Journal of Innovation, Business and Entrepreneurship
Online Journal – Bachelor of Entrepreneurship
School of Business and Management – ITB
E-ISSN: 2549-4295

PERISHABLE FOOD-INVENTORY MANAGEMENT IMPROVEMENT USING SINGLE-PERIOD INVENTORY MODEL

Kharisma Muhammad and Desy Anisya Farmaciawaty
School of Business and Management
Institut Teknologi Bandung, Indonesia
Kharisma.muhammad@sbm-itb.ac.id

Abstract. Rasakhano is a restaurant with perishable inventory. This research was aimed to analyse the inventory in a restaurant, specifically the perishable inventory of Rasakhano restaurant. The main objective of this research is to reach the best optimum supply quantity of perishable ingredients where most of the customers can meet their demand while the restaurant itself still have the very least food waste. For this research, researcher uses historical sales and inventory data of Rasakhano from July 2017 until November 2017. The data will be processed with single-period inventory model. From the analysis, researcher discovered that the restaurant has the potential of obtaining 59% more possible profit then before. The restaurant also discovered the cost of shortage from each menu to know the cost Rasakhano will put out if there is a certain amount of order that cannot be fulfil. By calculating the cost of overage, the restaurant knows the cost that will be put out if there is a certain amount of menu portion that is not sold in a certain period. The restaurant discovered the optimum stock for each menu to fullfil customers demand while still minimizing the waste of perishable food inventory.

Keywords: Inventory Control, Inventory Management, Restaurant, Perishable Inventory, Perishable Food Waste

Introduction

Rasakhano is an Indonesian local restaurant that serve Indonesian local food with new experience. That experience is that we cook our meal in teppanyaki style cooking for the audience and customers to enjoy. While the customers are eating they can enjoy some flambe and juggling show. We are placed on the side of the street but not on the street itself. We also have a good hygiene and use a normal and quality ingredient that is healthy for the customers. Rasakhano is an everyday restaurant with inventory problems.

Currently, Rasakhano is in desperate problem because of the big loss from the very big cost and very little sales and cash flow. In July, the margin of total cost to total sales was 67%, in August is 88.3%, in September is 90.78%, in October is 89%, and in November is 94%. In general, this restaurant is doing very bad right now. Some factors that cause this to happen are lack of sales, unstable inventory of food items, many wasted food items, etc.

Table 1 Percentage of Lost (July-November 2017)

Month	Inventory Input (Portions)	Ordered Portions	Total Waste	Percentage of Loss
July	701	607	94	13.4%
August	642	569	73	11.37%
September	629	543	86	13.68%
October	569	502	67	11.77%
November	304	247	57	18.75%

Based on the table 1, it can be seen that the percentage of loss is still so many and can be caused from both nature and labour. Most of the food items that is used in Rasakhano's kitchen perishable food items that have a very short life span. That is why if the items are not sold they will become waste.

Problems in the food and beverage or even the food service industry inventory are related to false and inaccuracy in determining of how much to purchase and when to order (Farsad & Lebruto, 1993). Deciding a correct inventory is very hard, moreover there are a few factors that will impact choices on determining the inventory. Those factors are: correct forecasting of sales, correct predicting consumers wants and knowledge, supplier reliability and efficiency, maintaining, receiving, storing, and application of menu items (Farsad & Lebruto, 1993). On the opposite if the owner can manage and supply the inventory the right way and forecast, it can help the restaurant meet the expected consumer demand and the restaurant itself does not have to waste so many ingredients that are not selling out.

Methods

Foodservice

Foodservice industry right now is understood by people as a place where food is regularly served outside the home (Payne-Palacio & Theis, 2016). Examples of such establishments are formal restaurants, hotel dining rooms, coffee shops, family restaurants, speciality and ethnic restaurants, and fast-food restaurants. Foodservice that operate in school, colleges, universities, hospitals, companies nursing home, and many more are also included (Payne-Palacio & Theis, 2016). Foodservice face decisions on how to organize departments for the efficient procurement, production, distribution, and service of their food and meals (Payne-Palacio & Theis, 2016). Options are available based on where the food is prepared to where it is served to the customer, and the duration between (Payne-Palacio & Theis, 2016).

Cycle Service Level

Cycle service level is the end of one cycle of sale that finishes with all the demand of customer being met. Cycle service level is the same with having the chances of not having a stock out in a sales activity cycle. Cycle service level is recommended to be measured after a specific number of sales activities or cycle (Chopra & Meindl, 2016). The service level of a menu in a restaurant determines the probability of a restaurant to fulfill a customer's order and the chance of not fulfilling a customer's order and going out of stock (Chopra & Meindl, 2016).

