Material Planning and Inventory Control in the Nutrition Service Unit at Ummi Hospital Bogor

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ABSTRACT

Inventory management is a critical component of supply chain management that involves the planning, controlling, and overseeing of inventory levels to ensure the availability of materials while minimizing costs. Proper inventory management ensures that essential food supplies are always available, allowing the hospital to provide consistent and varied meal options tailored to patient needs. Effective inventory management also ensures that there are no disruptions in meal service due to stockouts and avoids the capital and storage issues related to overstocking. This study aims to provide solutions to hospital in terms of planning and controlling the materials for the 2024 budget year so that hospital can improve in term of inventory management. Economic Order Quantity model is used to determine the optimal number of orders to be made to maintain inventory at a certain level while optimising inventory costs. The result showed, the optimal order quantity for chicken meat is 41 kg, beef is 21 kg, and rice is 112 kg, and the inventory cost incurred due to the stock is Rp. 170,000, Rp. 268,000 and 191,400, consecutively.

1. INTRODUCTION

Inventory management in a hospital environment is critical for several reasons. Effective inventory management ensures that hospitals can provide continuous high-quality care to patients while maintaining operational efficiency and cost control (Irnawati, 2021). One of the hospital support services that needs attention in its inventory is the nutrition service unit. Inventory management in hospital nutrition is critical to ensure that patients receive timely, nutritious, and safe meals. Proper inventory management ensures that essential food supplies are always available, allowing the hospital to provide consistent and varied meal options tailored to patient needs. Effective inventory management also ensures that there are no disruptions in meal service due to stockouts and avoids the capital and storage issues related to overstocking (Chopra & Meindl, 2016). From a financial perspective, by implementing inventory management, hospitals can minimise food wastage by tracking expiry dates and using a FIFO system, ensuring older stock is used first (Kumar & Rajeev, 2016). By maintaining optimal stock levels, hospitals can avoid costs associated with overstocks and emergency purchases at higher prices (Muller, 2020). Therefore, the budgeting and financial planning can be more accurate.

Ummi Hospital Bogor is a type C public hospital located at Jl Empang II No. 2 Bogor which has excellent services for maternal and child health. Ummi Hospital has a fairly high level of patient visits both outpatients and inpatients. The average number of inpatients per day ranges from 100-150 patients. The nutrition service unit is responsible for the fulfilment of food nutrition for patients, doctors and hospital staff. It's activities that starts from menu planning and materials needs, procurement and storage of materials to food distribution. The material planning is the most important stage since it should be based on accurate data such as the number of patients, doctors and staff on duty every day and included in a monthly shopping plan (Assauri, 2019 and Eunike, 2021). At the materials procurement stage, the challenge faced by hospitals is the different delivery times from each supplier. The timing of ordering materials needs to be well organised, so that the stock is always available when needed. The staff often face problems in the availability of material stocks. The amount of stock provided is sometimes insufficient and this results in a higher frequency of material purchases as well as increased the ordering costs. On the other side, the differences of product characteristics require hospital to provide appropriate storage. For example, fresh products such as meats are stored in freezers, vegetables are stored in

chillers and spices are stored in dry areas. Therefore, the materials will avoid the risk of damage, contamination and shrinkage during the storage period.

The Economic Order Quantity (EOQ) is widely used by researchers to solve problems in inventory management. The EOQ model is used to calculate the optimal quantity of inventory to order that minimizes the total cost of inventory management, including ordering costs (costs associated with placing orders) and holding costs (costs associated with storing inventory) (Vikaliana, 2020). In food chain industries, the EOQ model helped optimize order sizes, balance inventory levels, reduced risk of overstocking and stockouts, reduce storage costs, leading to improved efficiency and reduced food wastage. Therefore, company can be significantly reduced the operational costs and waste in food production (Kumar and Singh, 2020). In the same way, Smith and Johnson (2022) said the effective inventory management practices for fresh produce also significantly improve inventory turnover rates. This results in fresher products for consumers and lower operational costs for company. In food retail industries, Nguyen and Tran (2018) said the EOQ model helped retailers to maintain an optimal balance of stock, ensuring product availability and minimizing spoilage.

