

## SINGLE-PERIOD INVENTORY MODEL TO IMPROVE THE EFFICIENCY OF INVENTORY MANAGEMENT IN PERISHABLE RESTAURANTS

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*Abstract.* Santuy is a street food company which sell satay. Like every perishable restaurants, Santuy has a problem with perishable inventory, it has a waste problem that make a high decrease in profit margin. In keeping this company running, researcher have to find an optimal supply quantity and service level to decrease the waste value but on the other hand also keep fulfilling customers demand every day. In past 7 months, Santuy has a specified value of waste. The cost is Rp1,937.77 for waste in every portion and make the loss percentage of profit to 30.08%. Therefore, the objective of this research is to reach the best optimum supply quantity and the optimum service level in future for perishable ingredients where most of the customers can meet their demand while the restaurant itself still have the very least food waste, besides that this research also help the researcher in finding the possible profit in the future. For this research, researcher uses historical sales and inventory data of Santuy from October 2018 until April 2019, researchers also do a benchmarking by observing and interviewing Giggle-Box as a perishable restaurant for further research and comparison. The data processed with single-period inventory model. The optimum stock for gulai is 3 portions per day with total profit of Rp18,717.33 with 42% service level; opor is 2 portions per day with total profit of Rp12,478.22 with 42% service level; original is 2 portions per day with total profit of Rp12,478.22 with 42% service level. The ideal service level to create the most profitable income for gulai is from 42% to 92%. For opor is from 42% to 91.5%. For original is from 42% to 93%. The percentage of growth of Santuy Profit per Day by applying single-period inventory is 157% from Rp43,673.77 to Rp112,303.98. In the end researcher found the optimum supply quantity and using the sensitivity analysis, researcher found the optimum service level for the future and possible profit. On the other hand, Giggle-Box which take role as out benchmarking have some unique technique that can help Santuy in resolve this problem, one of the techniques called "thawing" which help in reducing the value of waste in the perishable restaurants.

*Keywords:* Inventory Control, Inventory Management, Restaurant, Perishable Inventory, Perishable Food Waste, Sensitivity Analysis

### INTRODUCTION

Based on Food and Agriculture Organization of the United Nations, Street foods are ready-to-eat foods and beverages prepared and/or sold by vendors or hawkers especially in the streets and other similar places. The major concern in street food is related to food safety, but other concerns are also reported, such as sanitation problems (waste accumulation in the streets and the congestion of waste water drains). In maintaining the hygiene and decrease the number of health problem we have to keep the sustenance and refreshment of the product. Santuy is a street food restaurant that sells taichan satay with traditional sauce, and like most of street food, its also has a waste inventory management problem which is waste problem. For the chicken, the waste 50gr/ portion, and make it 40% of the waste percentage, for the gulai and opor sauce, the waste is 13.53ml/ portion and make it 9.02% of waste percentage, for the carrot and cucumber, the waste is 1.25 gr/ portion and make it 50% of waste percentages. And if we pulled, it will also effected the profit. Total profit in last 6 months is Rp7,504,211.00 before waste, after waste, the total profit decrease to Rp5,768,948.90, the gap is Rp1,735,262.10 and 30.08% for the loss percentages. To reduce the waste and keep fulfilling the customers demand, researcher need to find the optimum portion for each menu. Other than that, researcher also need to find the optimum service level to get the optimum profit. In finding the service level and optimum portion right now, we will use a single-period inventory model. Keren (2009) in her book said a single period inventory model describes a situation in which one order is placed for a product. At the end of the sales period, any remaining product has little or no value (perishable goods). In finding the optimum service level for optimum profit, researcher use a sensitivity analysis. As refer to Saltelli (2002), Sensitivity analysis is the study of how the uncertainty in the output of a mathematical model or system (numerical or otherwise) can be divided and allocated to different sources of uncertainty in its inputs.

### LITERATURE REVIEW

#### 1. Inventory Management

As refer to Kenton (2019), Inventory management is a process of ordering, storing and using a company's inventory: raw materials, components and finished products. A company's inventory is one of its most valuable assets. In retail, manufacturing, food service and other inventory-intensive sectors, a company's inputs and finished products are the core of its business, and a

shortage of inventory when and where it's needed can be extremely detrimental. At the same time, inventory can be thought of as a liability (if not in an accounting sense). A large inventory carries the risk of spoilage, theft, damage, or shifts in demand. Inventory must be insured, and if it is not sold in time it may have to be disposed of at clearance prices – or simply destroyed.