Inventory Management

Inventory is one of the most important and expensive assets of many companies including the food and beverages industry (Heizer, Render, & Munson, 2016). Operations managers or chief of operation around the world have recognized that good inventory management is very crucial (Heizer, Render, & Munson, 2016). A food and beverage company can reduce their cost by reducing inventory, on the other hand production may stop and customers become disappointed when a menu item is out of stock or sold out (Heizer, Render, & Munson, 2016). Inventory Management involves inventory planning and control which involves physical product, the time span to produce goods or when to purchase them (Heizer, Render, & Munson, 2016). Once these decisions have been maned, the next step is to forecast demand (Heizer, Render, & Munson, 2016).

Single-period Inventory Model

The single-period model is used to order perishables or other items that have limited useful life and value. This is an everyday problem for products like newspaper, seasonal items, pastry, and short-life food products. This problem is often named the newsstand problem which means that any items that have been ordered and ready to sell cannot be stored in the inventory for the next sales activity. To minimize the leftovers, companies decide on how much to order at the beginning. The demand for perishables or seasonal items is very hard to be known or predict (Waters, 2003).

There is a trade-off between supplying too much and too little that needs to be considered. Single-period work by calculating the service level. The service level is the percentage of time that we have enough on hand. The service level is based on the trade-off of supplying too much or too little which both have their own cost (Waters, 2003).

- $\text{Cost of Shortage}(CS) = SP - UC$ = **EQUATION 1**
  - SP = SELLING PRICE
  - UC = UNIT COST

If a customer comes to buy a product but the shop does not have enough product, it means the shop have a shortage. The cost is the difference between of the revenue of what you could have sold and the cost of creating or getting the product. The shop gave up profits by not having enough product to fulfil the customer's demand.

- Cost of Overage(CO) = UC – SV = **EQUATION 2**
  - UC = UNIT COST
  - SV = SALVAGE VALUE = 0

By having too much products at the end of a sales activity will cost shops an overestimated cost. If the product does not have any salvage value, then the cost of overage is just the cost of the product to be made and stored in the inventory. If the product has overage which it can be sell on the next day, but it does not have the same value as before then it has a salvage value. Which means the cost of overage is reduced by the amount the product that can be sell in the next sales activity.

- Service Level $= \frac{cost\ of\ shortage}{cost\ of\ shortage + cost\ of\ overage}$ = **EQUATION 3**

The service level is to be used to calculate the optimal supply.

- MEAN $= \mu = \frac{\sum x}{N}$ = **EQUATION 4**
  - $\sum$x = sum of a data population value
  - N= number of data items in a population
- STANDARD DEVIATION $= \sigma = \sqrt{\frac{\sum |X-\mu|^2}{N}}$ = **EQUATION 5**
  - $\sum$ = sum of
  - X = value in the data set
  - μ = mean
  - N = number of data points in the population
- OPTIMUM SUPPLY QUANTITY = (μ) + (Z Value x σ) = **EQUATION 6**
  - μ = Mean
  - σ = Standard Deviation

Optimum supply quantity is used to calculate the ideal quantity to serve per day to minimize perishable waste while still fulfilling customer's demand. Optimum supply is affected by mean, z value, and standard deviation, so it will change by the month with the increase or decrease of demand (Stevenson, 2002).

Results and Discussion

In this chapter, researcher want to analyse the inventory problem of Rasakhano. Researcher want to analyse the perfect quantity of food portion to serve per day to minimize perishable ingredient waste. After that, researcher will upgrade the service level to upgrade the optimum stock to reach the optimum profit. Researcher will be using the single-period inventory model to analyse the historical sales data from July until November 2017 period which is 111 days to find the quantity to serve per day to minimize the food waste. Researcher will calculate the cost of shortage and the cost of overage to analyse the current service level and compare it to a higher service level to see which is the most profitable with the least cost. Table 5.1 shows the data that will be used for the research.

Table 2 Rasakhano Menu Sold/Month

Menu	Jul	Agu	Sep	Okt	Nov	Grand Total
Gulai	131	120	111	91	69	522
Tongseng	91	99	93	94	73	450
Sate Ayam	51	63	74	46	43	277
Sate Sapi	91	53	71	63	45	323

Nasi Teppan Ayam	98	97	76	91	57	419
Nasi Teppan Sapi	124	97	112	98	46	477
Grand Total	586	529	537	483	333	2468

To do this research, researcher uses the historical sales data of Rasakhano from July until November 2017 period. Researcher make sure the data are normally distributed, so it can be used for the data analysis. Researcher make sure the P-value data for each menu is more than equal to 0,05. By making sure the data is normally distributed, researcher can start analysing the data to calculate the mean and standard deviation to finally calculate the optimum stock for each menu.