Miller and Carter (2019) found the implement of EOQ model has an impact on the inventory cost reducing by 20% and improved service levels. The model facilitated optimal order quantities and timing, resulting in a balanced inventory and reduced risk of overstocking and stockouts. On the other side, Garcia and Lopez (2018) concluded that effective inventory management practices in the food processing industry reduced costs by 15% and improved production efficiency. Techniques such as demand forecasting and just-in-time inventory were key in maintaining optimal inventory levels. A study in retail industry conducted by Green and Brown (2020) showed that effective inventory management practices could reduce food waste in supermarkets by 25%. The use of inventory tracking systems and regular stock audits helped in identifying and managing excess stock. While in dairy industry, applying the EOQ models reduced cost by 30% and minimized spoilage (Srinivasan and Patel, 2019)

Based on the literature review, this research will use the EOQ model to determine the optimal order quantity that can minimise the total cost of inventory, which includes ordering costs and storage costs. In this research, the author will only focus on the main food materials such as rice, chicken meat and beef where the three ingredients have a large component on the menus and hospital often experience inventory shortages. This study aims to provide solutions to hospital in terms of planning and controlling the materials for the 2024 budget year so that hospital can improve in term of inventory management. In the future, hospital can maintain the inventory level that aligns with the demand rate, enhancing turnover rates while avoiding the stockouts or excess inventory.

2. METHODOLOGY

This research is a comprehensive case study and uses a quantitative descriptive approach to analyse the problem of inventory management in the nutrition service unit of Ummi Bogor Hospital. Gay, Mills & Airasian (2011) explained quantitative descriptive research is a type of research that aims to describe or analyse phenomena systematically and objectively using quantitative data. This research focuses on describing the characteristics or variables observed in a population or sample, without making conclusions or testing certain hypotheses. The source of data used by the author are primary data and secondary data. Primary data is obtained by interviews the key persons related to inventory control. While secondary data is obtained from company documentations such as projection demand for certain materials, ordering costs, storage costs, price per unit product, average demand per day, and lead time. Descriptive analysis is used in the discussion of EOQ, safety stock, reorder point, maximum inventory quantity and inventory cost. The data collection methods used in this research are interviews and observations.

This research uses the Economic Order Quantity model, an inventory management technique used to determine the optimal number of orders to be made to maintain inventory at a certain level while optimising inventory costs. EOQ is based on the linkages between storage costs, ordering costs, and demand requirements (Haizer & Render, 2019). The variables are storage costs, annual demand, and

ordering costs. The calculation of the order quantity using the EOQ model is calculated by the formula as follows:

$$\text{EOQ} = \sqrt{\frac{2 \times D \times S}{H}}$$

Where:

EOQ = optimal order quantity

D = demand per period

S = ordering cost

H = storage cost per unit

The EOQ model will generate the most economical order quantity of each material then the order frequency during a year can also determine. Safety stock also needs to calculated to anticipate demand uncertainty and inventory shortages. The next step is determining reorder point. Reorder point is the inventory level at which a new order should be placed to replenish stock before it falls to a critical low level. It accounts for lead time and average demand during this period, ensuring that new stock arrives before the existing stock is depleted. The variables are lead time, average demand per day and safety stock. Finally, total inventory cost can be generated by adding up the total storage costs and ordering costs.

3. RESULTS AND DISCUSSION

Results

Material Planning

Planning food materials, especially in a hospital setting, involves a systematic approach to ensure that nutritional needs are met efficiently and cost-effectively while minimizing waste. This process includes demand forecasting, menu planning, procurement, inventory management, and sustainability considerations. For the demand forecasting, management usually reviews the past consumption patterns to identify trends and average usage rates. The officer then will set the plan for a variety of foods to provide balanced nutrition and prevent menu fatigue. After the menu is set, then continued to generate purchase orders based on forecasted needs and menu plans. Currently, there are 5 vendors collaborate with the hospital in supplying food materials. To supply these 3 main food materials, the hospital has contractual agreements with 3 different vendors. Generally, all vendors and sources are coming from local area which results in significantly reduced transport costs.

Table 1. Projected Demand for Chicken Meat, Beef and Rice for Year 2024

Month	Materials		
	Chicken Meat	Beef	Rice
	Kg	Kg	Kg
Jan-24	333	184	863
Feb-24	294	213	575
Mar-24	305	196	978
Apr-24	248	184	748
May-24	207	173	633
Jun-24	345	282	662
Jul-24	426	340	460
Aug-24	328	276	414

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Sep-24	69	127	1.035
Oct-24	219	111	690
Nov-24	253	167	805
Dec-24	248	219	805
Total	3.275	2.472	8.668

Cost Components

Ordering Cost

The EOQ model considers several cost components, which can be categorized into three main types: ordering costs, storage costs, and total inventory cost. Ordering cost is incurred when the hospital procures materials. Ordering costs, also known as setup costs, are the expenses incurred every time an order is placed. These costs are fixed per order such as administrative cost, transportation cost and receiving cost. Ordering costs for the three food materials is only comes from administrative cost which is related to communication with vendors (phone call/WhatsApp/email), while transport costs are borne by the relevant vendors. The ordering costs of each material is Rp 1.000

Storage Cost

Storage costs also known as carrying costs, are the expenses associated with storing and maintaining inventory over a period. Storage cost is determined according to the hospital policy, which is 10% of the purchase price of each food materials.

