthcare logistics management initiative [9]. The focused on this research was four main components of the healthcare supply chain. Those were producers, purchasers, providers, and patients. Producers manufacture the tools and materials used by providers in delivering healthcare to patients. The providers acquire the tools and materials either directly from the producers or through purchasers such as group purchasing organizations (GPOs) and distributors. But this research does not explicitly study the delivery of healthcare to the patient.

From the few researches that have been conducted, the presence of gaps for future research was the study of Xiong and Pokharel [8] and Smith, *et al.* [9].The activity of the logistic mapping is the first step in conducting research on supply chain management. For further research, new research can do the same thing but expanded the scope of the activity in order for the purchasing of products from the supplier until the delivery products to the customer in a hospital environment.

B. Inventory Management System

Supply chain management consists of several sectors, one of which is inventory management, which is part of the internal company's job. If the company can manage inventory system effectively and efficiently, thus it could make a result in a reduction of operating costs [10]. Inventory system refers to the solving problems of stock in the business. Good stock management will maximize business benefits, and vice versa, the failure to control the stock will result in a loss benefit of company [11].

There are two replenishment policies are often used in practice, those are continuous review and periodic review. Continuous review indicates that inventory status is continues to be tracked and ordering according to lot size (Q) was done when the level is reached entrusted inventory reorder point (ROP). While periodic review indicates that inventory status tracked at regular periodic intervals and reorder was made to raise the inventory level to the point of a predefined. These inventory system policies are not comprehensive, but sufficiently to provide solutions to problems concerning the safety of the inventory management system [10].

The advantage of continuous review is to address the situation where demand is high but the disadvantage is variable order quantity. The supplier can make mistakes more often and they would prefer the customers who ordered the fixed order quantity. This situation is vice versa with periodic review policy [12]. Here there are inventory profiles:

1) Continuous Review (Q method)

$$SS = FS^{-1}(CSL) \times \sigma_L \quad (1)$$
$$ROP = D_L + SS \quad (2)$$
$$CI = Q/2 \quad (3)$$
$$AIL = CI + SS \quad (4)$$
$$D_L = DL \quad (5)$$
$$\sigma_L = \sqrt{L}\sigma_D \quad (6)$$
$$Q = \sqrt{(2DeS)/hC} \quad (7)$$

2) Periodic Review (P method)

$$SS = Fs^{-1}(CSL) \times \sigma_{T+L} \quad (8)$$
$$D_{T+L} = (T + L) D \quad (9)$$
$$\sigma_{T+L} = \sqrt{(T+L)}\,\sigma_D \quad (10)$$
$$OUL = D_{T+L} + SS \quad (11)$$
$$AIL = (DT)/2 + SS. \quad (12)$$

This is the definition of a few terms:

SS = safety stock
CSL = cycle service level
CI = cycle inventory
ROP = reorder point
Fs^{-1} = normsinv
σ_{T+L} = standard deviation of demand during T+L
T = review interval
L = average lead time for replenishment
D = average demand per period
σ_D = standard deviation of demand per period
σ_L = standard deviation of demand during lead time
D_{T+L} = mean demand during T+L
OUL = order up to level
AIL = average inventory level
Q = lot size

De = annual demand
S = order cost per lot
h = holding cost
C = unit cost

C. Perishable Product in Inventory Management System

Suppliers for perishable products with short product term have contract problems for products that have near the expired date and the new one. The situation is even more difficult when most of buyers have a high preference for newer products [13]. The other problem which comes out from perishable product is the inventory management for perishable product. Most of the problem in perishable product inventory management is the optimal or near optimal ordering policy system to minimize the operating cost items, such as standard inventory control, inventory position information, the optimal ordering policy of any product seen from the life of the product so that it can be expected when the product is expired. Problem is the standard problem of inventory management, but it will look more difficult because the products which studied more easily damaged [14].

Perishable products are the products with quality that deteriorate over time, and have a lower value. Perishable products are the most rapid decay rapidly if not refrigerated or other preservation techniques. Common perishable products include food, drugs, plants and agricultural products, dairy products, fish products, fruits and vegetables. These products are examples of products that are sensitive to temperatures that can affect the damage and decay [15].

The food which provided by hospital reflects the hospital services. Services include supply of food choices for all patients along with a balanced nutrition and the level of hygiene every day. Nutrition adequacy for inpatient, quality food supply, adequate services are not only for the patient but for the hospital staff also which served with the proper temperature and quality are a major factor in hospital food service [16]. There are two categories in the food supply. Those are catering management or independently management by the hospital itself. Problems faced by each category are different. If hospital used catering, the problem is health policy, whereas if it managed by themselves, the problem is point of sale and product management.

