Application of Material Requirement Planning with ARIMA Forecasting and Fixed Order Quantity Method in Optimizing the Inventory Policy of Raw Materials of Sederhana Restaurant in Palembang

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Abstract—Restaurant Sederhana is a cuisine that is famous for its characteristics throughout Indonesia originating from Minang. One of his favorite menus is rendang, fried Chicken and Omelette. Sederhana Restaurant Sudirman and Polygon branches have different needs. Therefore, to determine the minimum inventory costs at Sudirman and Polygon branches, the Material Requirement Planning (MRP) was applied with ARIMA forecasting and the Fixed Order Quantity (FOQ) method. Based on the calculation results, Sederhana Restaurant in Polygon produces lower inventory costs compared to one in Sudirman. The total inventory cost of rendang, fried chicken and pancake omelette in a row was 6,343,543,977 IDR, 2,719,741,084 IDR, 639,254,554 IDR, while in the Polygon branch is 3,396,976,681 IDR, 1,653,543,196 IDR and 721,227,835 IDR, with the minimum cost for rendang and fried chicken found in the Polygon branch with a difference of 2,946,567,296 IDR, for rendang and 1,653,543,196 IDR for fried chicken, while the minimum cost for an omelette is in the Sudirman branch with a difference of 61,973,281 IDR.

Keywords: Material Requirement Planning, ARIMA, FOQ, Inventory Planning

I. INTRODUCTION

Inventory is a company’s wealth that has an important role in business operations, so the company needs to do proactive inventory management, meaning that the company must be able to anticipate the conditions and challenges that exist in inventory management to achieve the final goal, which is to minimize the total costs incurred [1]. One method that can be done in raw material planning is the Material Requirement Planning (MRP) method. Sarkar, et.al, [2] state that MRP is a method that uses billing material, inventory data and schedules to calculate material requirements and also takes into account the combination of bill material structure and the exact installation time.

The purpose of the MRP is to provide the right material at the right time[3]. Tools are developed to solve MRP [4]. Kocaugolu, et.al [5] explain that demand forecasting can be used in a variety of ways ranging from inventory management, shipping, distribution, reclamation, repair, and maintenance to the coordination of suppliers and operating work. Meanwhile, [6] states that forecasting is ongoing processes that require product managers to think about the market and understand it. Forecasting method that will be used is the Autoregressive Intergrade Moving (ARIMA) method[7, 8].

Then, Iqbal and Naveed [9] compared forecasting performance for ARIMA models by using time series data and ARIMA is one of the time series analysis techniques that are widely used for forecasting future data. Calculation using MRP is to determine the demand forecast calculation and then calculated using the lot sizing method. When the net needs are known from the sales department or the planning department, then the decision of the number of materials that need to be ordered must be immediately determined, this decision is called lot sizing [10]. The lot sizing method used in the study is Fixed Order Quantity (FOQ).

Companies such as Sederhana Restaurant often experience inventory problems, including too much inventory or even shortages. Therefore inventory management is critically needed to analyze the optimum level of inventory. The Sederhana Restaurant was founded in 1972 and already has hundreds of branches spread throughout Indonesia and there are 6 branches spread in the city of Palembang. Sederhana Restaurants experience a fairly rapid business development but do not have a management system or method of making purchases or ordering raw materials so that they experience a state of excess or even shortage of raw materials during operations. The production of rendang, fried chicken and omelette menus is one of the favorite menus, so it is very dependent on the supply of raw materials that require accurate planning and control to meet consumer demand. The method used by the Palembang Sederhana Restaurant in the Palembang City Branch only estimates what is needed to be processed and stored.
Then, this research specifies how to formulate the problem by applying MRP method with ARIMA forecasting and FOQ methods for raw material requirements to be optimal at the Sederhana Restaurant Branch in Palembang. Limitation problems in this study are stated as follows. i) Inventory counts the main raw materials namely beef, chicken meat and chicken eggs, not counting the inventory of drinks at the location of RM Sederhana Sudirman and Polygon; ii) The calculation the supply of raw materials based on data one year before and lastly iii) The inventories calculate transportation costs, telephone costs and electricity costs but do not calculate employee wage costs.