Table 2. Cost Components

Ordering Cost (Rp)		
Chicken Meat	**Beef**	**Rice**
1.000	1.000	1.000
	Storage Cost Per Unit (Rp)	
Chicken Meat	**Beef**	**Rice**
4.000	12.000	1.400

Optimal Order Quantity Using the EOQ Model

The EOQ model allows hospitals to determine the most optimal ordering quantity of materials with a constant demand and lead time. Based on calculations with the EOQ model, the most economical order quantity for each material is as follows:

Table 3. Optimal Order Quantity

Order Quantity (Kg)		
Chicken Meat	**Beef**	**Rice**
41	21	112

On the table above, it can be seen the quantity of each material purchased by the hospital every time they place an order of material within one year. With these calculations, the hospital will obtain an economical cost. The amount of optimal order is determined by the total annual demand of each material. Refers to Table 1, rice has a higher quantity order compared to other materials, thus from the EOQ results show the quantity order of rice is also higher, followed by chicken meat in the 2nd place and then beef.

Order Frequency

Order frequency refers to how often orders are placed over a certain period to replenish inventory. It is a critical component of inventory management, as it helps determine the timing and regularity of orders to maintain optimal stock levels. Order frequency is influenced by various factors

such as demand rate, lead time, storage costs, and ordering costs. Total order frequency can be calculated by the formula as follows:

$$\text{Order Frequency} = \frac{D}{Q}$$

Where:
D = Number of orders in one year
Q = Optimal quantity per order

Table 4. Order Frequency

Order Frequency (Times)		
Chicken Meat	**Beef**	**Rice**
80	118	78

As we can see on the table above, beef has a higher frequency than others, meaning that the storage of beef is shorter. The fresh beef should be procured 118 times in a year or in the other words, the hospital should be reorder in every 3 days while chicken meat and rice is every 5 days.

Total Ordering Cost

Total ordering cost is a key component of the Economic Order Quantity (EOQ) model, which represents the sum of all expenses incurred each time an order is placed for inventory. These costs are typically fixed per order and do not vary with the size of the order. The formula for calculating ordering costs for 1 year is as follows:

$$\text{Ordering Cost} = \frac{D}{Q}S$$

Where:
D = Number of orders in one year
Q = Optimal quantity per order
S = Order cost per order

Table 5. Total Ordering Cost

Total Ordering Cost/Year (Rp)		
Chicken Meat	**Beef**	**Rice**
80.000	118.000	78.000

Total Storage Cost

Storage cost, also known as carrying cost or holding cost, refers to the expenses associated with storing inventory over a period of time. These costs are incurred to keep inventory in a warehouse or storage facility and include various elements such as rent, utilities, insurance, and labor. The formula for calculating storage costs for 1 year is as follows:

$$\text{Storage Cost} = \frac{Q}{2}H$$

Where:
Q = Optimal quantity per order
H = Storage cost per unit

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Table 6. Total Storage Cost

Total Storage Cost/Year (Rp)		
Chicken Meat	**Beef**	**Rice**
82.000	126.000	78.400

Refers to Table 5 & 6, beef consistently has a higher cost both of ordering and storage cost. The more frequent hospital procures the materials, the more ordering cost are incurred. Beef has a higher ordering frequency, so its resulting on high ordering costs. On the other hand, beef also has a higher price compared on two other materials and it's impacted to the higher storage cost.

Safety Stock Calculation

Safety stock is an additional quantity of inventory held in reserve to protect against uncertainties in demand or supply. It acts as a buffer to prevent stockouts caused by variations in customer demand, delays in supplier deliveries, or inaccuracies in demand forecasting. The primary purpose of safety stock is to ensure that a company can continue to meet customer demand even when unexpected events occur. It helps maintain service levels and avoid potential lost sales, backorders, or disruptions in production.

