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 Poligon 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 Poligon 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 81,973,281 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		Poligon	
Feb-18	324	328	238	242
Mar-18	311	315	235	240
Apr-18	321	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	353	360	237	239
Nov-18	371	377	222	253
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		Poligon	
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		Poligon	
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	320
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	311	313
Total	3777	3788	3682	3688

TABLE IV. RAW MATERIAL INVENTORY DATA FOR SUDIRMAN AND POLYGON BRANCHES

No	Product Name	Sudirman Branch Supply (kg)	Poligon Branch Supply (kg)
1	Chicken	50	45
2	beef	40	30
3	Chicken egg	25	20
4	Coconut milk	20	20
5	rendang seasoning	10	5
6	Fried chicken seasoning	10	5
7	Vegetable mix	10	5
8	Salt	2	1
9	Flour	2	1
10	Flavouring	0.5	0.1

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

TABLE V.   SUDIRMAN BRANCH ORDER COST

No	Product Name	Order Period (times)	Order Cost (IDR)
1	Chicken	4	(7000)(4) + (1250)(4) = 33,000
2	Beef	4	(7000)(4) + (1250)(4) = 33,000
3	Chicken egg	4	(1250)(4) = 5000
4	Coconut milk	4	5000
5	rendang seasoning	4	5000
6	Fried chicken seasoning	4	5000
7	Vegetable mix	4	5000
8	Salt	4	5000
9	Flour	4	5000
10	Flavouring	4	5000

TABLE VI.   SUDIRMAN BRANCH STORAGE COST

No	Product Name	Order Cost (IDR)
1	Chicken	(4464+1440)(30)= 177,120
2	beef	(4464+1440)(30)= 177,120
3	Coconut milk	177,120
4	Chicken	177,120
5	Fried chicken seasoning	177,120
6	Chicken egg	(1,440)(30) = 43,200
7	Vegetable mix	43,200
8	Flavouring	43,200
9	Salt	43,200
10	Flour	43,200

TABLE VII.   POLIGON BRANCH ORDER COST

No	Product Name	Order Period (times)	Order Cost (IDR)
1	Chicken	4	24,300
2	beef	4	24,300
3	Chicken egg	4	4300
4	Coconut milk	4	4300
5	Rendang seasoning	4	4300
6	Fried chicken seasoning	4	4300
7	Vegetable mix	4	4300
8	Salt	4	4300
9	Flour	4	4300
10	Flavouring	4	4300

As Table VII-VIII, the order cost and storage cost for raw material in Poligon Branch are also presented. All cost are in IDR and the raw materials needed are in 4 period time.

TABLE VIII.   POLIGON BRANCH STORAGE COST

No	Product Name	Order Cost(IDR)
1	Chicken	162,720
2	beef	162,720
3	Coconut milk	162,720
4	Fried Chicken Seasoning	162,720
5	Rendang seasoning	162,720
6	Chicken egg	28,800
7	Vegetable mix	28,800
8	Flavouring	28,800
9	Salt	28,800
10	Flour	28,800

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 IX.   RESULTS OF FORECASTING REQUEST FOR MAKING RENDANG IN SUDIRMAN BRANCH

Month	Forecast (kg)	Lower (kg)	Upper (kg)	Forecasting rounding (kg)
Feb-19	322.2	260.3	38.1	322
Mar-19	322.5	234.9	410.0	323
Apr-19	322.7	215.4	430.0	323
May-19	323.0	199.0	446.9	323
Jun-19	323.3	184.6	461.8	323
Jul-19	323.5	171.6	475.4	324
Aug-19	323.7	159.6	487.9	324
Sep-19	324.0	148.4	499.5	324
Oct-19	324.2	138.0	510.5	324
Nov-19	324.5	128.1	520.9	325
Dec-19	324.7	118.7	530.8	325
Jan-20	325.0	109.7	540.3	325

