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# Aggregate Production Planning for Cost Optimization: A Case Study of Van'z Collection, a Small-Scale Garment Manufacturer

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## ABSTRACT

*This study aims to evaluate the aggregate production planning system and explore alternative aggregate strategies to improve cost efficiency in the production planning process. The primary objective of aggregate planning is to mitigate unpredictable fluctuations, such as those caused by seasonal or external factors, and to minimize total planning costs. The research focuses on small and medium-sized enterprises (SMEs) operating in the garment manufacturing sector in Bandung, West Java. The methodological approach includes a case study design, data analysis, and demand forecasting using QM for Windows with forecasting techniques such as Moving Average and Exponential Smoothing. Microsoft Excel is utilized to simulate and analyze various aggregate planning strategies. This study examines three key strategies: subcontracting, labor adjustment, and working hour regulation. Each strategy incurs distinct cost components, subcontracting costs, recruitment and termination costs, and overtime costs, respectively. Field analysis reveals that subcontracting is the most cost-effective strategy. Its advantages include the ability to engage other SMEs in meeting demand, low risk of delivery delays, and reduced exposure to raw material shortages and processing time constraints. However, it carries a risk of quality variation. Therefore, it is recommended that firms implementing a subcontracting strategy maintain strict quality control to ensure compliance with product specifications.*

***Keywords:*** *Aggregate Planning; Exponential Smoothing; Forecasting; Moving Average; Production Planning*

## 1. Introduction

In order to remain competitive, manufacturers must be committed to meeting consumer needs by delivering products on time and at the lowest possible cost. However, fulfilling dynamic and fluctuating consumer demand often leads to increased operational expenses, making effective planning essential. Production planning serves as a key strategy to anticipate uncertainty, both within the internal organization and in the external environment (Tajik et al., 2024). Such uncertainty is frequently associated with consumer demand behavior, which is influenced by various factors, including pricing, competitor offerings, and shifting consumer preferences (Mula et al., 2006).

Numerous studies have addressed the role of production planning in managing uncertainty, often highlighting the importance of supply chain collaboration to enable rapid decision-making (Elyasi et al., 2024). Nonetheless, effective production planning requires solid internal coordination across departments, such as procurement, production, finance, and warehousing, as well as external collaboration with suppliers, transportation providers, and manufacturing partners. Consequently, the integration of information technology is vital in supporting these processes (Adenekan et al., 2024; Cadavid et al., 2020).

One of the primary sources of uncertainty in production planning is demand fluctuation. Producers must, therefore, carefully balance demand fulfillment with cost control, whether related to inventory holding or the consequences of unfulfilled demand (Su et al., 2025). The ultimate objective of production planning is to optimize the trade-off between meeting consumer demand and minimizing total production costs (Abdi & Nozari, 2023; Gozali et al., 2021). This involves integrated decision-making regarding production quantities, equipment maintenance, and quality management, which collectively influence cost efficiency (Nazabadi et al., 2024).

Van'z Collection is a small and medium-sized enterprise (SME) operating in the garment industry, primarily producing clothing for adult Muslim women. Located at Pacul No. 3A, Babakan Sari, Kiaracondong, Bandung, West Java, the company follows a make-to-order production system, meaning that products are manufactured in response to specific customer orders. This system presents challenges in forecasting future demand with precision. **Table 1** presents the company's demand data over the past three years.

**Table 1. Sales Data for the Period 2021 to 2023**

| Month | 2021 | 2022 | 2023 | Total |
|---|---|---|---|---|
| **January** | 5,290 | 5,319 | 5,369 | 15,978 |
| **February** | 4,289 | 4,987 | 4,032 | 13,308 |
| **March** | 7,084 | 6,786 | 7,643 | 21,513 |
| **April** | 9,439 | 10,323 | 10,106 | 29,868 |
| **May** | 10,876 | 12,349 | 6,408 | 29,633 |
| **June** | 7,589 | 8,753 | 6,630 | 22,972 |
| **July** | 6,765 | 7,594 | 5,369 | 19,728 |
| **August** | 4,981 | 6,549 | 4,032 | 15,562 |
| **September** | 5,032 | 5,692 | 7,643 | 18,367 |
| **October** | 4,875 | 4,987 | 10,106 | 19,968 |
| **November** | 4,890 | 4,657 | 6,408 | 15,955 |


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| | | | | |
|---|---|---|---|---|
| **December** | 4,910 | 5,012 | 6,630 | 16,552 |
| **Total** | **78,041** | **85,030** | **82,399** | **239,404** |

*Source: Van'z Collection internal data*

As illustrated in **Table 1**, demand over the three years has been highly variable. Notably, demand tends to peak between April and June each year. **Figure 1** graphically presents this seasonal pattern.