## 2. Service Level

Schalit (2014) once said that in the supply chain, the service cycle level (or just the service level) is the probability that it is expected not to run out of stock during the next filling cycle, and thus, also the probability of not losing sales. The cycle duration is implicitly the waiting time. Service level can also be defined as the probability of being able to serve the demand of customers who have faced any orders or lost sales. The cycle service level should not be confused with the fill rate which represent the fraction of demand that is served without delays or lost sales. Indeed, the notion of service levels is only relevant for situations where future demand is uncertain - if not, achieving a 100% service level is just the right scheduling problem. When future demand is uncertain, the only theoretical way to not leave space to run out of stock consists of choosing unlimited supplies. So, in practice, inventory managers need to be satisfied with an imperfect trade-off inventory. This exchange is measured precisely through the idea of service level.

## 3. Normality Test

In statistics, based on D'Agostino (1986) normality tests are used to determine if a data set is well-modeled by a normal distribution and to compute how likely it is for a random variable underlying the data set to be normally distributed.

## 4. The Assumption of Normality

Based on Mordkoff (2016), When you take the parametric approach to inferential statistics, the values that are assumed to be normally distributed are the means across samples. To be clear: the Assumption of Normality (note the upper case) that underlies parametric stats does not assert that the observations within a given sample are normally distributed, nor does it assert that the values within the population (from which the sample was taken) are normal.

## 5. Single Period Inventory Model

Keren (2009) in her book said a single period inventory model describes a situation in which one order is placed for a product. At the end of the sales period, any remaining product has little or no value (perishable goods). This is typical problem for Christmas tree, seasonal goods, bakery goods, newspaper, and magazines. In other word, even though items at newsstand are ordered weekly or daily, they cannot be held over and used as inventory in the next sales period. Because the exact demand for such seasonal product is never known, we consider a probability distribution related to demand. If the normal distribution is assumed, and we stocked and sold an average of 100 Christmas trees each season, then there is a 50% chance we would stock out and a 50% chance we would have trees left over. To determined the optimal stocking policy for trees before the season begins, we also need to know the standard deviation and consider these two marginal costs:

$$C_u = \text{Cost of Understocking} = \text{Sales Price per unit} - \text{Cost per unit} (p - c) \quad (\text{EQ 1})$$

$$C_o = \text{Cost of Overstocking} = \text{Cost per unit} - \text{Salvage value per unit} (c - s) \quad (\text{EQ 2})$$

$$\text{Optimal Cycle Service Level (CSL)} = C_u / (C_u + C_o) \quad (\text{EQ 3})$$

$$\text{Expected benefit of purchasing extra unit} = (1 - \text{CSL})(p - c) \quad (\text{EQ 4})$$

$$\text{Expected cost of purchasing extra unit} = \text{CSL}(c - s) \quad (\text{EQ 5})$$

$$\text{Optimum Supply Quantity} = (\mu) + (z \text{ score}) \times (\sigma) \quad (\text{EQ 6})$$

$$\mu = \text{Mean} \rightarrow \mu = \sum x / N \quad (\text{EQ 7})$$

$$\sigma = \text{Standard Deviation} \rightarrow \sigma = \sqrt{\frac{\sum (x - \mu)^2}{N}} \quad (\text{EQ 8})$$

## 6. Sensitivity Analysis

As refer to Saltelli (2002), Sensitivity analysis is the study of how the uncertainty in the output of a mathematical model or system (numerical or otherwise) can be divided and allocated to different sources of uncertainty in its inputs. A related practice is uncertainty analysis, which has a greater focus on uncertainty quantification and propagation of uncertainty; ideally, uncertainty and sensitivity analysis should be run in tandem.

## METHODOLOGY

### 1. Data Collecting

In this phase, researchers will collect all the data needed for research. Data that will be needed is sales and inventory activities. The researcher will use previous historical sales and Santuy inventory activities from October 2018 to January 2019. Researchers will also use observation and interviews for further research and comparison.

- Observation

In this phase, researcher will be observing the inventory activities from Santuy and Giggle Box. In Santuy, researcher will observe the performance of the employee; how the employee making a solution in solving the waste of inventory; input, process, and output system in inventory management.

- Interview

The type of interview used is an unstructured interview. The interview will be addressed to Giggle Box. Data to be collected from interviews are sales and inventory data. The researcher will also interview Giggle Box about how they manage their inventory and manage their perishable ingredients.

2. Data Analysis

To process data, researchers will calculate data with a single period model and calculate the service level. After calculating the data, researchers will use data to analyze and see the optimal level for Santuy to optimize profits. After this, the researcher will process interviews with other companies in the same food and beverage industry, GiggleBox to improve restaurant inventory preparation. *These are the techniques that the researcher used.*

- Single period inventory model describes a situation in which one order is placed for a product. At the end of the sales period, any remaining product has little or no value (perishable goods) (Keren, 2009). In this research, researcher will use a single period inventory model to decrease the waste in Santuy but still can keep up with the customers demand.
- Sensitivity analysis is the study of how the uncertainty in the output of a mathematical model or system (numerical or otherwise) can be divided and allocated to different sources of uncertainty in its inputs. Researcher will use sensitivity analysis in finding the optimum service level in future.

