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Inventory System Improvement for Poultry

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Abstract. R&R is a company located in Menganti, Gresik, East Java that sells poultry with a short life cycle. The purchase price of poultry from suppliers and customer demand fluctuates daily. The objectives of this research are suggesting daily demand forecasting, predicting selling price, and determining the optimal single order quantity (SOQ) to maximize profit for the company. The results of the study showed that the SOQ method could maximize the profit by considering the results of daily demand forecast, selling price and purchase price prediction to compare with the real condition. During the planning horizon, the increase of total profit was 60.23% and 6.39% in total revenue. There is an application that was developed to support determination of optimal quantity of poultry by the company.

Keywords: Perishable Product, Single Order Quantity, fluctuate price, demand forecasting, short lived items

INTRODUCTION

Inventory has always been the main actor in the trade business sector. The stock must be available and there should be no excess or deficiency at all times. The price of inventory items that have fluctuating value makes challenges for the companies for having good plans to order inventory from suppliers by using forecast demand and prices in certain periods. According to Heizer et al [2], forecasting is the science of predicting things that will happen in the future. This can be done by using historical data and a calculation process to predict a projection of future events. Forecasting is based on the time horizon and can be grouped into three parts including short-term forecasting, medium-term forecasting, and long-term forecasting. According to Yamit [6], the time series forecasting method or often called the periodic series forecasting method is a description of the various movements that occur in a series of data at a certain time. There are four methods in the time series, including the Naïve Method, Moving Average, and Exponential Smoothing. In addition to the time series forecasting method, there is also a causal forecasting method. This method assumes that the predicted factors have a causal relationship with one or more independent variables [3]. This method has a condition that does not allow the existence of a causal variable that has a strong relationship between other causal variables. From some methods of calculating the inventory system, one of them is Single Order Quantity (SOQ). This method is used for short-lived items with frequent ordering intervals, thus it will be suitable for products with fluctuating demands. Short-lived items research in recent years have been focused on health medicine, for example blood distribution [4] and diagnostic cancer test [1].

R&R is a company which is located in Menganti District, Gresik Regency, East Java. The R&R Company serves the sale of broiler chickens to the market and mobile sellers. To determine the number of chickens purchased by the company, R&R uses the determination of the business owner's estimation that makes the current inventory system of R&R is not optimal. The profit cannot be maximized because the remaining stock will be sold the next day by giving a discount to the customer. The purpose of this research is to determine daily demand forecasting and selling price prediction, to determine the optimal single order quantity. This proposed system will increase the profit for R&R.

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METHODOLOGY

The primary data was collected by observation and interviews with the owners of the R&R company. The secondary data was historical data that consists of demand, purchase price, selling price, transportation costs, operational costs, and other supporting data. At first data was processed by testing the homogeneity of the variance of the data and homogeneous grouping using the Duncan method. The homogeneity of variance test is carried out to provide confidence that two or more groups of sample data under study comes from populations that have uniform variance (homogeneous). In this study, homogeneity testing was carried out with day and week factors. While the dependent list includes daily demand and daily selling prices. The next process was determining the quantity of poultry orders by predicting customer demand and the selling price using Time Series. Finally, to determine the order, it used the Single Order Quantity (SOQ) method for short-lived items with frequent ordering intervals. The Single Order Quantity method is used for short-lived items with frequent ordering intervals, items with unsustainable and subject to change demand. This single order model only have the opportunity to order once. The item can be produced or ordered at a certain time and can only be used to fulfill demand during that period. At the end of the period, the demand of the item is very few or no longer in demand. If the company is not able to meet the demand with the existing inventory, then there is no second chance for the company to fulfill it and the product will decline in value.

There are several formulas used in Single Order Quantity with a probabilistic distribution of normally distributed demand, for this research it used method from Tersine [5].

