Optimization Of Bread Production Quantity At The "Fadila Kitchen" Bakery

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Abstract

This research was conducted in the Fadila Kitchen bakery industry which produces various breads and desserts. The purpose of this research is to determine the planning of bread production quantities based on company policy, planning of bread production quantities based on aggregate planning, and the best production quantities for the company in order to produce minimum production costs with final inventory not piling up. The research was conducted using the Aggregate Planning method with demand forecasting using the exponential smoothing with trend method. The research results show that calculations using aggregate planning result in lower production costs and final inventory results do not accumulate compared to planning based on company policy. The advice given to Fadila Kitchen is that the company can carry out aggregate planning by forecasting demand to determine production quantities and adjust machine operations according to existing capacity in order to reduce excess production and a pileup of finished products.

Keywords: Aggregate Planning, Demand Forecasting, Bakery

Abstrak

Penelitian ini dilakukan di industri roti Fadila Kitchen yang memproduksi aneka roti dan *dessert*. Tujuan dari penelitian ini adalah untuk mengetahui perencanaan jumlah produksi roti berdasarkan kebijakan perusahaan, perencanaan jumlah produksi roti berdasarkan perencanaan agregat dan jumlah produksi yang terbaik pada perusahaan agar menghasilkan biaya produksi minimum dengan persediaan akhir tidak menumpuk. Penelitian yang dilakukan menggunakan metode Perencanaan Agregat dengan peramalan permintaan metode *exponential smoothing with trend*. Hasil penelitian menunjukkan bahwa perhitungan dengan perencanaan agregat menghasilkan biaya produksi yang lebih rendah dan hasil persediaan akhir tidak menumpuk dibandingkan dengan perencanaan berdasarkan kebijakan perusahaan. Saran yang diberikan kepada Fadila Kitchen adalah perusahaan dapat melakukan perencanaan agregat dengan peramalan permintaan untuk menentukan jumlah produksi dan menyesuaikan operasional mesin sesuai dengan kapasitas yang dimiliki agar dapat mengurangi kelebihan produksi dan penumpukkan produk jadi.

Kata Kunci: *Perencanaan Agregat, Peramalan Permintaan, Toko Roti*

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INTRODUCTION

Scheduling is one of the important parts that must be considered by companies to win business competition (Heizer & Render, 2015). Companies must be able to make the right decisions in production scheduling to be able to complete production with optimal time and quantity according to consumer demand. Currently, the development of the food and beverage (F&B) industry in Indonesia has experienced a significant increase, where various types of food and beverages are increasingly diverse.

Fadila Kitchen is a small and medium industry in the food and beverage sector with a focus on bread or bakery products. Production is carried out using the make-to-order method according to incoming orders. However, to increase profits, Fadila Kitchen also provides product stock to be sold at outlets per day. Based on this policy, production experiences an uncertain increase and decrease. Products that are not durable cause quality to decrease if not sold immediately.

Table 1. Difference in Production and Sales Amounts

Product Type	Period	Production (1)	Sales (2)	Difference |1-2| (3)
Steamed Brownies	Nov 1	313	305	8
	Nov 2	300	296	4
	Nov 3	294	285	9
	Nov 4	280	280	0
Baked Brownies	Nov 1	170	168	2
	Nov 2	162	157	5
	Nov 3	165	165	0
	Nov 4	175	170	5
Melted Brownies	Nov 1	162	154	8
	Nov 2	150	160	10
	Nov 3	153	158	5
	Nov 4	155	150	5
Cream Cheese	Nov 1	155	150	5
	Nov 2	145	142	3
	Nov 3	148	138	10
	Nov 4	140	135	5
Brownies Bite	Nov 1	330	326	4
	Nov 2	345	340	5
	Nov 3	342	336	6
	Nov 4	348	342	6
Bomboloni	Nov 1	264	258	6
	Nov 2	279	262	17
	Nov 3	281	268	13
	Nov 4	280	273	7
Fudgy Brownies	Nov 1	210	208	2

Product Type	Period	Production (1)	Sales (2)	Difference |1-2| (3)
	Nov 2	200	196	4
	Nov 3	192	180	12
	Nov 4	189	184	5
Total				

Source: Fadila Kitchen (2024) processed

Based on table 1, the difference between production and sales becomes unsold leftover products so Fadila Kitchen loses sales opportunities. The biggest difference is in Bomboloni products, then fudgy brownies and melted brownies. The difference in unsold products causes a fairly high total cost of lost sales due to different product prices.