II. RESEARCH METHOD

The steps in conducting this research are as follows.

1) Collect data. Data in this study are primary data consisting of bill of materials, sales data of rendang, fried chicken and omelette, inventory data and data on message costs and save costs
2) Forecast the results in mixed models on the ARIMA method.
3) Calculate the order plan (Lot Sizing for each raw material using the FOQ method.
4) Analysis of the calculation results of the Sederhana Restaurant in Sudirman and Polygon.

III. RESULTS AND ANALYSIS

A. Data Description

The research data were obtained by interviewing the manager/staff of Sederhana Restaurant in Sudirman and Polygon Branch and a field survey to collect the food menu production process including the food raw material data, sales data, food raw material inventory data, and food raw material price data, order cost data and save costs as Table I-IV shown.

| TABLE I. ORDERING DATA OF RENDANG IN SUDIRMAN AND POLYGON BRANCH |
|----------------|----------------|----------------|----------------|
| Mon            | Demand Data (Kg) | Prod Data (Kg) | Demand Data (Kg) | Prod Data (Kg) |
|----------------|----------------|----------------|----------------|----------------|
| Sudirman       | Polygon        | Sudirman       | Polygon        |
| Feb-18         | 24            | 22             | 238            | 242            |
| Mar-18         | 311           | 315            | 235            | 240            |
| Apr-18         | 327           | 322            | 242            | 244            |
| May-18         | 356           | 345            | 236            | 235            |
| Jun-18         | 301           | 341            | 233            | 237            |
| Jul-18         | 318           | 308            | 228            | 233            |
| Aug-18         | 348           | 339            | 230            | 224            |
| Sep-18         | 362           | 363            | 224            | 222            |
| Oct-18         | 355           | 360            | 237            | 239            |
| Nov-18         | 371           | 377            | 222            | 233            |
| Dec-18         | 388           | 381            | 245            | 244            |
| Jan-19         | 322           | 300            | 264            | 271            |
| Total          | 4075          | 4079           | 2834           | 2884           |

As Table I-III explained, the demand for rendang, fried chicken and omelette are explained in detail while in Table IV, the raw material needed are listed including the demand of those materials in kilograms.

| TABLE II. ORDERING DATA OF FRIED CHICKEN IN SUDIRMAN AND POLYGON BRANCH |
|----------------|----------------|----------------|----------------|
| Mon            | Demand Data (Kg) | Prod Data (Kg) | Demand Data (Kg) | Prod Data (Kg) |
|----------------|----------------|----------------|----------------|----------------|
| Sudirman       | Polygon        | Sudirman       | Polygon        |
| Feb-18         | 388           | 401            | 253            | 247            |
| Mar-18         | 363           | 358            | 255            | 256            |
| Apr-18         | 356           | 360            | 247            | 243            |
| May-18         | 368           | 366            | 251            | 263            |
| Jun-18         | 344           | 346            | 266            | 266            |
| Jul-18         | 322           | 328            | 233            | 268            |
| Aug-18         | 334           | 361            | 241            | 254            |
| Sep-18         | 361           | 302            | 239            | 232            |
| Oct-18         | 366           | 377            | 227            | 223            |
| Nov-18         | 374           | 375            | 222            | 215            |
| Dec-18         | 392           | 395            | 256            | 260            |
| Jan-19         | 341           | 345            | 241            | 231            |
| Total          | 4309          | 4314           | 2931           | 2958           |