III. Research Methodology

This research was used qualitative research because it used field survey study and interview for data collection with the experts at the hospital which was classified as qualitative method. This research also classified as case study research which concern at nutrition installation division for one public hospital in Indonesia especially in the inventory management system. It used a set of data which collected in 2009-2012 for the calculation of inventory management system. The research was conducted in several stages. There are six stages in the conceptual framework of this research which shown at the image.

Based on the flow of research, Fig. 1 describes which policy that suitable for every product under study and also this research can show the scenario periodic review that can give positive impact for the department, such as profit or a new system that can be applied.

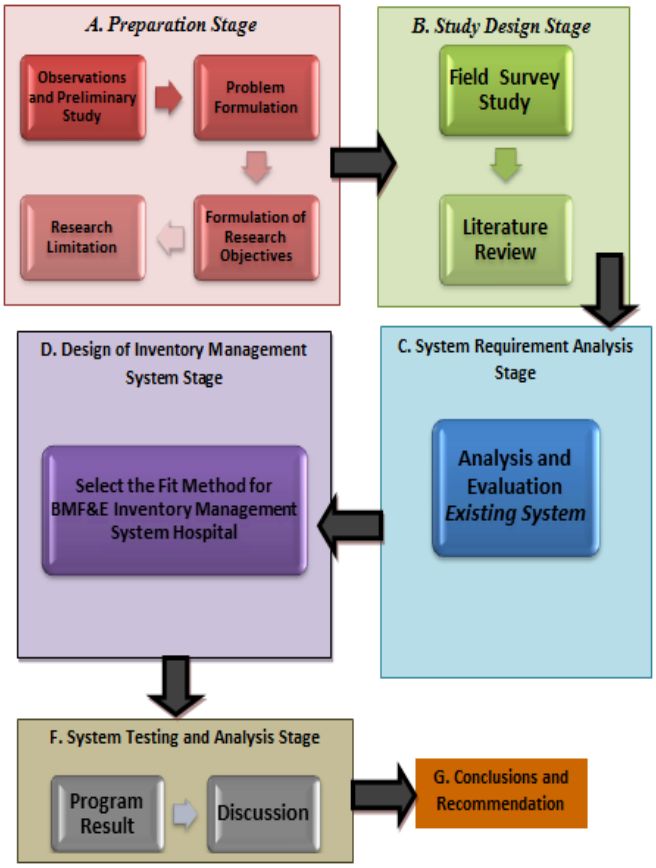

Fig. 1. Research methodology.

IV. Data Calculation

The main issue on Nutrition Installation is the number of products that had expired in large quantities. From the analysis of the BMF&E data January to September 2012, here are 11 products that have high inventory value levels that impact to the high inventory cost as well and often appear in the data:

TABLE I: Formula and Enteral Food Supply High Inventory Value

No	Product Name	Unit	Brand
1	High Calcium Milk	boxes	Anlene
2	Infant Formula + Lactose and FOS	boxes	Vitalac 1
3	Infant Further Formula by Imuno Nutrient	boxes	Lactogen 2
4	Special Babies Formula BBLR MCT	can	Neosure
5	Enteral Feeding Children Low Lactose	can	Pediasure
6	Semi Elemental Peptide	can	Peptamen
7	Polymeric Multivitamin, Mineral with Prebiotic	can	Ensure FOS
8	Special Infant Formula BBLR with Whey Protein	boxes	Enfalac
9	High Polymeric Fibers	can	Nutren Fibre
10	Enteral Feeding Children with DHA & FOS	boxes	Vitaplus
11	Special High-Carbohydrate Liver Disorders	boxes	Hepatosol

If it looks from inventory stock and usage, then the products can be classified as follows:

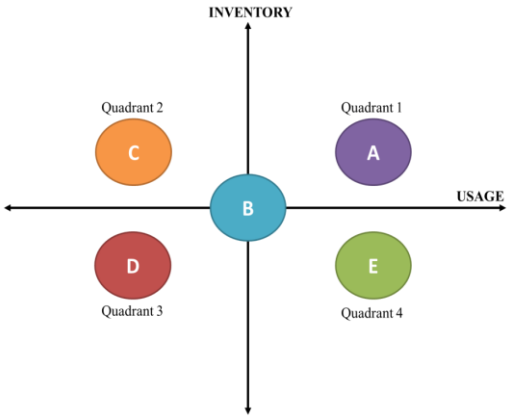

Fig. 2. Product classification.

TABLE II: CLASSIFICATION EXPLANATION

Product Type	Usage	Inventory
A	High	High
B	Medium	Medium
C	Low	High
D	Low	Low
E	High	Low

Product type E is one problem because the demand was high but the availability was quite minimal in the warehouse. In this research, product type D and E are not further analyzed because they are not a major problem in Nutrition Installation. Product of A, B and C is the main point, which have a high inventory levels that affect to the inventory cost of Nutrition Installation warehouse. The 11 products that often arise will be elaborate for the inventory data, monthly usage and purchase of each month. After the analysis, those products classified into products type, this research chose 5 products from type A, B and C.