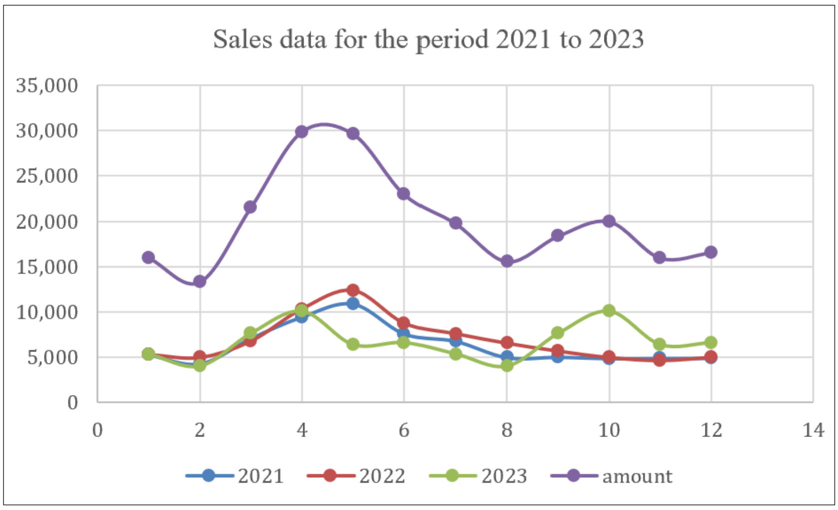


**Figure 1. Sales Trend for the Period 2021 to 2023**

Van'z Collection's current production capacity averages 5,040 units per month. A comparison of monthly demand with this capacity reveals periods of underutilization (e.g., February, October, November) as well as periods where demand exceeds capacity (e.g., March through July). To address these fluctuations and manage production costs effectively, companies can implement aggregate planning strategies (Rasmi & Türkay, 2021).

Van'z Collection currently employs a subcontracting strategy, wherein 25% of production is outsourced to third parties under normal demand, and up to 35% during periods of high demand. In-house employees handle the remaining production. While this approach is considered effective for managing spikes in demand, it also leads to higher production costs during peak periods.

Given this context, the present study seeks to evaluate alternative aggregate planning strategies, including subcontracting, labor adjustment, and working hour optimization, to determine the most cost-efficient approach. The novelty of this study lies in its analysis of subcontracting practices among SMEs, with particular attention to the benefits, limitations, and operational requirements for effective implementation. This research contributes to the field of production management by offering practical insights into cost reduction and competitiveness enhancement for small-scale garment manufacturers.

## 2. Literature Review

A company's ability to reduce operational costs is a key strategy in offering competitive selling prices to consumers (Fitriyani, 2022). In the manufacturing industry, where raw materials are processed into finished goods, careful planning is required to ensure the availability and timely procurement of raw materials. Labor and machine scheduling must also be aligned with demand patterns, which are often difficult to predict. Aggregate planning refers to a company's ability to evaluate and implement strategic options when demand exceeds capacity, such as using overtime, subcontracting, or deploying multiple production teams. Conversely, when demand is


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below capacity, firms must decide whether to reduce the workforce, shorten working hours, or maintain production levels and store the surplus as inventory. Aggregate planning, therefore, is a systematic approach to simultaneously optimizing production schedules, inventory levels, workforce size, and raw material allocation in response to demand uncertainty (Qasim et al., 2024).

Each company must establish an effective production planning and control system to achieve efficiency and productivity (Ridwah et al., 2024). A core challenge in aggregate planning is managing uncertainty. When poorly handled, this can lead to increased costs and deteriorated service quality (Karimi-Zare et al., 2024). Production planning significantly affects business performance in both goods and service sectors and typically comprises multiple components, including aggregate planning, capacity planning, and inventory planning. According to Cheraghalikhani et al., aggregate production planning (APP) is concerned with optimizing production levels across time periods by selecting alternative strategies that minimize costs (Cheraghalikhani et al., 2019). Its purpose is to determine aggregate production targets for different product families in anticipation of demand fluctuations in the near future. Broadly, aggregate planning falls under mid-term planning, covering a forecast horizon of two to eighteen months. It serves a strategic role as an intermediary between short-term planning (under three months) and long-term planning (beyond two years) (Rasmi & Türkay, 2021).

Further, aggregate planning involves identifying and coordinating key operational variables, including production rates (units produced per time period), labor requirements, overtime hours, subcontracting capacity, and inventory levels for each planning period (Qasim et al., 2024; Rasmi & Türkay, 2021). Arfiana et al. emphasized that aggregate planning is fundamentally about balancing capacity with anticipated demand, with the primary goal of minimizing total operational costs (Arfiana et al., 2021).