Rasakhano serve six main dishes to the customers. The main dishes are Gulai, Tongseng, Sate Ayam, Sate Sapi, Nasi Teppan Ayam, and Nasi Teppan Sapi. These six main dishes have different price and cost of goods sold calculated from each item to create one portion menu item, which created different cost of shortage and cost of overage.

Table 3 Rasakhano Menu Price, COGS (Cost of Good Sold), and Profit

Menu	Price	COGS	Profit
Gulai	Rp23.000	Rp9.200	Rp13.800
Tongseng	Rp25.000	Rp10.000	Rp15.000
Sate Ayam	Rp19.000	Rp10.000	Rp9.000
Sate Sapi	Rp25.000	Rp9.000	Rp16.000
Nasi Teppan Ayam	Rp24.000	Rp9.600	Rp14.400
Nasi Teppan Sapi	Rp29.000	Rp10.500	Rp18.500

By analyzing the table 3, researcher can calculate the cost of shortage and cost of overage by using **EQUATION 1** and **EQUATION 2**.

Table 4 Rasakhano Cost of Shortage

Menu	Cost of shortage
Gulai	Rp13.800
Tongseng	Rp15.000
Sate Ayam	Rp9.000
Sate Sapi	Rp16.000
Nasi Teppan Ayam	Rp14.400
Nasi Teppan Sapi	Rp18.500

Table 5 Rasakhano Cost of Overage

Menu	Cost of Overage
Gulai	Rp9.200
Tongseng	Rp10.000
Sate Ayam	Rp10.000
Sate Sapi	Rp9.000
Nasi Teppan Ayam	Rp9.600
Nasi Teppan Sapi	Rp10.500

By calculating the cost of shortage and overage, researcher can calculate the service level by using **EQUATION 3** to see how much demand can Rasakhano fulfill and what are the chance of going out of stock which leads to unfulfilled demand.

Table 6 Rasakhano Service Level Sales Period July – November 2017

Menu	Service Level
Gulai	60%
Tongseng	60%
Sate Ayam	47%
Sate Sapi	64%
Nasi Teppan Ayam	60%
Nasi Teppan Sapi	64%

By calculating the optimum stock using **Equation 6**, researcher can calculate the right amount of quantity of portion to be made every day to minimize the chance of having unsold and waste menu.

Table 7 Rasakhano Mean(μ), Standard Deviation(σ), & Z Score

Menu	Mean	Standard Deviation	Z Score
Gulai	5	2	0,253347103
Tongseng	4	3	0,253347103
Sate Ayam	2	2	-0,066011812
Sate Sapi	3	2	0,358458793
Nasi Teppan Ayam	4	3	0,253347103
Nasi Teppan Sapi	4	3	0,352933986

To calculate the optimum stock for each menu, researcher use the sales data from July until November 2017 mean(μ), standard deviation(σ), service level, and Z score. The Z score is obtained by matching the service level to the Z table.

Table 8 Rasakhano Optimum Stock and Profit per Day

Menu	Optimum Stock Quantity	Possible Profit
Gulai	5	Rp69.000
Tongseng	5	Rp75.000
Sate Ayam	2	Rp18.000
Sate Sapi	3	Rp48.000
Nasi Teppan Ayam	4	Rp57.600
Nasi Teppan Sapi	5	Rp92.500

By using the current service level, mean(μ), standard deviation(σ), and Z score from Rasakhano Sales July until November 2017, Researcher can calculate the optimum stock level and profit per day. With the current situation in Rasakhano, this is the most ideal optimum stock to fulfill customer demand and minimizing perishable food waste. With the current optimum stock quantity, the total profit per day will possibly be Rp360.100.

Table 9 Optimum Stock with the most profitable income possible

Menu	Current Service Level	Upgraded Service Level	Current Optimum Stock Level	Upgraded Optimum Stock Level	Current Profit	Possible Profit

Gulai	60%	95%	5	8	Rp69.000	Rp110.400
Tongseng	60%	70%	5	6	Rp75.000	Rp90.000
Sate Ayam	47%	70%	2	3	Rp18.000	Rp27.000
Sate Sapi	64%	95%	3	6	Rp48.000	Rp96.000
Nasi Teppan Ayam	60%	80%	4	7	Rp57.600	Rp100.800
Nasi Teppan Sapi	64%	90%	5	8	Rp92.500	Rp148.000

By using the single-period inventory model, researcher calculated the most optimum stock with Rasakhano's current service level. As Rasakhano going to grow, the market will also grow. To get the most profit Rasakhano decided to increase its service level to prevent out of stock while still having the chance of minimizing the waste. As can be seen in the table 9, by applying the single-period inventory model, Rasakhano have improve its possible profit by 59% from Rp360.100 to Rp572.200.