| TABLE III. ORDERING DATA OF OMELETTE IN SUDIRMAN AND POLYGON BRANCH |
|----------------|----------------|----------------|----------------|
| Mon            | Demand Data (Kg) | Prod Data (Kg) | Demand Data (Kg) | Prod Data (Kg) |
|----------------|----------------|----------------|----------------|----------------|
| Sudirman       | Polygon        | Sudirman       | Polygon        |
| Feb-18         | 301           | 303            | 313            | 316            |
| Mar-18         | 321           | 325            | 312            | 313            |
| Apr-18         | 312           | 313            | 310            | 300            |
| May-18         | 318           | 315            | 316            | 315            |
| Jun-18         | 311           | 320            | 300            | 300            |
| Jul-18         | 306           | 300            | 304            | 300            |
| Aug-18         | 307           | 307            | 323            | 320            |
| Sep-18         | 323           | 315            | 293            | 288            |
| Oct-18         | 313           | 310            | 301            | 302            |
| Nov-18         | 327           | 333            | 300            | 296            |
| Dec-18         | 333           | 336            | 299            | 304            |
| Jan-19         | 305           | 311            | 313            | 313            |
| Total          | 3777          | 3788           | 3682           | 3688           |

Table V-VI describe the order cost and storage cost in IDR in Sudirman Branch, respectively along with the period time. For instance, Chicken in Table V is needed to be ordered for times with the order cost of 33,000 IDR.
As Table VII-VIII, the order cost and storage cost for raw material in Poligon Branch also presented. All cost are in IDR and the raw materials needed are in 4 period time.

Table IX-XI explain the forecasting results for making rendang, fried chicken and omelette in kilograms in Sudirman Branch, respectively. The tables show different value but least difference. The value is quite similar for each raw material.
### TABLE XI. RESULTS OF FORECASTING REQUEST FOR MAKING OMELETTE IN SUDIRMAN BRANCH

| Month | Forecast (kg) | Lower (kg) | Upper (kg) | Forecasting rounding (kg) |
|-------|---------------|------------|------------|--------------------------|
| Mar-19 | 304.997       | 278.802    | 331.192    | 305                      |
| Apr-19 | 304.997       | 278.949    | 332.040    | 305                      |
| May-19 | 304.997       | 252.600    | 357.379    | 305                      |
| Jun-19 | 304.987       | 246.414    | 363.559    | 305                      |
| Jul-19 | 304.984       | 240.821    | 369.147    | 305                      |
| Aug-19 | 304.981       | 235.676    | 374.285    | 305                      |
| Sep-19 | 304.978       | 230.806    | 379.067    | 305                      |
| Oct-19 | 304.976       | 226.944    | 383.558    | 305                      |
| Nov-19 | 304.973       | 222.140    | 388.806    | 305                      |
| Dec-19 | 304.970       | 218.095    | 391.846    | 305                      |
| Jan-20 | 304.968       | 214.230    | 395.705    | 305                      |

### TABLE XII. RESULTS OF FORECASTING REQUEST FOR MAKING RENDANG IN POLIGON BRANCH

| Month | Forecast (kg) | Lower (kg) | Upper (kg) | Forecasting rounding (kg) |
|-------|---------------|------------|------------|--------------------------|
| Feb-19 | 263.818       | 241.229    | 286.406    | 264                      |
| Mar-19 | 263.635       | 231.702    | 295.560    | 264                      |
| Apr-19 | 263.453       | 224.456    | 302.351    | 263                      |
| May-19 | 263.271       | 218.142    | 308.401    | 263                      |
| Jun-19 | 263.090       | 212.650    | 313.529    | 263                      |
| Jul-19 | 262.908       | 207.617    | 318.142    | 263                      |
| Aug-19 | 262.726       | 203.087    | 322.366    | 263                      |
| Sep-19 | 262.545       | 198.810    | 326.280    | 263                      |
| Oct-19 | 262.364       | 194.785    | 329.942    | 262                      |
| Nov-19 | 262.182       | 190.973    | 333.391    | 262                      |
| Dec-19 | 260.01       | 187.342    | 336.660    | 262                      |
| Jan-20 | 261.820       | 183.868    | 339.772    | 262                      |