• Shortage Probability

$$P\ (demand>Q^{*}) = C_{u/(}C_{u}+C_{o}) \quad \text{a)}$$

• Excess Stock Probability

$$P\ (demand<Q^{*}) = 1-(C_{u/(}C_{u}+C_{o})) \quad \text{b)}$$

C_u is shortage cost, and Co is excess cost

If profit is expected, there are formulas that can be used:

• Shortage condition ($Q_i \leq M_j$)

$$F\ (Q_i, Mj) = Q_i\text{J}-(M_j-Q_i)\ A \quad \text{c)}$$

• Excess condition ($Q_i > M_j$)

$$F\ (Q_i, Mj) = M_i\text{J}-(Q_i-M_j)\ L \quad \text{d)}$$

$$Expected\ Value\ E\ (QN) = \Sigma\ (matrix\ value\ x\ probability) \quad \text{e)}$$

A = shortage cost per unit
J = profit per unit
L = lost per unsold unit
Q_i = order quantity i unit
M_j = demand quantity i unit

This probability will be used to calculate the service level used. Optimal order quantity, based on Normal demand distribution:

$$Q^{*} = \mu + \sigma z \quad \text{f)}$$

Q^{*} = optimal order quantity
μ = demand mean with normal distribution
σ = demand standard deviation with normal distribution
z = service level

RESULTS AND DISCUSSION

The homogeneity test of variance was taken to provide confidence that two or more groups of samples come from populations that have uniform (homogeneous) variances and are not significantly different. The data consisted of daily demand and selling prices in the R&R company. The results of the test show the P-Value of demand is 0.964 which is greater than the table value (0.05) and the P-Value of the selling price is 0.999 which is greater than 0.05. Thus, it can be concluded that the variance of demand and selling price variance is homogeneous in days. For the weekly variance, the P-Value demand value is 0.223 which is greater than the table value (0.05) and the P-Value selling price value is 0.001, which is smaller than the table value (0.05). Thus, it can be concluded from these data that demand variance is homogeneous between weeks and variance of selling price is not homogeneous between weeks.

To test the difference in data groups, Post Hoc Test was taken by using One Way ANOVA and Post Hoc Test. Because the P-Value Demand (0.622)> (0.05) failed to reject H0, it meant that there was no difference in average demand between days. The Post Hoc test resulted in one group average with a Sig value 0.138 that was greater than the table value (0.05), meaning the group average daily demand had no significant difference. From a test for Sunday's Effect on Demand, H0 was rejected, meaning that there was a difference in the average demand between weeks. The Post Hoc test also resulted in the average of the first and second weekly demand groups being not significantly different. The Effect of Days on Selling Prices test gave the result that there was a difference in the average selling price between days in the R&R company because the profit is almost fixed, so the test of the day's effect on the selling price will give the same results as the purchase price. Meanwhile, what affects customer demand is the selling price. It failed to reject H0, meaning that there was no difference in the average selling price between days. The last was a test for The Effect of Week on Selling Prices. H0 was rejected, meaning that there was a difference in the average selling price between weeks. Thus, the average groups of the first and second weekly selling prices were not significantly different.

The next step was to test with One Way ANOVA to find out the effect of the average purchase price on profit. This test will check the average purchase price against profit in the company to determine the purchase price value during the comparison period. The decision and conclusion were rejected by H0, meaning there was a difference between the average purchase price and profit. So during the comparison period, the purchase price forecast should pay attention to the forecast value of the selling price and the percentage profit in certain periods.

The average daily demand of chicken that occurred in the company fluctuated. The highest demand was on Tuesday with the amount of 2,575 kilograms, while the lowest demand during the study period was on Thursday with the amount of 2,454 kilograms. The normality test was used in this research to test whether the data distribution was normally distributed or not. Using Kolmogorov Smirnov, most of the data distribution lied in the value of 2,300 to 2,800 kilograms. The result of the mean daily demand had a value of 2,518 kilograms. Meanwhile, the standard deviation is 155.9 with a total of 108 data. It showed that the P-Value (0.042) less than table value (0.05), thus the daily demand data was not normally distributed. Then there was a correlation test between daily demand and selling price. It showed that there was no significant correlation between daily demand and selling prices.

Demand forecast was done using the Linear forecasting method (Quadratic Model) with an MSE value of 15,050.6. The results can be seen in Table 1.