TABLE III: BMF&E (*BAHAN MAKANAN FORMULA & ENTERAL*) UNDER STUDY

Product Type	Product Name	Brand	Unit
A	High Calcium Milk	Anlene	boxes
	Enteral Feeding Children Low Lactose	Pediasure	can
B	Special High-Carbohydrate Liver Disorders	Hepatosol	boxes
C	Special Babies Formula BBLR MCT	Neosure	can
	Semi Elemental Peptide	Peptamen	can

Based on the explanation in the previous section, there are two policy inventory management systems which are continuous and periodic review. The following table is a calculation of the continuous review inventory policy management system enteral formulas and food supply. From these calculations will be seen average inventory level and average inventory value which will be compared with the current situation that already happened in this department. This research will compare the policy depends on the same cycle service level.

TABLE IV: PROPOSED CONTINUOUS REVIEW POLICY INVENTORY SYSTEM

Product Name	Unit	Q	σ_L	ROP	SS	CI	AIL	AI Value Q Rev (IDR Tho)
Anlene	boxes	94	1	7	4	47	51	3,034
Pediasure	can	33	4	7	6	16	22	4,152
Hepatosol	boxes	81	7	18	15	41	56	4,332
Neosure	can	26	1	3	3	13	15	1,695
Peptamen	can	51	3	14	12	26	37	5,953

The calculation will produce a continuous review inventory system profile with safety stock policy for each product and it can be seen in the picture below.

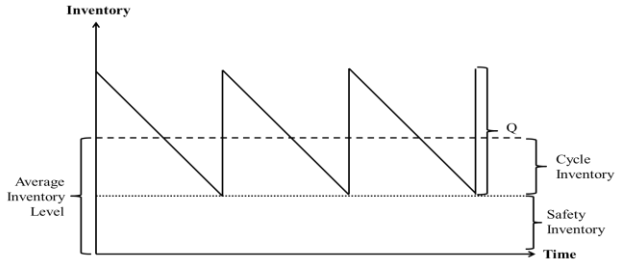

Fig. 3. Continuous review policy inventory management system.

In contrast to the continuous review policy, the following table is a calculation of periodic review inventory policy management system.

TABLE V: PROPOSED PERIODIC REVIEW POLICY INVENTORY SYSTEM

Product Name	Unit	D_{T+L}	σ_{T+L}	SS	OUL	AIL	AI Value P Rev (IDR Tho)
Anlene	boxes	17.5	1.6	10	28	17	1,025
Pediasure	can	6.7	10.9	14	21	17	3,212
Hepatosol	boxes	17.0	16.6	37	54	44	3,441
Neosure	can	2.4	2.8	6	9	7	807
Peptamen	can	14.0	7.1	29	43	34	5,493

Based on calculation, this is the periodic review inventory system profile with safety stock policy for each product.

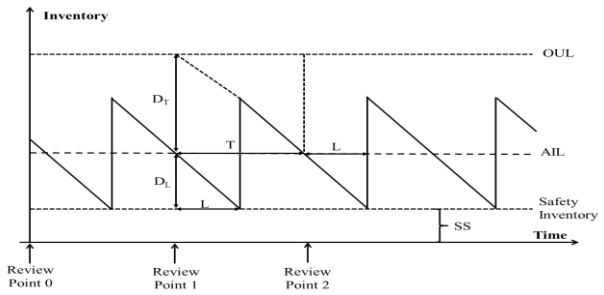

Fig. 4. Continuous review policy inventory management system.

Based on the calculation of both review policy inventory management system and then compared to the current situation average inventory value. It can see percentage

saving at the following table from both policies. This table below is a comparison between those policies.

TABLE VI: COMPARISON CONTINUOUS AND PERIOD REVIEW

Product Name	Unit	AI Value Q Rev (IDR Tho)	AI Value P Rev (IDR Tho)	AI Value Old Rev (IDR Tho)	Q Rev Saving	P Rev Saving
Anlene	boxes	3,034	1,025	12,976	77%	**92%**
Pediasure	can	4,152	3,212	16,288	75%	**80%**
Hepatosol	boxes	4,332	3,441	6,439	33%	**47%**
Neosure	can	1,695	807	7,158	76%	**89%**
Peptamen	can	5,953	5,493	28,149	79%	**80%**

After the comparison between those two policies, then it carried out experiments for different periods of inventory checks. These times are derived from the provisions of the hospital. Back then it compared again between continuous review, periodic review and current situation.

