

## IMPLEMENTATION OF AGGREGATE PLANNING FOR SMES IN THE MANUFACTURING INDUSTRY

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### Abstract

*This study aims to examine the use of aggregate planning methods in micro, small, and medium enterprises (MSMEs) operating in the aluminum industry within the Greater Jakarta (Jabodetabek) region. It addresses the lack of structured aggregate planning practices in these enterprises and introduces an illustrative framework for evaluating labor control strategies. A heuristic approach is applied to compare cost estimations under three different aggregate planning methods: Permanent Workforce Control, Subcontract Control, and Hiring and Layoffs Control. Four MSMEs were selected as case study subjects, and cost-based simulations were conducted to demonstrate the potential impact of each method. The analysis reveals comparative outcomes of each method across the four case studies. While specific results are not detailed here, the study provides a practical view of cost variations associated with each planning strategy. The study is limited to illustrative simulation based on four MSMEs in a single industrial sector and region. Further empirical validation is recommended. The study serves as a preliminary reference for MSMEs to assess the suitability of different workforce planning approaches in response to fluctuating production demands.*

**Keywords:** *Aggregate Planning; MSMEs; Labor Control Strategies; Cost Efficiency; Aluminum Industry*

### 1. Introduction

The production process is a crucial process for business units in determining the output of products produced. Especially for business units engaged in manufacturing, the production process affects every step taken by the business unit from the beginning until the goods produced reach the hands of consumers (Napitupulu, 2021). According to Pratiwi, A.; Sarjono, H. (2014). Low process management performance can be caused by several things, including inaccurate forecasting, unintegrated inventory planning, weak coordination between divisions in the company, inadequate supplier performance, poor inventory management, and no inventory checks in the warehouse, therefore a company needs a new policy with a specific relevant method to facilitate process management, one of which is planning its raw material inventory so that it is expected to facilitate production needs (Alfi, R., Harif, M., Pharmayeni. 2022). According to Reid & Sanders (2013) in Sarjono, H.

(2020), Capacity planning is the process of determining the level of output that can be achieved by a facility. Capacity planning is important if a company wants to grow and maximize demand, therefore, all decisions taken in the production process must be made carefully and with full calculation. One method that can be used to plan the production process in a business unit is the Aggregate Planning method.

According to Sukendar & Kristomi (2008), Aggregate planning is a business unit process in determining the most efficient level of output or production capacity. This planning is carried out to meet the level of demand obtained from the forecasting results and to fulfill orders with the lowest possible total cost. The presence of aggregate planning is expected to provide benefits to business units after systematic and detailed calculations are carried out. According to Sumartono & Prayitna (2021), the output of aggregate planning is scheduling as a guideline for the production process so that it can be in accordance with customer demand, to ensure that the output obtained is in accordance with the plan. According to Firmansyah et al., 2022, in Prastiya, D.S and Wahyuni, R.S. (2024) the purpose of aggregate planning is to streamline

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production costs by involving factors such as the amount of final product storage, the amount of production, labor, overtime, subcontracts and raw materials. According to Maharani and Titi Sari (2025), warehouse efficiency can be achieved through cost control and streamlined operations. This is supported by Heizer and Render (2014), who emphasize the importance of determining optimal inventory levels based on forecasting.

Although effective for implementation in business units, the detailed aggregate planning method has not been widely used by MSMEs in Indonesia. This happens for several reasons, such as lack of human resources, lack of skills related to management operations, lack of access to technology, and market conditions that often change causing business units to focus more on short-term planning. Therefore, our group is interested in implementing aggregate planning for MSME business units. Prima Cipta Aluminum is a shop/service business for manufacturing aluminum products located at Jl. Mohammad Toha, Km. 4 No. 89, Periuk, Tangerang, Banten, 15131, Indonesia. Where this company produces household appliances or household furniture such as dish racks, wardrobes, kitchen sets, cigarette racks, drying racks, frames, and others. In its operational process, Prima Cipta Aluminum has not implemented aggregate planning, therefore it is necessary to adapt aggregate planning to the business.