TABLE 1. Demand Forecast

Date	*F*' (Kg)	Date	*F*' (Kg)	Date	*F*' (Kg)
1-Feb-20	2.460,4	17-Feb-20	2.596,4	4-Mar-20	2.589,4
2-Feb-20	2.460,5	18-Feb-20	2.603,1	5-Mar-20	2.593,8
3-Feb-20	2.460,7	19-Feb-20	2.610,0	6-Mar-20	2.598,2
4-Feb-20	2.460,9	20-Feb-20	2.617,1	7-Mar-20	2.602,8
5-Feb-20	2.461,3	21-Feb-20	2.624,4	8-Mar-20	2.592,7
6-Feb-20	2.461,7	22-Feb-20	2.600,8	9-Mar-20	2.596,8
7-Feb-20	2.462,1	23-Feb-20	2.607,0	10-Mar-20	2.601,0
8-Feb-20	2.526,2	24-Feb-20	2.613,4	11-Mar-20	2.605,3
9-Feb-20	2.530,2	25-Feb-20	2.619,9	12-Mar-20	2.609,6

10-Feb-20	2.534,4	26-Feb-20	2.626,6	13-Mar-20	2.614,0
11-Feb-20	2.538,7	27-Feb-20	2.633,4	14-Mar-20	2.618,5
12-Feb-20	2.543,2	28-Feb-20	2.640,4	15-Mar-20	2.598,2
13-Feb-20	2.547,8	29-Feb-20	2.647,6	16-Mar-20	2.601,9
14-Feb-20	2.552,6	1-Mar-20	2.576,9	17-Mar-20	2.605,7
15-Feb-20	2.583,5	2-Mar-20	2.581,0	18-Mar-20	2.609,6
16-Feb-20	2.589,9	3-Mar-20	2.585,2	19-Mar-20	2.613,5

After the demand forecast was carried out, the next step was to forecast the selling price to predict the selling price value that will occur in the future. The resulting demand forecast variation coefficient value was 7.62%. Therefore, it can be concluded that the results of the demand forecast are said to be good because the coefficient of variation was less than 20%. Forecasting for selling prices also used a double exponential smoothing forecasting method with an MSE value of 135,598. The results can be seen in Table 2.

TABLE 2. Selling Price Forecast

Date	*F'*	Date	*F'*	Date	*F'*
1-Feb-20	Rp 19.674,5	17-Feb-20	Rp 22.444,1	4-Mar-20	Rp 18.622,5
2-Feb-20	Rp 19.825,1	18-Feb-20	Rp 22.520,3	5-Mar-20	Rp 18.476,9
3-Feb-20	Rp 19.975,7	19-Feb-20	Rp 22.596,5	6-Mar-20	Rp 18.331,4
4-Feb-20	Rp 20.126,4	20-Feb-20	Rp 22.672,8	7-Mar-20	Rp 18.185,8
5-Feb-20	Rp 20.277,0	21-Feb-20	Rp 22.749,0	8-Mar-20	Rp 19.404,8
6-Feb-20	Rp 20.427,7	22-Feb-20	Rp 22.725,4	9-Mar-20	Rp 19.094,1
7-Feb-20	Rp 20.578,3	23-Feb-20	Rp 22.747,4	10-Mar-20	Rp 18.783,3
8-Feb-20	Rp 20.240,2	24-Feb-20	Rp 22.769,4	11-Mar-20	Rp 18.472,5
9-Feb-20	Rp 20.522,8	25-Feb-20	Rp 22.791,4	12-Mar-20	Rp 18.161,8
10-Feb-20	Rp 20.805,4	26-Feb-20	Rp 22.813,4	13-Mar-20	Rp 17.851,0
11-Feb-20	Rp 21.088,0	27-Feb-20	Rp 22.835,4	14-Mar-20	Rp 17.540,2
12-Feb-20	Rp 21.370,6	28-Feb-20	Rp 22.857,4	15-Mar-20	Rp 18.938,8
13-Feb-20	Rp 21.653,3	29-Feb-20	Rp 22.879,4	16-Mar-20	Rp 19.208,0
14-Feb-20	Rp 21.935,9	1-Mar-20	Rp 19.059,2	17-Mar-20	Rp 19.477,2
15-Feb-20	Rp 22.291,6	2-Mar-20	Rp 18.913,6	18-Mar-20	Rp 19.746,5
16-Feb-20	Rp 22.367,8	3-Mar-20	Rp 18.768,1	19-Mar-20	Rp 20.015,7