LITERATURE REVIEW

Scheduling is one of the important activities that must be carried out by every company to determine the time and series of activities (Heizer & Render, 2015). Scheduling is a process that is routinely used in many manufacturing and service industries that includes the allocation of resources for tasks from a certain time period (Pinedo, 2016). The application of scheduling is carried out to allocate production equipment, process sequences, product types, raw material purchases, etc. Based on (Heizer & Render, 2015), scheduling an activity is divided into three types, as follows: Short-Term Scheduling: Scheduling consisting of work center loading and job sequencing. Short-term scheduling usually uses a period of hours or days so that it is used to schedule operational activities; Medium-Term Scheduling: This scheduling is used during aggregate planning or master scheduling. The aggregate planning carried out consists of facilities, labor requirements, and subcontracts; Project Scheduling: This scheduling is carried out to schedule company projects within an annual period. Project scheduling is typically used when planning capacity related to the procurement of facilities and equipment.

Aggregate planning is a process of planning the quantity and timing of output for the medium term, which is around 3 months to 1 year (Heizer & Render, 2015). Aggregate planning is carried out to develop a comprehensive production plan, and meet demand according to capacity, and optimally. Optimal means using resources wisely at the lowest possible cost (Efendi, et al. 2019). According to (Heizer & Render, 2015), aggregate planning methods are divided into several types.

Table and Graph Method: The table and graph method is carried out with several variables at one time by comparing demand projections and available capacity. Aggregate planning using the graph method has several stages in its application, namely: Determining demand in each period; Determining capacity for regular, overtime, and sub-contract time in each period; Determining the cost of regular labor, overtime labor, and subcontract labor; Considering the company's policies that are implemented; Determining alternative plans from the results of the total cost analysis. Mathematical Method: The mathematical method is done by using linear programming transportation and management coefficient models.

Transportation Method: Transportation method or transport shipment problem is done by using transportation table assistance.

Forecasting is an estimation of future demand associated with aspects of quantity, quality, time of occurrence, and location that require the product or service in question (Prasetyawan, 2008). Determining the forecasting method to be used requires consideration of achieving goals and paying attention to the type/pattern of data used (Prasetyawan, 2008). According to (Heizer & Render, 2015), forecasting has several methods that can be carried out by companies, the methods are as follows: Naive Method; Simple Mean or Average; Moving Averages Method; Weighted Moving Averages; Moment trend method; Least square method; Exponential Smoothing Method; Exponential smoothing with trend method.

The measure of forecasting accuracy is a measure or level of error from the forecasting results to actual demand. There are three measurements that can be used, namely: Mean Absolute Deviation (MAD); Mean Square Error (MSE); Mean Absolute Percentage Error (MAPE).
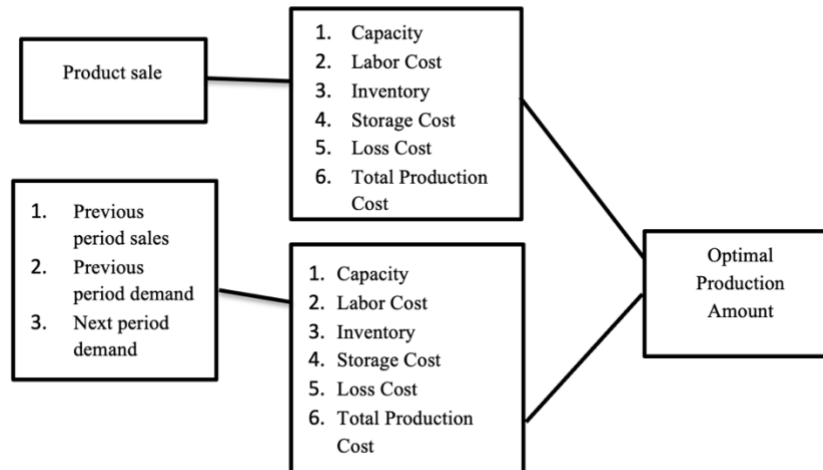

Figure 1. Framework of Thought

RESEARCH METHODS

The research was conducted at the Fadila Kitchen bakery located at Jl. Semangka No. 08 Pare, Kediri Regency, East Java (64215). The type of research used in the study is applied research to implement and evaluate existing problems. The research was conducted by evaluating calculations based on company policies, calculations based on aggregate planning, and comparing calculations based on company policies with aggregate planning.