This study addresses two main research problems: the implementation of aggregate planning in four MSMEs in the aluminum industry—Prima Cipta Aluminum in Banten, Rizki Tama Interior in South Jakarta, Harapan Bersama Jaya Aluminum in Sawangan, Depok, and Berkah Aluminum in Sawangan, Depok—and the identification of the most effective and cost-efficient aggregate planning method for these businesses.

Accordingly, the objectives of this study are to examine how aggregate planning is implemented in these four MSMEs and to determine which method proves to be the most effective and cost-efficient.

### 1.1 Understanding Aggregate Planning

Integrated production planning is one of the medium-term plans of the Supply Chain which covers a planning period of several months (Gonzalez, E.S; et al. 2023), so that Aggregate Planning is a short and medium-term planning process in operations management which is used to determine the resources needed to meet demand for products or services. Aggregate planning can be defined as a capacity planning that is classified as medium-term planning, where this planning aims to minimize production costs, inventory costs, labor and prioritize consumer demand (Cheraghalikhani, et al., 2019; Hafezalkotob, et al., 2019; C. Nivasanon, I. Srikun, and P. Aungkulanon. (2021). Aggregate Planning itself involves making a planned schedule such as planning inventory level requirements, production levels, labor levels, and utilization levels of other resources. Aggregate planning solves problems at the aggregate level, not at the stock keeping unit level (Chopra & Meindl, 2016).

Aggregate planning is also called production planning, which according to Wati (2020), production planning is planning that involves activities in obtaining products based on the needs of two parties, namely the company and consumers.

### 1.2 Aggregate Planning Function

According to the Big Indonesian Dictionary, function means the usefulness of something. Aggregate planning or production planning aims to maximize the use of capacity with fluctuating consumer demand (Ayough, 2018). Aggregate planning itself has many functions, including forecasting product demand expressed in the number of products, monitoring actual demand and comparing it with previous demand forecasts, and making revisions if there are deviations. In addition, it also functions to determine the amount of raw materials and supplies needed. The main function of aggregate planning is to create a planned schedule for production, assignment of tasks, and labor in detail. According to Pereira, D.F. et. al. (2020). From a systematic point of view, in the problem of Aggregate Production Planning, capacity constraints, demand, company policies, and strategies are mentioned as system inputs from integrated production planning, while production levels, inventory, and labor are considered as system outputs.

### 1.3 Aggregate Planning in MSMEs

MSMEs stands for Micro, Small, and Medium Enterprises, which are businesses carried out by individuals, groups, or small business entities that meet the criteria. This definition is regulated in Law of the Republic of Indonesia No. 20 of 2008 concerning Micro, Small, and Medium Enterprises. Aggregate Planning in this context is a very important aspect of business because it can help their businesses operate efficiently. In its application, aggregate planning can help minimize costs, in addition aggregate planning is used to determine the volume or schedule of medium-term production (usually 3 months to 18 months).

### 1.4. Previous research

The function of previous research in new studies, according to Creswell (2014), Booth, Colomb, & Williams (2008), and Randolph (2009), is to:

1. Identify research gaps
2. Build theoretical and conceptual foundations
3. Compare approaches or findings
4. Avoid duplication or redundancy
5. Support the validity of the selected approach
6. Identify trends and patterns
7. Serve as a scientific foundation and point of reference

Key differences from previous research:

- Prior studies have primarily focused on MSMEs in the textile, food, and furniture industries, or on large-scale companies such as those in the cement sector.
- The aggregate planning strategies commonly examined include Level, Chase, Mixed, Compromise, and Linear Programming approaches.