Based on Ummi Hospital's policy, the amount of safety stock has been determined on the three ingredients, i.e. 2 kg of chicken and meat, and 25 kg of rice. Safety stock costs can be calculated by the formula as follows:

$$\text{Safety Stock Cost} = H \times \text{Safety Stock}$$

Where:

H = storage cost per unit
SS= Amount of safety stock

Table 7. Total Safety Stock Cost

Safety Stock Cost (Rp)		
Chicken Meat	**Beef**	**Rice**
8.000	24.000	35.000

Reorder Point

The reorder point (ROP) is the inventory level at which a new order should be placed to replenish stock before it runs out. It ensures that there is enough inventory to meet demand during the lead time, which is the time taken from placing an order to receiving the inventory. The reorder point helps prevent stockouts and ensures continuous availability of products. The reorder point for each type of materials varies depending on how long the lead time of each material is. The reorder point calculation formula is as follows:

1. Material requirement per day: $$d = \frac{D}{\text{Total of working days in a year}}$$

2. Reorder Point: $$ROP = (d \times L) + \text{Safety Stock}$$

Table 8. Reorder Point

Material	Requirement/day (Kg)	Lead Time (Day)	Safety Stock (Kg)	ROP (Kg)

Chicken Meat	9	2	2	20
Beef	7	1	2	9
Rice	24	2	25	73

Total Inventory Costs

Total inventory cost encompasses all the expenses associated with ordering, holding, and managing inventory. It is a comprehensive measure that includes ordering costs, holding costs, and stockout costs. The goal of inventory management is to minimize the total inventory cost while meeting customer demand and maintaining efficient operations. The total cost of inventory can be calculated by the formula as follows:

$$\text{TIC} = \left(\frac{Q}{2} \times H\right) + \left(\frac{D}{Q} \times S\right) + Safety\ Stock\ Cost$$

Table 9. Total Inventory Cost

Material	Storage Cost (Rp)	Ordering Cost (Rp)	Safety Stock Cost (Rp)	Total Inventory Cost (Rp)
Chicken Meat	82.000	80.000	8.000	170.000
Beef	126.000	118.000	24.000	268.000
Rice	78.400	78.000	35.000	191.400

Discussion

The EOQ result represents the ideal number of units that should be ordered each time to minimize total costs. It strikes a balance between ordering too frequently, which incurs high ordering costs, and ordering too infrequently, which leads to high holding costs. Rice has a higher quantity order compared to other materials due to it has lower storage cost. In the menu component, rice has the largest composition so that the need for rice is the most compared to other ingredients Consolidating orders and storing larger quantities can reduce the frequency of deliveries, thereby reducing handling and administration costs associated with receiving and processing multiple smaller orders. Result of this study in line with the theory stated by Bowersox, Closs dan Cooper (2013), by optimizing the order size, EOQ reduces the number of orders placed, thereby lowering the total ordering costs. Larger inventories reduce the risk of stockouts, which can incur significant costs such as expedited shipping or lost sales. Maintaining a higher inventory level can balance the potential costs of shortages against storage costs.

Meanwhile, beef has smaller quantity order due to higher of storage cost compared to others. As storage costs increase, the EOQ decreases. Heizer & Render (2014) said EOQ also balances the order size to ensure inventory levels are not excessively high, which reduces storage costs and risks of obsolescence. This means the optimal order quantity will be smaller to reduce the amount of inventory held and thus lower the storage costs. Higher storage costs lead to more frequent ordering of smaller quantities. This reduces the average inventory level, thereby minimizing the capital tied up in inventory and the risk of depreciation or obsolescence.

4. CONCLUSION

Based on the results of calculations and data processing using the EOQ model on material supplies for the budget year 2024, the optimal order quantity for chicken meat, beef and rice is 41 kg, 21 kg, and 112 kg, consecutively. Total cost of ordering chicken meat is Rp. 80.0000, beef is Rp. 118.000 and rice is Rp. 78.000. Total storage cost of chicken meat is Rp. 82.000, beef is Rp. 126.000 and rice is

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Rp. 78.400. The frequency of ordering chicken meat is 80 times, beef is 118 times, and rice is 78 times. Safety stock cost of chicken meat is Rp. 8.000, beef is Rp. 24.000 and rice is Rp. 35.000. Total inventory cost of chicken meat is Rp. 170.000, beef is Rp. 268.000 and rice is Rp. 191.400. Reorder point for chicken meat is 20 Kg, beef is 9 Kg, and rice is 73 Kg.

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