## FINDINGS AND ARGUMENT

In this chapter, researcher want to analyze the inventory problem of Santuy. Researcher want to analyze 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 service level which keep the waste in lowest value also fulfilling the customers demand. Researcher will be using the single-period inventory model to analyze the historical sales data from October 2018 to April 2019 period to find the quantity to serve per day to minimize the food waste. Researcher will calculate the cost of understacking and the cost of overstacking to analyze the current service level and compare it to a higher service level to see which is the most profitable with the least cost using the sensitivity analysis.

Santuy serve three main dishes to the customers. The main dishes are Satay Taichan Gulai Sauce, Satay Taichan Opor Sauce, and Satay Taichan Original. These three main dishes have same price and cost of good sold calculated from each item to create one portion menu item which created same cost of understocking and cost of overstocking. By calculating the cost of understocking and overstocking, researcher can calculate the service level to see how much demand can Santuy fulfill and what are the chance of going out of stock which leads to unfulfilled demand.

Optimum stock is the amount of stock that has the least waste but also fulfil the customers demand. By calculating the optimum stock, 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. The mean and standard deviation is calculated.

Table 1. Z Score Table

No	Menu	Mean	Standard Deviation	Z Score
1	Gulai	3.47	1.88	-0.2
2	Opor	2.36	1.90	-0.2
3	Original	1.92	1.43	-0.2

- Optimum Supply Quantity of Gulai =  $(3.47) + (-0.2) \times (1.88) = 3.09 \rightarrow 3$   
 The optimum stock quantity are 3 portions per day to minimize the perishable food waste and fulfill most customer demand. It means that the restaurant has to served 3 portion each day to have the least amount of waste and at the time it also fulfil the customers demand.
- Optimum Supply Quantity of Opor =  $(2.36) + (-0.2) \times (1.90) = 1.98 \rightarrow 2$   
 The optimum stock quantity are 2 portions per day to minimize the perishable food waste and fulfill most customer demand. . It means that the restaurant has to served 3 portion each day to have the least amount of waste and at the time it also fulfil the customers demand.
- Optimum Supply Quantity of Original =  $(1.92) + (-0.2) \times (1.43) = 1.63 \rightarrow 2$

The optimum stock quantity are 2 portions per day to minimize the perishable food waste and fulfill most customer demand. It means that the restaurant has to served 3 portion each day to have the least amount of waste and at the time it also fulfil the customers demand.

Like every business, Santuy wanted to be better every month. Santuy wants to see the most profitable optimum stock by increasing the service level and adjust it with the cost of waste and cost of customers satisfaction.

- Using the sensitivity analysis, we can see from 42% service level to 87% service level, the cost of satisfaction level is higher than cost of waste, but in 92%, there is a turning point which the cost of waste has the higher value than the cost of satisfaction level. In this case researcher has found the most suitable and optimal service level for gulai which is 92%.
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- Using the sensitivity analysis, we can see from 42% service level to 92% service level, the cost of satisfaction level is higher than cost of waste, but in 93%, there is a turning point which the cost of waste has the higher value than the cost of satisfaction level. In this case researcher has found the most suitable and optimal service level for original which is 93%.

The restaurant right now has a lot of waste as we can see in introduction, but using the single time inventory model we can find the optimum stock quantity to reduce the waste but also fulfilling the customers demand. The restaurant will also find the most ideal service level to get the optimum profit using the sensitivity analysis.

## CONCLUSIONS

Based on the data analysis with the single-period inventory, it can be seen to reach the optimum quantity stock of menu portion, Santuy should consider the cost of understocking, cost of overstocking, 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, Santuy wants to improve as a restaurant and reach higher customer. Researcher then compare the current service level of Santuy to certain service level to see the possibility of reaching that service level and getting higher customer while having the smallest food waste with some consideration from each menu.

From this research, to make the inventory management specifically the perishable inventory in Santuy more effective. Santuy 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, Santuy needs to calculate the cost of understocking to see the cost that Santuy will put out if there is a certain amount of order that cannot be fulfilled because the menu is out of stock. Santuy also calculate the cost of overstocking to see the cost that Santuy 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 understocking and cost of overstocking, using the sensitivity analysis, Santuy have another factor to consider on how much stock will be added to reach the most profitable optimum stock while still minimizing waste. By using the Single-Period inventory model. This study can be useful for researcher and other food & beverages business industry to calculate and knows the most optimum stock with the most optimum possible profit while still minimizing perishable waste.

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