**Table 1.** Research Novelty

Author (Year)	Industry/Company Context	Aggregate Planning Strategy	Key Findings (Cost/Efficiency)
Afifah, Z. N.; Tejaningrum, A. (2025)	Garment MSME “Van’z Collection”, Bandung, Jawa Barat	Subcontracting,	The most cost-effective subcontracting
Sutthibutr, N., Hiraishi, K., & Chiadamrong, N. (2024)	General manufacturing supply chain (simulation-based study)	FMCDM with Linear Programming for aggregate planning optimization	This approach simultaneously minimizes cost and risk under uncertainty, yielding more stable and efficient plans than conventional methods.
Cahyono, A., Prihono, P., & Febrianto, I. D. (2023)	Children's clothing industry (MSME)	Level, Chase & Mixed	Mixed Strategy IDR124,900,000, optimal cost efficiency
W. F. Mahmudy, G. E. Yuliastuti, A. M. Rizki, I. P. Tama, dan A. P. Wibawa (2022)	Unspecified multi-product manufacturing company	Optimization-based APP using an improved genetic algorithm	The proposed algorithm outperforms conventional methods and standard GAs in reducing total production cost and improving efficiency
Febryanti, A.R., & Rani, A.M. (2019)	CV.X Garment Manufacturing	Subcontracting and Mixed Strategy	Pure Strategy (Subcontract) IDR 147,960,000 - Highest cost and Mixed Strategy IDR 140,670,000 Lowest cost
I Gozali, IN Pujawan, NI Arvitrida, (2018)	Indonesian cement company	Mixed Strategy based on quantitative approach (Linear Programming)	Subcontract & inventory for cost minimization under demand uncertainty
Noegraheni, E., & Nuradli, H. (2016)	PT Anela, Seafood Processing Company	Chase Strategy Level Strategy Mixed Strategy	Mixed Strategy IDR 32.97 billion, lowest production cost
Sarjono, et. al., (2025)	Implementing Aggregate Planning for SMEs In the Aluminum Industry	Permanent Workforce Control, Subcontract Control, Hiring and Layoffs Control	Hiring and Layoffs Control, IDR 26,255,000

Source: from several papers, processed by researchers (2025)

**Table 2.** Four MSMEs in the Aluminum Industry

Prima Cipta Aluminium	Rizki Tama Interior	Harapan Bersama Jaya Aluminium	Berkah Alumunium
Jl. Mohammad Toha, Km. 4 No. 89, Periuk, Tangerang, Banten, 15131	Jl. Poncol Raya Cilandak Barat, Jakarta Selatan, 12430	Jl. Raya Pengasingan No. 36, Sawangan, Depok, 16518	Jl. Raya Pengasingan RT 1/RW 6, No. 17, Sawangan, Depok, 16518

Source: Data processed by researchers (2025)

In contrast, this research uniquely investigates the comparative effectiveness of three labor control methods, Permanent workforce control, Subcontracting, and Hiring/layoffs, within the context of aluminum manufacturing MSMEs, a topic that has received limited attention in existing literature. For more details, see **Table 1**.

## 2. Method

The method used in this research process is a quantitative method which is a systematic research by collecting data that can be measured using statistical, mathematical, or computational techniques. According to Ghanad, A. (2023), quantitative research intends to test data and generalize the design of research samples of various dimensions. This research requires data accumulation, analysis, and interpretation of measurable data to show the hypothesis built in a

particular study. The most important thing about quantitative research is recognizing patterns and averages, estimating results, testing causal relationships, and generalizing the composition to a group or population (Pandey, P. et. al. 2023).

## 3. Results and Discussion

### 3.1 The Implementation of Aggregate Planning at Prima Cipta Aluminium, an MSME in Banten, as a Case Example

Implementing aggregate planning can significantly minimize costs, particularly when demand exceeds capacity. This paper presents a case study from Prima Cipta Aluminum, which includes comparative calculations from four other MSMEs in the aluminum industry, can be seen in **Table 2**.