The variation coefficient of sales price forecast was 6.126% or less than 20% that was good. The purchase price used a benchmark from the sales price forecast, and it has the result on Table 3.

TABLE 3. Purchasing Forecast

Date	*F'*	Date	*F'*	Date	*F'*
1-Feb-20	Rp 17.486,2	17-Feb-20	Rp 19.971,6	4-Mar-20	Rp 16.598,6
2-Feb-20	Rp 17.663,7	18-Feb-20	Rp 20.060,3	5-Mar-20	Rp 16.421,1
3-Feb-20	Rp 17.752,5	19-Feb-20	Rp 20.060,3	6-Mar-20	Rp 16.332,3
4-Feb-20	Rp 17.930,0	20-Feb-20	Rp 20.149,1	7-Mar-20	Rp 16.154,8
5-Feb-20	Rp 18.018,8	21-Feb-20	Rp 20.237,9	8-Mar-20	Rp 17.308,7
6-Feb-20	Rp 18.196,3	22-Feb-20	Rp 20.237,9	9-Mar-20	Rp 16.953,6
7-Feb-20	Rp 18.285,1	23-Feb-20	Rp 20.237,9	10-Mar-20	Rp 16.687,4

8-Feb-20	Rp 18.018,8	24-Feb-20	Rp 20.237,9	11-Mar-20	Rp 16.421,1
9-Feb-20	Rp 18.285,1	25-Feb-20	Rp 20.237,9	12-Mar-20	Rp 16.154,8
10-Feb-20	Rp 18.551,3	26-Feb-20	Rp 20.326,6	13-Mar-20	Rp 15.888,5
11-Feb-20	Rp 18.728,9	27-Feb-20	Rp 20.326,6	14-Mar-20	Rp 15.622,2
12-Feb-20	Rp 18.995,2	28-Feb-20	Rp 20.326,6	15-Mar-20	Rp 16.864,9
13-Feb-20	Rp 19.261,5	29-Feb-20	Rp 20.326,6	16-Mar-20	Rp 17.131,2
14-Feb-20	Rp 19.527,8	1-Mar-20	Rp 16.953,6	17-Mar-20	Rp 17.308,7
15-Feb-20	Rp 19.794,1	2-Mar-20	Rp 16.864,9	18-Mar-20	Rp 17.575,0
16-Feb-20	Rp 19.882,8	3-Mar-20	Rp 16.687,4	19-Mar-20	Rp 17.841,3

From the profit obtained, the lowest profit per kilo of chicken was IDR 1,900/kilogram and the highest was IDR 2,500 /kilogram. The profit was calculated using the difference between the selling price forecast data and the buying price forecast. The next step was to calculate the optimal purchase quantity using the single order quantity method.

In determining the optimal purchase quantity using the single order quantity (SOQ) method, the results can be seen in Table 4.