RESULTS AND DISCUSSION

Forecasting is done using 8 forecasting methods, namely the naive method, simple mean or average, moving averages, weighted moving averages, trend moment, least square,

exponential smoothing, and exponential smoothing with trend. Based on the calculation results of the 8 methods, it was found that the smallest forecasting error was using the exponential smoothing with trend forecasting method. The following are the results of demand forecasting based on sales in the period December 2023 to February 2024:

Table 2. Fadila Kitchen Request Data

Week	Forecasting							Total
	Steamed Brownies	**Baked Brownies**	**Meltde Brownies**	**Cream Cheese**	**Brownies Bite**	**Bomboloni**	**Fudgy Brownies**	
Des 1	297	175	153	140	350	276	189	1580
Des 2	294	152	151	134	366	264	192	1553
Des 3	285	181	132	125	382	262	205	1572
Des 4	315	206	141	145	379	269	197	1652
Jan 1	289	195	146	146	379	280	212	1647
Jan 2	295	192	167	152	382	280	214	1682
Jan 3	304	178	158	160	386	250	219	1655
Jan 4	310	153	155	167	368	278	224	1655
Feb 1	319	164	162	161	354	289	244	1693
Feb 2	332	166	118	135	343	326	247	1667
Feb 3	325	160	136	148	350	328	238	1685
Feb 4	339	164	144	150	346	302	241	1686
Total	3704	2086	1763	1763	4385	3404	2622	

Source: *Primary data processed (2024)*

Based on table 2, it shows that the highest total demand is for Brownies Bite products and the lowest total demand is for Brownies Lumer and Cream Chessee products. Demand experiences an uncertain increase and decrease based on the warnings on certain days. Capacity at Fadila Kitchen is divided into regular capacity and overtime capacity. Working hours are every Monday to Saturday starting at 07.30 to 16.30. Here is the regular capacity at Fadila Kitchen:

Table 3. Regular Time Capacity

Machine	Amount	Time (1x)	Working Hours	∑Production	Total Production	Reguler /period
Mixer	4	35 mnt/10 product	I : 08.30-09.40	2X	80	1200
			II : 13.00-14.40	3X	120	
Oven	2	30 mnt/10 product	I : 09.10-10.10	2X	40	600
			II : 13.40-14.40	2X	60	

Steamer	5	10 mnt/3 product	I : 09.50-10.20	4X	45	630
			II : 14.10-14.50	3X	60	

Source: *Primary data processed (2024)*

Based on table 3, shows that the production process at Fadila Kitchen is divided into three machines with different capacities. In the mixer, there are 4 machines with a capacity of 10 products each in 1 operation with a time of 35 minutes. The mixer starts at 08.30 to 09.40 which operates 2 times and produces a total of 80 products. In the afternoon session, it starts at 13.00 to 14.40 which operates 3 times and produces a total of 120 products. So the total regular capacity of the mixer per day is 80 products plus 120 products, which is 200 products. Fadila Kitchen carries out production activities from Monday to Saturday so that the mixer capacity per period/week is 1,200 products.

Table 4. Overtime Capacity

Machine	Amount	Time (1x)	Working Hours	∑Production	Total Production	Reguler /period
Mixer	4	35 mnt/10 product	15.00-16.10	2X	80	480
Oven	2	30 mnt/10 produk	15.40-16.40	2X	40	240
Steamer	5	30 mnt/10 product	16.15-16.45	3X	45	270

Source: *Primary data processed (2024)*

Based on table 4, shows that the overtime capacity at Fadila Kitchen has three machines with different capacities. In the mixer, there are 4 machines with a capacity of 10 products each in 1 operation with a time of 35 minutes. Overtime on the mixer starts at 15.00 to 16.10 which operates 2 times and produces a total of 80 products. Fadila Kitchen carries out production activities both regularly and overtime from Monday to Saturday so that the mixer capacity per period or per week is 80 products multiplied by 6 producing 480 products.

Labor costs at Fadila Kitchen are divided into regular labor costs and overtime labor costs. Labor costs incurred are calculated per day, per hour, and per unit according to the work section or job desk that has been determined by the company. The following are labor costs per worker at Fadila Kitchen based on regular and overtime labor costs.