Prima Cipta Aluminum itself has not yet implemented aggregate planning. However, if such

**Table 3.** Request Data

Period	Demand	Production Days	Demand per-Day
Dec-2023	50	26	2
Jan-2024	48	26	2
Feb-2024	45	24	2
Mar-2024	42	25	2
Apr-2024	49	22	3
May-2024	58	21	3
<b>Total</b>	<b>292</b>	<b>144</b>	-

**Table 4.** Recapitulation of Permanent Labor Control Methods

Period	Production Day	Production 2 units per-day	Demand Forecast	Inventory Change per-Month	Ending Inventory
Dec-23	26	52	50	+2	2
Jan-24	26	52	48	+4	6
Feb-24	24	48	45	+3	9
Mar-24	25	50	42	+12	21
Apr-24	22	44	49	-5	16
May-24	21	42	58	-16	0
<b>Total</b>					<b>54</b>

**Table 5.** Subcontract Control Method Recapitulation

Cost	Calculation
Regular-time labor	IDR 96,768,000 (= 3 workers x IDR 224,000 x 144 days)
Subcontracting	IDR 4,000,000 (= 4 units x IDR 1,000,000 per-unit)
<b>Total Cost</b>	<b>IDR 100,768,000</b> -

planning is adopted, it is expected to help minimize total costs, improve operational efficiency, and increase profitability, thereby supporting the company's growth. In this study, the application of aggregate planning in this MSME will be analyzed using various methods and production data. This approach will provide concrete evidence of the total costs associated with each method, allowing the company to compare the cost implications of the available options and identify the differences among them.

### 3.2 Cost Calculation with Heuristic Method

- Daily working capacity of 8 hours with 6 working days per week.
- Working hours to produce 1 unit is 10 hours/unit.
- The average pay rate is IDR 28,000/hour per day.
- Overtime pay rate is IDR 7,000/hour.
- Inventory carrying cost is IDR 40,000/unit.
- Subcontract cost IDR 1,000,000/unit
- Hiring cost IDR 350,000
- Layoffs cost IDR 1,000,000

$$\text{Average requirements} = \frac{\text{Total Expected Demand}}{\text{Number of Production Days}} = \frac{292}{144} = 2 \text{ unit per-day}$$

Cost calculation can be seen in **Table 3**.

### Permanent Labor Control Methods

Recapitulation of permanent labor control methods can be seen in **Table 4**. Total storage units from month to month = 54 units. Labor required to produce 2 units per-day = 3 workers.

- Inventory Carrying Cost = 54 units x IDR 40,000 per-unit = IDR 2,160,000

- Regular-time Labor = 3 workers x IDR 224.000 per-day x 144 days = IDR 96,768,000
- Other costs = 0

$$\begin{aligned} \text{Total Cost} &= \text{Storage cost} + \text{Regular working time cost} + \text{Other costs} \\ &= \text{IDR } 2,160,000 + \text{IDR } 96,768,000 + \text{IDR } 0 = \text{IDR } 98,928,000 \end{aligned}$$

### Subcontract Control Methods

- In-house Production = 2 unit per-day x 144 days = 288 units
- Subcontracts Units = 292 - 288 = 4 units

Subcontract Control Method Recapitulation can be seen in **Table 5**.

### Methods of Controlling Recruitment and Retrenchment of Workforce

Recapitulation of workforce recruitment and reduction control methods can be seen in **Table 6**.

### 3.3 Options That Should Be Offered to Manufacturing MSMEs

From the three calculation results using different methods, a cost comparison was obtained as shown in **Table 7**. Table-based calculations for the three additional MSMEs in the aluminum manufacturing sector, as outlined in the Appendix, are summarized as follows.

**Table 6.** Recapitulation of Workforce Recruitment and Reduction Control Methods

Period	Demand Forecast (units)	Daily Production on Rate	Production Cost (demand x 10 hours/unit x IDR 28,000/hour)	Additional Costs (Recruitment) (IDR)	Additional Fees (Reduction)	Total Cost (IDR)
Des-23	50	2	14,000,000	-	-	14,000,000
Jan-24	48	2	13,440,000	-	-	13,440,000
Feb-24	45	2	12,600,000	-	-	12,600,000
Mar-24	42	2	11,760,000	-	-	11,760,000
Apr-24	49	3	13,720,000	350,000 = (1x350,000)	-	14,070,000
May-24	58	3	16,240,000	-	-	16,240,000
<b>Total</b>			<b>81,760,000</b>	<b>350,000</b>	-	<b>82,110,000</b>