TABLE X.   RESULTS OF FORECASTING REQUEST FOR MAKING FRIED CHICKEN IN SUDIRMAN BRANCH

Month	Forecast (kg)	Lower (kg)	Upper (kg)	Forecasting rounding (kg)
Feb-19	341.4	296.33	386.51	341
Mar-19	341.8	278.0	405.64	342
Apr-19	342.2	264.0	420.46	342
May-19	342.7	252.3	433.04	343
Jun-19	343.1	242.0	444.19	343
Jul-19	343.5	232.7	454.33	344
Aug-19	343.9	224.2	463.7	344
Sep-19	344.4	216.3	472.4	344
Oct-19	344.8	208.9	480.7	345
Nov-19	345.2	201.8	488.6	345
Dec-19	345.6	195.2	496.1	346
Jan-20	346.1	188.8	503.3	346

TABLE XI.   RESULTS OF FORECASTING REQUEST FOR MAKING OMELETTE IN SUDIRMAN BRANCH

Month	Forecast (kg)	Lower (kg)	Upper (kg)	Forecasting rounding (kg)
Feb-19	304.997	278.802	331.192	305
Mar-19	304.995	267.949	342.040	305
Apr-19	304.992	259.621	350.363	305
May-19	304.989	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	235.678	374.285	305
Sep-19	304.978	230.890	379.067	305
Oct-19	304.976	226.394	383.558	305
Nov-19	304.973	222.140	38.806	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	295.569	264
Apr-19	263.453	224.456	302,551	263
May-19	263.271	218.142	308.401	263
Jun-19	263.090	212.650	313.529	263
Jul-19	262.908	207.673	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	26.001	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	145.624	341.759	244
Nov-19	243.993	140.556	247.429	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 OMELETTETE 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	312.155	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*(Kg/year)	TC(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

TABLE XVI.   COMPUTATION OF LOT SIZING
BY USING FOQ METHOD FOR
POLIGON BRANCH

Raw material	$Q*$(Kg/year)	TC(IDR)
Rendang		
- Beef	3,975.95	2.772.528.056
- Salt	49.6	2.412.517
- Coconut Milk	1463.9	419.231.584
- Flavouring	4.7	978.937
- Rendang Seasoning	418.3	201,825,587
Fried Chicken		
- Chicken meat	5,971.3	1,325,058,058
- Salt	132.48	5,505,007
- Fried chicken seasoning	966.93	320,669,588
- Flavouring	11.48	2,310,543
Omelette		
- Chicken egg	2,946.89	292,334,516
- Salt	5.75	327,668
- Vegetable mix	1474.99	420,804,516
- Flavouring	1	228,627
- Flour	147.42	7,532,508

Table XVII-XIX show the comparison of FOQ Calculation for each raw material in two branches.

TABLE XVII. COMPARISON OF THE FINAL RESULTS OF THE FIXED ORDER QUANTITY METHOD FOR RENDANG RAW MATERIALS IN SUDIRMAN AND POLYGON BRANCHES

No	Raw Material	Rendang (IDR)	
		Sudirman	Poligon
1	Beef	5,124,174,540	2,772,528,056
2	Salt	7,341,981	2,412,517
3	Flavouring	3,051,874	978,937
4	Coconut Milk	587,549,790	419,231,584
5	Rendang Seasoning	621,425,792	201,825,587
	Total	6,343,543,977	3,396,976,681

TABLE XVIII. COMPARISON OF THE FINAL RESULTS OF THE FIXED ORDER QUANTITY METHOD FOR FRIED CHICKEN RAW MATERIALS IN SUDIRMAN AND POLYGON BRANCHES

No	Raw Material	Fried Chicken (IDR)	
		Sudirman	Poligon
1	Chicken meat	2,164,249,548	1,325,058,058
2	Salt	7,783,876	5,505,007
3	Flavouring	3,237,875	2,310,543
4	Fried Chicken seasoning	544,469,785	320,669,588
	Total	2,719,741,084	1,653,543,196

TABLE XIX. COMPARISON OF THE FINAL RESULTS OF THE FIXED ORDER QUANTITY METHOD FOR OMELETTE RAW MATERIALS IN SUDIRMAN AND POLYGON BRANCHEs

No	Raw Material	Omelette (IDR)	
		Sudirman	Poligon
1	Chicken Egg	383,847,005	292,334,516
2	Salt	743,249	327,668
3	Flavouring	608,300	228,627
4	Flour	7,384,000	7,532,508
4	Vegetable mix	246,672,000	420,804,516
	Total	639,254,554	721,227,835

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. 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.

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