Table 5. Regular and Overtime Labor Costs

Section	Wage	Overtime wages/hour
Production	Rp35.000/hari	Rp7.000
Decoration/cutting	Rp20.000/hari	Rp5.000
Packing	Rp6.000/jam	Rp3.000
Folding packaging	Rp40/unit	

Source: *Primary data processed (2024)*

Based on table 5, regular labor costs are calculated in time per unit, per day, and per hour. While overtime costs are calculated in time per hour because each overtime that is done

will be determined by the amount of production needed. In the production section, wages are given per day of Rp35,000. The cutting and decoration section is given per day of Rp20,000. The packing section is given per hour of Rp6,000. While the packaging folding section is calculated per unit of Rp40. In the overtime costs of the production section, it is given Rp7,000 per hour. The cutting and decoration section is given Rp5,000 per hour. While the packing is given Rp3,000 per hour.

Calculations based on company policy are adjusted to the policies currently implemented by Fadila Kitchen. Currently, the company has not implemented forecasting, so production is adjusted to the number of orders received plus the amount of daily production set. So that the scheduling of machine use is done when it is used only. Production is carried out every Monday-Saturday with a workforce of 5 people in the production section and 2 people decorating/cutting. The machines used for production are 4 mixers, 2 ovens, and 5 steamers. The following are the results of the accumulated calculations based on company policy:

Table 6. Calculation based on Company Policy for the Period December 2023

Information	Type (in units)			
	Des 1	Des 2	Des 3	Des 4
Beginning inventory	33	83	155	147
Sales	1548	1534	1580	1667
Production				
Regular	1200	1200	1200	1200
Overtime	398	406	372	402
Ending Inventory	83	155	147	82
Holding Cost	Rp20.750	Rp38.750	Rp36.750	Rp20.500
Prodution Cost				
Regular Fee	Rp1.290.000	Rp1.290.000	Rp1.290.000	Rp1.290.000
Overtime Fee	Rp450.000	Rp450.000	Rp450.000	Rp450.000
Packaging Folding Fee	Rp63.920	Rp64.240	Rp62.880	Rp64.080
Packing Fee	Rp432.000	Rp432.000	Rp432.000	Rp432.000
Lost Sales Fee	Rp2.510.900	Rp3.741.700	Rp3.387.250	Rp1.367.650
Total production costs	Rp4.767.570	Rp6.016.690	Rp5.658.880	Rp3.624.230

Source: Fadila Kitchen (2024) processed

Table 7. Calculation based on Company Policy for the Period January 2024

Information	Type (in units)			
	Jan 1	Jan 2	Jan 3	Jan 4
Beginning inventory	82	79	58	84

Information	Type (in units)			
	Jan 1	**Jan 2**	**Jan 3**	**Jan 4**
Sales	1640	1689	1651	1654
Production				
Regular	1200	1200	1200	1200
Overtime	437	468	477	483
Ending Inventory	79	58	84	113
Holding Cost	Rp19.750	Rp14.500	Rp21.000	Rp28.250
Production Cost				
Regular Fee	Rp1.290.000	Rp1.290.000	Rp1.290.000	Rp1.290.000
Overtime Fee	Rp495.000	Rp540.000	Rp540.000	Rp540.000
Packaging Folding Fee	Rp65.480	Rp66.720	Rp67.080	Rp67.320
Packing Fee	Rp432.000	Rp432.000	Rp432.000	Rp432.000
Lost Sales Fee	Rp1.262.675	Rp1536.375	Rp2.297.550	Rp3.288.650
Total production costs	Rp3.564.905	Rp3.879.595	Rp4.647.630	Rp5.646.220

Source: Fadila Kitchen (2024) processed

Table 8. Calculation based on Company Policy for the Period February 2024

Information	Type (in units)			
	Feb 1	**Feb 2**	**Feb 3**	**Feb 4**
Beginning inventory	113	102	95	100
Sales	1693	1683	1685	1669
Production				
Regular	1200	1200	1200	1200
Overtime	482	476	490	465
Ending Inventory	102	95	100	77
Holding Cost	Rp25.500	Rp23.750	Rp25.000	Rp24.000
Production Cost				
Regular Fee	Rp1.290.000	Rp1.290.000	Rp1.290.000	Rp1.290.000
Overtime Fee	Rp540.000	Rp540.000	Rp600.000	Rp540.000
Packaging Folding Fee	Rp67.280	Rp67.040	Rp67.600	Rp66.600
Packing Fee	Rp432.000	Rp432.000	Rp432.000	Rp432.000
Lost Sales Fee	Rp3.007.300	Rp2.600.575	Rp2.581.450	Rp2.239.325
Total production costs	Rp5.362.080	Rp4.953.365	Rp4.976.450	Rp4.591.925

Source: *Primary data processed (2024)*

Tables 6, 7, and 8 show the accumulation of calculations based on company policy for three months. Where in the accumulation it can be seen that in February the 3rd week was the week with the most overtime, namely 490 but resulted in a fairly high loss of sales cost of Rp2,581,450. Then in December the 2nd week was the week with the highest total ending inventory with 153 products, the storage costs incurred were Rp38,750 and the total unsold products were Rp3,741,700.