**Table 7.** Three Calculation Results Using Different Methods

Method	Total Cost (IDR)	Least Cost Order
Permanent Workforce Control	98,928,000	2
Subcontract Control	100,768,000	3
Hiring and Layoffs Control	82,110,000	1

**Table 8.** Cost Comparison of Four Similar MSMEs

MSME's	Prima Cipta Aluminium		Rizki Tama Interior		Harapan Bersama Jaya		Berkah Alumunium	
Comparison of Aggregate Planning Method Costs:	Total Cost (IDR)	Least Cost Order	Total Cost (IDR)	Least Cost Order	Total Cost (IDR)	Least Cost Order	Total Cost (IDR)	Least Cost Order
Permanent Workforce Control	98,928,000	2	99,690,000	2	71,380,000	3	59,557,000	3
Subcontract Control	100,768,000	3	106,840,000	3	70,000,000	2	57,857,000	2
Hiring and Layoffs Control	<b>82,110,000</b>	<b>1</b>	<b>75,600,000</b>	<b>1</b>	<b>27,400,000</b>	<b>1</b>	<b>26,255,000</b>	<b>1</b>

As shown in **Table 8**, based on the ranking of total costs from lowest to highest, the Hiring and Layoffs Control method consistently occupies the top position when compared to the other two methods, namely Permanent Workforce Control and Subcontract Control, across all MSMEs engaged in aluminum production in the Greater Jakarta area (Jabodetabek). This finding indicates that the hiring and layoffs strategy is the most efficient in minimizing overall operational costs while simultaneously maximizing the profit potential for each company.

For example, at Prima Cipta Aluminium, the total costs for Permanent Workforce Control were recorded at IDR 98,928,000, for Subcontract Control at IDR 100,768,000, while Hiring and Layoffs Control produced the lowest cost at IDR 82,110,000. A similar pattern is observed at Rizki Tama Interior, with respective costs of IDR 99,690,000 (Permanent Workforce), IDR 106,840,000 (Subcontract), and IDR 75,600,000 (Hiring and Layoffs). At Harapan Bersama Jaya Aluminium, although Subcontract Control cost (IDR 70,000,000) was slightly lower than Permanent Workforce Control (IDR 71,380,000), the lowest cost was still achieved through the Hiring and Layoffs method, at just IDR 27,400,000. Likewise, at Berkah Aluminium, Permanent Workforce Control incurred a cost of IDR 59,557,000, Subcontract Control IDR 57,857,000, and Hiring and Layoffs Control the lowest at IDR 26,255,000.

The consistent cost efficiency demonstrated by the Hiring and Layoffs Control method across all four

case studies suggests that this strategy is not only economically feasible but also strategically advantageous for MSMEs in the aluminum industry within the Jabodetabek region. Therefore, this method is recommended as the primary approach in implementing aggregate planning for similar industrial contexts.

#### 4. Conclusions

Based on the calculations and analysis of four MSMEs operating in the aluminum production sector within the Greater Jakarta area (Jabodetabek), it was found that none of the companies had implemented aggregate planning as part of their business operations. In fact, the adoption of aggregate planning is expected to assist companies in minimizing total operational costs, improving efficiency, and maximizing profitability. To illustrate the potential benefits of aggregate planning, this study applied a heuristic approach comprising three labor control methods: Permanent Workforce Control, Subcontract Control, and Hiring and Layoffs Control.

The simulation results reveal that the Hiring and Layoffs Control method consistently produced the lowest total costs compared to the other two methods across all four MSMEs. This cost efficiency was particularly evident in Harapan Bersama Jaya Aluminium and Berkah Aluminium, where the cost differences were most pronounced. These findings suggest that the Hiring and Layoffs strategy represents an optimal approach for aggregate planning

implementation, especially for medium-term workforce planning. Accordingly, this method is recommended for adoption by MSMEs in the aluminum industry as an efficient and responsive labor control strategy in managing production fluctuations.

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