### TABLE XIII. RESULTS OF FORECASTING REQUEST FOR MAKING FRIED CHICKEN IN POLIGON BRANCH

| Month | Forecast (kg) | Lower (kg) | Upper (kg) | Forecasting rounding (kg) |
|-------|---------------|------------|------------|--------------------------|
| Feb-19 | 241.298       | 208.770    | 273.824    | 241                      |
| Mar-19 | 241.596       | 195.566    | 287.625    | 242                      |
| Apr-19 | 241.894       | 185.484    | 298.304    | 242                      |
| May-19 | 242.193       | 177.016    | 307.369    | 242                      |
| Jun-19 | 242.492       | 169.577    | 315.406    | 242                      |
| Jul-19 | 242.791       | 162.868    | 322.715    | 243                      |
| Aug-19 | 243.091       | 156.710    | 329.472    | 243                      |
| Sep-19 | 243.391       | 150.989    | 335.793    | 243                      |
| Oct-19 | 243.692       | 145.824    | 341.759    | 244                      |
| Nov-19 | 243.993       | 140.556    | 347.429    | 244                      |
| Dec-19 | 244.294       | 135.741    | 352.846    | 244                      |
| Jan-20 | 244.595       | 131.146    | 358.045    | 245                      |

### TABLE XIV. RESULTS OF FORECASTING REQUEST FOR MAKING OMELETTETTE IN POLIGON SUDIRMAN BRANCH

| Month | Forecast (kg) | Lower (kg) | Upper (kg) | Forecasting rounding (kg) |
|-------|---------------|------------|------------|--------------------------|
| Feb-19 | 311.128       | 286.152    | 336.104    | 311                      |
| Mar-19 | 311.256       | 275.927    | 346.585    | 311                      |
| Apr-19 | 311.385       | 268.107    | 354.662    | 311                      |
| May-19 | 311.513       | 261.530    | 361.496    | 312                      |
| Jun-19 | 311.641       | 255.47     | 367.536    | 312                      |
| Jul-19 | 311.770       | 250.528    | 373.012    | 312                      |
| Aug-19 | 311.898       | 245.735    | 378.061    | 312                      |
| Sep-19 | 312.027       | 241.281    | 382.772    | 312                      |
| Oct-19 | 312.153       | 237.103    | 387.207    | 312                      |
| Nov-19 | 312.284       | 233.155    | 391.412    | 312                      |
| Dec-19 | 312.412       | 229.405    | 395.420    | 312                      |
| Jan-20 | 312.541       | 225.825    | 399.257    | 313                      |

### TABLE XV. COMPUTATION OF LOT SIZING BY USING FOQ METHOD FOR SUDIRMAN BRANCH

| Raw material | \(Q^*(\text{Kg/year})\) | \(Y(\text{IDR})\) |
|--------------|--------------------------|-------------------|
| Rendang      |                          |                   |
| - Beef       | 8,208.17                 | 5,124,174.540    |
| - Salt       | 134.62                   | 7,341,981        |
| - Coconut Milk | 2,120.58             | 587,549,790     |
| - Flavouring | 13.35                    | 3,051,874        |
| - Rendang Seasoning | 1,331.68            | 621,425,792     |
| Fried Chicken |                          |                   |
| - Chicken meat | 10,894.34              | 2,164,249,548   |
| - Salt       | 142.81                   | 7,783,876       |
| - Fried chicken seasoning | 1697.15          | 544,469,785     |
| - Flavouring | 14.18                    | 3,237,875       |
| Omelette     |                          |                   |
| - Chicken egg | 2,538.04               | 383,847,005     |
| - Salt       | 12.43                    | 743,249         |
| - Vegetable mix | 761.1                  | 246,672,000    |
| - Flavouring | 2.4                      | 608,300         |
| - Flour      | 126.95                   | 7,384,000       |

Table XV-XVI describe the lot sizing computation by FOQ method for each branch. As Table XV explained, for beef in
Based on the results of forecasting by the ARIMA method on raw materials of rendang, fried chicken and omelette at Sudirman branches, 3,888 kg, 4,125 kg and 3,660 kg were obtained, while in the Polygon branch 3,154 kg, 2,915 kg and 3,742 kg were obtained.