TABLE 4. Single Order Quantity

Date	Q^* (Kg)	Date	Q^* (Kg)	Date	Q^* (Kg)
1-Feb-20	2.726	17-Feb-20	2.381	4-Mar-20	2.641
2-Feb-20	2.539	18-Feb-20	2.928	5-Mar-20	2.549
3-Feb-20	2.529	19-Feb-20	2.750	6-Mar-20	2.659
4-Feb-20	2.600	20-Feb-20	2.305	7-Mar-20	2.611
5-Feb-20	2.561	21-Feb-20	2.464	8-Mar-20	2.419
6-Feb-20	2.696	22-Feb-20	2.681	9-Mar-20	2.547
7-Feb-20	2.543	23-Feb-20	2.966	10-Mar-20	2.640
8-Feb-20	2.487	24-Feb-20	2.552	11-Mar-20	2.496
9-Feb-20	2.569	25-Feb-20	2.525	12-Mar-20	2.708
10-Feb-20	2.540	26-Feb-20	2.376	13-Mar-20	2.643
11-Feb-20	2.670	27-Feb-20	2.292	14-Mar-20	2.624
12-Feb-20	2.535	28-Feb-20	2.443	15-Mar-20	2.358
13-Feb-20	2.663	29-Feb-20	2.557	16-Mar-20	2.453
14-Feb-20	2.575	1-Mar-20	2.471	17-Mar-20	2.081
15-Feb-20	2.616	2-Mar-20	2.605	18-Mar-20	2.657
16-Feb-20	2.442	3-Mar-20	2.577	19-Mar-20	2.533

TABLE 5. Comparison of Proposed Method (SOQ) and Existing Method

	Proposed Method	Existing Method	Δ%
Total Purchasing Quantity	122.783 Kg	122.430 Kg	-0,29%
Total *Lost Sales*	0 Kg	16,5 Kg	100%
Average Final Inventory	341,15 Kg	146,49 Kg	-132,89%
Total Revenue	Rp 2.778.820.900	Rp 2.611.836.900	6,39%
Total Expense	Rp 2.351.902.900	Rp 2.345.401.550	0,28%
Total Profit	Rp 426.918.000	Rp 266.435.350	60,23%

The values in Table 5 are the results of calculations during the observation period. After forecasting and determining the quantity of purchases, the next step was the making of Inventory Control Application. The purpose

of making this application is to make it easier for the company to control the stock of chickens and make right decisions on the quantity of chicken purchases from the suppliers. Here are some descriptions of the Inventory Control Application that have been created:

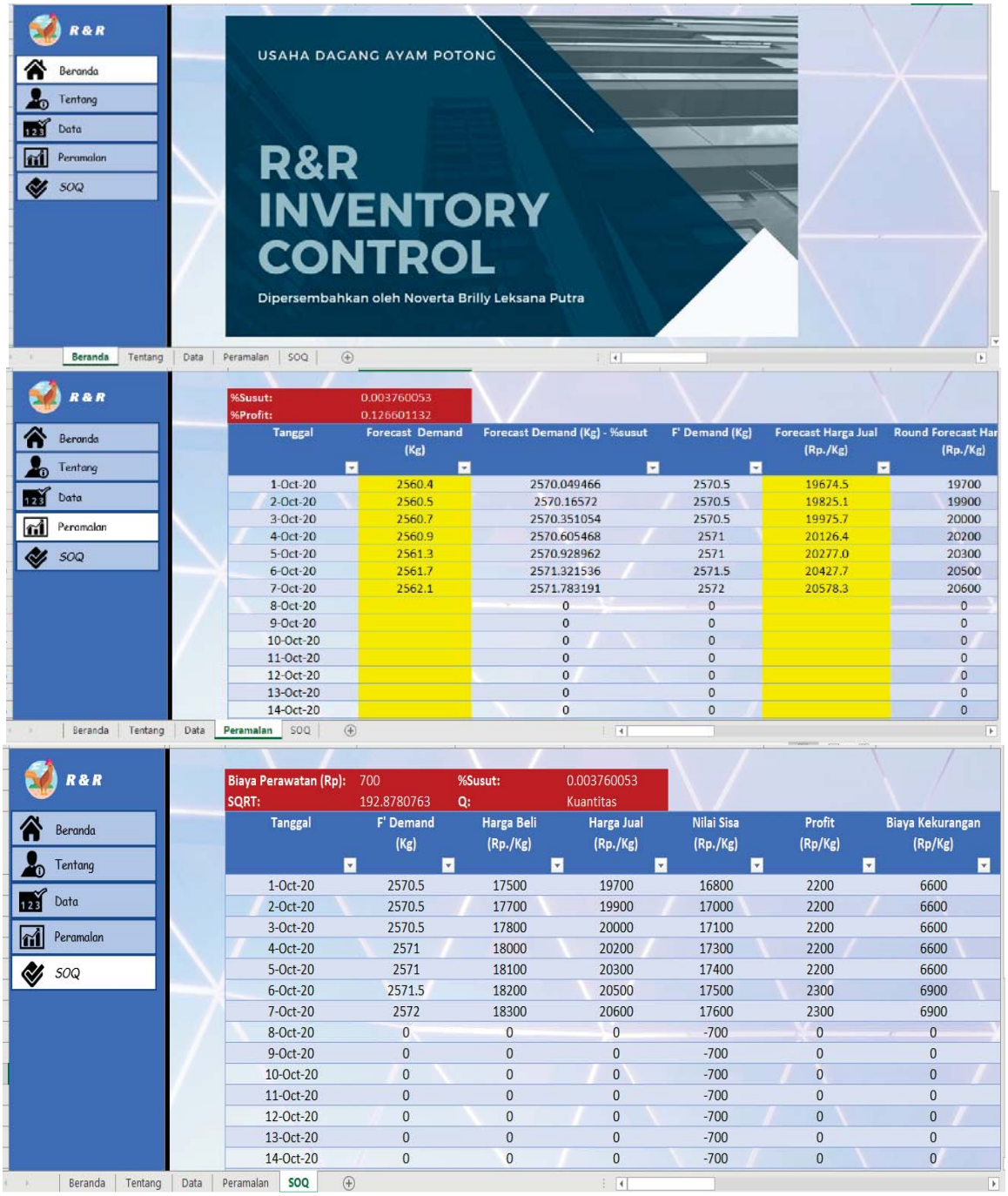

FIGURE 1. Inventory Control Application

The Inventory Control application (Fig. 1) consists of several sheets including the homepage, information about applications, data, forecasting, and SOQ. Each sheet consists of various tables and the input tables have been filled with formulations. When using this application, users are required to input data in a yellow table. After that, the other table will automatically display the data results according to the head of the table in each sheet. On the

Inventory Control Application SOQ sheet, there is a red table as the output for the quantity of purchases that the company will make to suppliers.

CONCLUSION

Based on the problems that occurred by the R&R company regarding the system of merchandise inventory in the form of chicken, the total quantity of purchases made in the proposed method is greater than that of the company method. The reason is that the results of daily demand forecasting have a greater average than the real conditions during the comparison period. The proposed method of forecasting results has an average daily demand of 2,575.2 kilograms, while the average daily demand for real conditions or company methods is 2,539.1 kilograms. The increase in the average demand in forecasting results is also followed by an increase in the average yield of forecasting selling prices and buying prices when compared to the real conditions of the company. The average sales price forecast is IDR 20,533 / kilogram, while the company method is IDR 20,408 / kilogram. The average result of forecasting the purchase price is Rp. 18,316 / kilogram, while the company method is Rp. 18,308 / kilogram.

For the difference in the total purchase quantity in the proposed method and company method of 353 kilograms. The total purchase quantity for the proposed method has a value of 122,783 kilograms. Meanwhile, the total quantity purchased by the company method has a value of 122,430 kilograms. This increase in value resulted in an increase in the average final stock of chicken in the warehouse so as to minimize the occurrence of lost sales in the R&R company. It can be proven that the average final stock for the proposed method has a value of 341.15 kilograms, while for the proposed method, it has a value of 146.49 kilograms. During the comparison period, the proposed method did not experience lost sales or lost sales due to limited inventory.

Based on calculations during the comparison period, the total profit earned by the R&R company using the proposed method was IDR 426,918,000. Meanwhile, the company method is Rp266,435,350. This value has increased by 60.23%. The total income and total expenditure of the proposed method also increased. However, the increase in total revenue of the proposed method is much higher than the increase in total expenditure of the proposed method which results in an increase in the total profit of the proposed method. The percentage increase in total revenue from the proposed method when compared to the company method is 6.39%. The percentage increase in total expenditure of the proposed method when compared to the company method is 0.28%.

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