Calculations based on aggregate planning are done by determining demand forecasts from the previous period's sales volume. Then determining the capacity and labor costs so that production activities run optimally. The following is an accumulation of calculations based on aggregate planning:

Table 9. Calculation based on Aggregate Planning Period December 2023

Information	Type (in units)			
	Des 1	Des 2	Des 3	Des 4
Beginning inventory	33	65	84	81
Sales	1548	1534	1580	1667
Production				
Regular	1200	1200	1200	1200
Overtime	380	353	377	452
Ending Inventory	65	84	81	61
Holding Cost	Rp16.250	Rp21.000	Rp20.250	Rp16.500
Production Cost				
Regular Fee	Rp1.290.000	Rp1.290.000	Rp1.290.000	Rp1.290.000
Overtime Fee	Rp450.000	Rp400.000	Rp450.000	Rp510.000
Packaging Folding Fee	Rp63.200	Rp62.120	Rp63.080	Rp66.080
Packing Fee	Rp432.000	Rp432.000	Rp432.000	Rp432.000
Lost Sales Fee	Rp1.655.800	Rp2.351.100	Rp2.369.800	Rp1.423.325
Total production costs	Rp3.907.250	Rp4.556.220	Rp4.625.130	Rp3.737.905

Source: *Primary data processed (2024)*

Table 10. Calculation based on Aggregate Planning Period January 2024

Information	Type (in units)			
	Jan 1	Jan 2	Jan 3	Jan 4
Beginning inventory	66	73	64	68
Sales	1548	1534	1580	1667
Production				

Regular	1200	1200	1200	1200
Overtime	447	480	455	455
Ending Inventory	73	64	68	70
Holding Cost	Rp18.250	Rp16.000	Rp17.000	Rp17.500
Production Cost				
Regular Fee	Rp1.290.000	Rp1.290.000	Rp1.290.000	Rp1.290.000
Overtime Fee	Rp495.000	Rp540.000	Rp540.000	Rp540.000
Packaging Folding Fee	Rp65.880	Rp67.200	Rp66.200	Rp66.240
Packing Fee	Rp432.000	Rp432.000	Rp432.000	Rp432.000
Lost Sales Fee	Rp1.492.175	Rp1.243.125	Rp1.382.525	Rp1.382.525
Total production costs	Rp3.793.305	Rp3.588.325	Rp3.744.300	Rp3.728.265

Source: Fadila Kitchen (2024) processed

Table 11. Calculation based on Aggregate Planning Period February 2024

Information	Type (in units)			
	Feb 1	Feb 2	Feb 3	Feb 4
Beginning inventory	70	57	41	36
Sales	1548	1534	1580	1667
Production				
Regular	1200	1200	1200	1200
Overtime	480	467	480	480
Ending Inventory	57	41	36	42
Holding Cost	Rp14.250	Rp10.250	Rp9.000	Rp11.750
Production Cost				
Regular Fee	Rp1.290.000	Rp1.290.000	Rp1.290.000	Rp1.290.000
Overtime Fee	Rp540.000	Rp540.000	Rp540.000	Rp540.000
Packaging Folding Fee	Rp67.720	Rp66.680	Rp67.200	Rp67.200
Packing Fee	Rp432.000	Rp432.000	Rp432.000	Rp432.000
Lost Sales Fee	Rp1.197.650	Rp852.125	Rp841.925	Rp998.325
Total production costs	Rp3.541.100	Rp3.191.055	Rp3.180.125	Rp3.339.275

Source: *Primary data processed (2024)*

Tables 9, 10, and 11 show the accumulation of aggregate planning for 3 months where in December the 2nd week became the week with the most ending inventory, namely 77 products with the highest storage costs incurred of Rp21,000 and the second largest lost sales costs of Rp2,351,100. Then in December the 3rd week became the second largest ending inventory with the second highest storage costs of Rp20,250 and the highest lost sales costs of Rp2,369,800.