Furthermore, based on demand forecast data with the ARIMA method it can be seen the number of ordering raw material needs for rendang, fried chicken and omelette with the lot sizing method (FOQ) for each different raw material. The calculation is done as a whole one by one from the method for each raw material for rendang, fried chicken and omelette. FOQ method produces the total cost of rendang raw material inventory in Sudirman and Polygon branches in February 2019 - January 2020 of 6,343,543,977 IDR and 3,396,976,681 IDR. For raw materials of fried chicken in the Sudirman and Polygon branches in February 2019 - January 2020 are in the amount of 2,719,741,084 IDR and 1,653,543,196 IDR and lastly, for raw material for omelette in the Sudirman and Polygon branches in February 2019 - January 2020 amounting to 639,254,554 IDR and 721,227,835 IDR.

Thus the calculation results from the FOQ method for both Sudirman and Polygon branches is achieved by obtaining the optimum cost for rendang and fried chicken contained in the Polygon branch with a difference of 2,946,567,296 IDR for rendang and 1,066,197,888 IDR for fried chicken in both branches, and the optimum cost for the omelette is in Sudirman branch with a difference of 81,973,281 IDR. So that a significant difference is obtained to process raw materials rendang, fried chicken and omelette at Sudirman Branch Sederhana Restaurant and Polygon Branch Sederhana Restaurant.

### IV. Conclusion

From the results of research that has been done, based on data on the number of requests for rendang, fried chicken and omelette in Sudirman and Polygon branches, there is a significant difference with the application of MRP using the lot sizing FOQ technique resulting in an optimal cost inventory for rendang and fried chicken raw materials found in branches Polygon, which is 3,396,976,681 IDR and 1,653,543,196 IDR with a difference of Rp. 2,946,567,296 IDR for rendang and 1,066,197,888 IDR for fried chicken in both branches. Whereas for the inventory of omelette raw material costs, the optimum cost for the Sudirman branch is 639,254,554 IDR with a difference of 81,973,281 IDR in Polygon branch.

This study discusses the MRP method with the lot sizing FOQ technique and obtains optimum costs in the supply of raw materials for rendang, fried chicken and omelette, ignores the cost of labor costs due to the fact that regional minimum wage (UMR) is unknown. So for future research, the use of labor costs in order to get a better and more efficient inventory cost.
REFERENCES

[1] Z. Yamit, Manajemen Persediaan. Jakarta: Ekonisia, 2005.

[2] A. Sarkar, D. Das, S. Chakraborty, and N. Biswas, “A Simple Case Study of Material Requirement Planning,” Journal of Mechanical and Civil Engineering vol. 9, pp. 58-64, 2013.

[3] A. Iasya and Y. Handayati, “Material Requirement Planning Analysis in Micro, Small and Medium Enterprise Case Study: Grooveline: An Apparel Outsourcing Company Final Project,” Journal of Business and Management, vol. 4, pp. 317-329, 2015.

[4] M. S. Islam, M. M. Rahman, R. K. Saha, and A. M. Saifuddoha, "Development of material requirements planning (MRP) software with C language," Global Journal of Computer Science and Technology Software & Data Engineering vol. 13, 2013.

[5] B. Koucaglu, A. Z. Acar, and B. Yilmaz, "Demand Forecast, up-to-date models, and Suggestions for Improvement an example of a Business," Journal of Global Strategic Management vol. 8, pp. 26-37, 2014.

[6] S. Haines, The Product Manager's Desk Reference. NY, USA: McGraw-Hill Professional, 2008.

[7] P. Yenradee, A. Pinnoi, and A. Charoenthavornying, "Demand forecasting and production planning for highly seasonal demand situations: case study of a pressure container factory," cienceAsia, vol. 27, pp. 271-278, 2001.

[8] F. A. Khalid and S. R. Lim, "A Study on Inventory Management towards Organizational Performance of Manufacturing Company in Melaka," International Journal of Academic Research in Business and Social Sciences, vol. 8, pp. 1216-1227, 2018.

[9] M. Iqbal and A. Naveed, "Forecasting Inflation: Autoregressive Integrated Moving Average Model," European Scientific Journal, vol. 12., 2016.

[10] R. Maleyak, Management Inventory dan Logistik: Pusat Bahan Mengajar dan Elearning., 2017.