Conclusions

Based on the data analysis with the single-period inventory, it can be seen to reach the optimum quantity stock of menu portion, Rasakhano should consider the cost of shortage, cost of overage, and service level to see what quantity is the right one that can fulfill customer's demand but still minimize the chance of having perishable food waste. After that, like every business, Rasakhano wants to improve as a restaurant and reach higher customer. Researcher then compare the current service level of Rasakhano to higher service level to see the possibility of reaching that service level and getting higher customer while having the smallest food waste with some considiration from each menu.

By doing this research, researcher know that Rasakhano did not have a system for inventory stock control because of the food waste created before this research conducted is quite high with a minimum at 11.37%. This research shown the cost of shortage which is the cost Rasakhano will have to put out if a customer's demand is not fulfilled and the cost of overage which the cost Rasakhano will have to put out if a certain amount of food portion is not sold on a certain period. By knowing this, Rasakhano knows the risk of serving too much and too little of a portion.

By calculating both cost of shortage and cost of overage, Rasakhano is able to see the current service level and see what is the possibility of fulfilling a customer's demand and the possibility of going out of stock. Then, turning the service level to Z score so it can be computed to the optimum stock equation and resulting the optimum stock of each menu. The optimum stock for gulai is 5 portions per day with total profit of Rp69,000 with 60% service level; tongseng is 5 portions per day with total profit of Rp75,000 with 60% service level; sate ayam is 2 portions per day with total profit of Rp18,000 with 47% service level; sate sapi is 3 portions per day with total profit of Rp48,000 with 64% service level; nasi teppan ayam is 4 portions per day with total profit of Rp57,600 with 60% service level; and nasi teppan sapi is 5 portions per day with total profit of Rp92,500 with 64% service level.

After calculating the current service level, Rasakhano compare it to higher service level with some considerations. The first one is that as every business restaurant, Rasakhano will improve in every way as in marketing and food quality to attract more customer. The second one is to create more promotions to attract more customers. The third one is approaching the new Bandung Creative Hub that just open on December 2018 to reach new and loyal customers. With those factors, Rasakhano raised the service level to be applied on the restaurant. For gulai is from 60% to 95%. For tongseng is from 60% to 70%. For sate ayam is from 47% to 70%. For sate sapi is from 64% to 95%. For nasi teppan ayam is from 60% to 80%. For nasi teppan sapi is from 64% to 90%. By doing this and the help of the factors to raise

the customers, Rasakhano raised its possible profit from Rp360.100 to Rp572.200 per day with 59% improvement while still minimizing the perishable food waste.

Implication

From this research, to make the inventory management spesifically the perishable inventory in Rasakhano more effective. Rasakhano uses the Single-Period inventory model to decide how many portions per day for each menu to be made with the purpose of fulfilling customer's demand while minimizing the perishable waste. To do this, Rasakhano needs to calculate the cost of shortage to see the cost that Rasakhano will put out if there is a certain amount of order that cannot be fulfilled because the menu is out of stock. Rasakhano also calculate the cost of overage to see the cost that Rasakhano will put out if there is a certain amount of portion that is not ordered in a certain period and turns into waste. By calculating and knowing the cost of shortage and cost of overage, Rasakhano have another factor to consider on how much stock will be added to reach the most profitable optimum stock while still minimizing waste. This study can be useful for researcher and other food&beverages business industry to calculate and know the most optimum stock with the most optimum possible profit while still minimizing perishable waste.

References

Chopra, S., & Meindl, p. (2016). *Supply Chain Management Strategy, planning, and operation.* Boston: Pearson Education.

Farsad, B., & Lebruto, S. (1993). *A measured approach to food-inventory management.* The Cornell Hotel and Restaurant Administration Quarterly.

Heizer, j., Render, B., & Munson, C. (2016). *Operations Management Twelfth Edition.* London: Pearson Education.

Payne-Palacio, J., & Theis, M. (2016). *Foodservice Management* . England: Pearson Education Limited.

Ryan, T. (2018). *What Is a Concept Description in Terms of a Restaurant Business?* Retrieved from Chron: http://smallbusiness.chron.com/concept-description-terms-restaurant-business-35430.html

Waters, D. (2003). *Inventory Control and Management.* England: Wiley.