TABLE VII: COMPARISON AVERAGE INVENTORY VALUE

Product Name	AI Value (IDR 10^6)						
	P Rev 5 Days	P Rev 7 Days	P Rev 10 Days	P Rev 15 Days	P Rev 30 Days	Current Data	Q Rev
Anlene	0.7	0.8	1.0	1.4	**2.3**	13.0	3.0
Pediasure	2.3	2.7	3.2	**4.0**	6.0	16.3	4.2
Hepatosol	2.5	2.9	3.4	**4.3**	6.4	6.4	4.3
Neosure	0.6	0.7	0.8	1.0	**1.5**	7.2	1.7
Peptamen	3.9	4.6	**5.5**	6.8	10.2	28.1	6.0

V. DATA ANALYSIS AND DISCUSSION

The reason for the calculation method in managing inventory management system is because high values of inventory management system in formulas and enteral food supply of this hospital. Sustainability of high value inventory management system will cause losses for the hospital, not only the defective product is wasted, but also the financial benefit of diminishing returns. This research tries to provide solutions for the appropriate storage techniques so that it does not happen again in the future by using the basic calculations inventory management system.

Tracking inventory system is one of the things that are important for a business that sells tangible goods. Continuous and periodic reviews are two common methods in tracking inventory system that includes accounting and ordering products. Both policies have own advantages and disadvantages. Calculation and documentation of the periodic review policy made during a certain period, meanwhile the continuous review policy involves the calculation and documentation of each item in each time when the item is removed from inventory.

Nutrition installation department did not use any particular calculation for inventory management system as an existing method, so that the five products under study had about 40% of the cost of storage itself. Nutrition installation department only do meet the demand without notice other things such as safety stock products, cost of inventory, warehouse capacity and others which are actually important for hospital's profit.

Table IV describes the results of those calculation policies. Continuous and periodic review produced better results than keep running the existing method. If this department still runs existing methods, there will be impact to the wasted destruction food and lost financially intense. Comparison of the results can be seen from the average inventory level, average inventory value and saving BMF&E. Continuous review policy result in saving about 75% for all the products, except on Hepatosol by 33%, while the periodic review policy result in saving around 85%, except for Hepatosol by 47%.

The advantage of using continuous review policy are to allow updating inventory counts in real time so it will be easier to know when to reorder items in the future. Furthermore, it can facilitate an accurate accounting calculation, because the system can provide the costs of goods sold in real time. The disadvantage is the high cost of implementation. While the advantages of periodic review policy is the reduction of time for business owner or manager to analyze the amount of inventory, so they can use that time to think about other aspects of the business. The disadvantage is that inaccuracies in determining the amount of inventory if a business have a high sales volume. The business owner or manager must build the assumption of the analysis period inventories and supplies, besides it is of course make an impact on the accounting inaccuracies.

This research resulted in the suggestion that all of five BMF&E products should be used periodic policy in the future. It can be seen in Table IV that most of the product BMF&E under study better use of periodic review policy. With periodic review policy, savings can be made on the product Anlene by 92%, Pediasure 80%, Hepatosol 47%, Neosure 89% and Peptamen 80%.

Broadly, the BMF&E is better to use of periodic review policy in the calculation of inventory management system in the future because most of the BMF&E products consumed in small amounts and have the unit prices are not too high. Thus, it performed experiments to change the time period inventory tracking system. Generally dry food ordering between 5, 7 to 10 days [17]. It was conducted with the addition of trial order for every 15 and 30 days. The smaller tracking period, the lower the average inventory value and in periods of a month it is still relies value of average inventory value is lower than other methods, so it can be tolerated. Anlene and Neosure still can do a review between 30 days, while Pediasure and Hepatosol still can do a review between 15 days; 10 days for Peptamen. BMF&E more appropriate to use periodic review policy due to the amount of demand for the product is not too high.

VI. CONCLUSION

Based on the problem which has been faced of nutrition installation department, that is the excess accumulation of inventory in formulas and enteral food supply affecting the financial loss and ineffectiveness of the inventory

management system was the reason for this research. This paper provides advice on the department to perform mathematical calculations such as average inventory level, economic order quantity, average inventory value, safety stock and others in their inventory management system. So it will not happen again in the future undesirable losses and it can make improvement system as well.

The result showed about savings in inventory cost of each product. Savings of average inventory value proposed method on Anlene is 92%, Pediasure 80%, Hepatosol 47%, Neosure 89% and Peptamen 80%. All of these products are more suitable for use periodic review policy. In addition to the experiments done with the ordering period, Anlene and Neosure still can do a review between 30 days, while Hepatosol and Pediasure still can do a review between 15 days and Peptamen for 10 days. For further research, it will be conduct simulation modeling system with variable which match with the character of BMF&E. Then, it will make several of scenarios that can be show us the more effective and efficient scenario for inventory management system in nutrition installation department of public hospital in Bandung city.

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