In the calculations that have been presented, there are differences in the results of calculations based on company policy with aggregate scheduling based on forecasting. The differences in the analysis results are also seen in the amount of production carried out. Here is a comparison of the amount of production:

Table 12. Comparison of Production Quantities

Information	Company Policy	Aggregate Planning
Beginning inventory	33	33
Sales	19.693	19.693
Production		
Regular	14.400	14.400
Overtime	5.365	5.306
Ending Inventory	96	42

Source: *Primary data processed (2024)*

In table 12, the difference between production based on company policy and aggregate planning production can be seen. Production produced based on company policy and aggregate planning results in an overtime difference of 59 days with a difference in the final inventory of 54 products and results in a difference in storage costs of Rp110,500, which is greater using calculations based on company policy.

The difference is also seen in the costs generated. Here are the differences in costs generated based on company policy with demand forecasting:

Table 13. Comparison of Production Costs

Information	Company Policy	Aggregate Planning
Holding Cost	Rp298.500	Rp188.000
Regular Fee	Rp15.480.000	Rp15.480.000
Overtime Fee	Rp6.135.000	Rp6.085.000
Packaging Folding Fee	Rp790.240	Rp788.280
Packing Fee	Rp5.184.000	Rp5.184.000
Lost Sales Fee	Rp29.821.400	Rp17.190.400
Total production costs	**Rp57.709.140**	**Rp44.932.255**

Source: *Primary data processed (2024)*

Based on table 13, shows that the difference in costs in overtime costs with a difference of IDR 50,000 is smaller using demand forecasting. In the cost of folding packaging, the company's policy produces a higher cost of IDR 790,140, while the demand forecast produces a cost of IDR 788,280. The resulting storage costs show that the demand forecast is smaller than the company's policy. The total production costs produced appear slightly higher than the company's policy compared to the demand forecast with a difference of IDR 162,860.

Based on the calculations that have been carried out, production based on company policy produces a greater number of products, resulting in ending inventory and unsold products. The accumulated ending inventory results in higher holding costs and lost sales costs. In addition, if the ending inventory swells, it will cause storage costs to increase and product

damage considering that the product is a type of non-durable product. According toRatih et al., (2022), planning based on policy or strategy level can make costs more efficient but by varying the amount of inventory.

The use of demand forecasting in aggregate planning results in less ending inventory. This is supported by research conducted by (Gusdian et al., 2016) where demand forecasting can be used to forecast fluctuating demand. The results of the study show that the application of forecasting with the moving average method can make it easier to forecast demand and determine demand for the coming period accurately. In addition, aggregate planning with demand forecasting can minimize production costs and control production as in the study (Ensaftyan et al., 2022) where the total production costs generated are smaller with aggregate planning. Fadila Kitchen can use aggregate planning based on demand forecasting as in the research that has been presented. This is supported by research by (Ensaftyan et al., 2022)) and Nirwansyah & Bastuti (2022) aggregate planning can produce the lowest production costs by controlling overtime costs and storage costs. In addition, the demand forecasting carried out is used to obtain appropriate demand results by forecasting in advance based on sales in the previous period. The use of forecasting can reduce excessive production results that will accumulate into ending inventory. Piling up ending inventory will increase storage costs. In addition, if the final inventory piles up, it can cause product damage considering that the product is a type of product that does not last long.

CONCLUSION

Based on the results of the presentation in the research that has been conducted, the conclusion can be drawn based on the formulation of the problem in the research. Based on the evaluation conducted at Fadila Kitchen. Planning based on company policy has the result of higher costs incurred with a fairly large total of final inventory. The use of company policy causes higher costs incurred because production is only based on estimates and incoming orders so when demand increases the company will experience overtime that exceeds capacity and when demand decreases it will produce leftover products/final inventory which increases storage costs. Aggregate scheduling can be used to determine the capacity of the machine to carry out its production. Demand forecasting is done to find out whether the market trend is increasing or decreasing. Then the determination of machine and labor capacity to determine regular capacity and maximum capacity so as not to increase costs too much. This aggregate scheduling is also done to determine production hours so that the machine can work optimally. Based on the calculation of aggregate scheduling with forecast demand, the results obtained are that the company's costs are smaller with a total ending inventory of less. Fadila Kitchen can use aggregate scheduling with demand forecasting to carry out its production activities. Based on the evaluation that has been explained, aggregate scheduling is carried out to determine the amount of demand based on previous period sales and determine the regular capacity and maximum use of the machine. In addition, the scheduling of machine working hours is also determined so that the machine can operate optimally. Thus, if the capacity and amount of production have been optimized, the costs incurred can be reduced and unsold

products/ending inventory will not accumulate, resulting in lower lost sales costs and lower storage costs.

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