The initial step in aggregate planning is demand forecasting. According to Januschowski et al., forecasting is the process of estimating future events based on historical data and appropriate analytical techniques (Januschowski et al., 2020). Forecasting provides the foundation for production planning by generating projections of future demand (Barus et al., 2022). Forecasts are commonly categorized according to their time horizons. Wang and Tan classify forecasting horizons into several categories and outline various methods suited to each (Wang & Tan, 2021). For short-term projections, particularly for monthly demand variations, two frequently used techniques are the moving average and exponential smoothing methods (Mutia et al., 2024; Santoso et al., 2024; Suryawan et al., 2024; Widiarto & Kurniawan, 2024).

The moving average method is calculated using the formula:

$$\textbf{Moving Average} = \frac{\sum \textbf{Demand in the previous n periods}}{\boldsymbol{n}}$$

The exponential smoothing method is expressed as:

$$\boldsymbol{F_t = F_{t-1} + \alpha(A_{t-1} - F_{t-1})}$$

Where:

- $F_t$ = forecast for the current period
- $F_{t-1}$ = forecast for the previous period
- $A_{t-1}$ = actual demand in the previous period
- $\alpha$ = smoothing constant, where $0 \leq \alpha \leq 1$


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To evaluate forecasting accuracy, several performance measures are commonly employed, including Mean Absolute Deviation (MAD), Mean Squared Error (MSE), and Mean Absolute Percentage Error (MAPE). These metrics play a critical role in assessing the effectiveness of time series forecasting models (Ahaggach et al., 2024; Sari & Winarno, 2023). A good forecasting model is generally indicated by lower values of MAD, MSE, and MAPE (Alburshaid & Al-Alawi, 2024; Santoso et al., 2024; Sari & Winarno, 2023).

Aggregate planning presents several alternative strategies that operations and production managers may adopt in response to fluctuating demand. According to Wang and Tan (2021), these strategies are categorized into two groups. The first category, *capacity options*, involves adjusting internal capacity without altering demand. The second, *demand options*, seeks to influence or shift customer demand to better align with capacity constraints.

This study focuses on capacity-oriented strategies, specifically five methods:

1) Varying inventory levels
   This strategy involves maintaining steady production regardless of fluctuating demand. When demand is low, excess output is stored in inventory; when demand exceeds capacity, inventory is used to supplement production. However, this strategy incurs storage costs, including warehousing, administration, labor, potential product damage, and insurance.
2) Adjusting workforce size
   Labor is increased or decreased through hiring and layoffs, depending on changes in demand. This approach leads to additional costs related to recruitment, training, and termination.
3) Varying working hours
   The company adjusts output by using overtime or reducing regular hours. Overtime is employed when demand exceeds capacity, and reduced hours are applied during periods of low demand.
4) Subcontracting
   When demand surpasses internal capacity, production is outsourced to third-party manufacturers. This strategy allows companies to avoid fixed costs associated with capacity expansion but introduces subcontracting costs and the need for quality control.
5) Utilizing part-time employees
   Temporary workers are employed to meet increased demand without providing long-term contracts. This option offers labor flexibility and cost control if properly managed.

However, in this particular study, only three strategies, subcontracting, labor adjustment, and working hour flexibility, are analyzed. Inventory-based strategies are excluded due to the absence of a dedicated warehouse facility at the case company. The part-time workforce strategy is also excluded because part-time workers at the firm still receive full wages, thereby eliminating the expected cost advantage and rendering the strategy economically inefficient.

## 3. Research Methodology

This study employs a descriptive method combined with a quantitative approach. The descriptive method is used to illustrate the initial conditions of production planning at Van'z Collection, while the quantitative approach is applied to identify the most effective production planning strategy that the company can adopt.


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Data were collected using three techniques: interviews, secondary data analysis, and literature review. Each method is detailed as follows:

- Interviews were conducted through direct, face-to-face interactions with key informants, focusing on the company's organizational structure, production planning practices, and observed operational phenomena relevant to the study objectives.
- Secondary data analysis involved obtaining company records in raw, unprocessed form. These included operational data such as production equipment capacity, historical production figures, and scheduling information, which were used to support quantitative analysis.
- Literature review was conducted by examining relevant theoretical and empirical sources from academic books, peer-reviewed journals, and reputable websites. The review focused on concepts and models related to production planning and aggregate planning strategies.

The overall research process followed a structured cycle, as illustrated in **Figure 2** below.

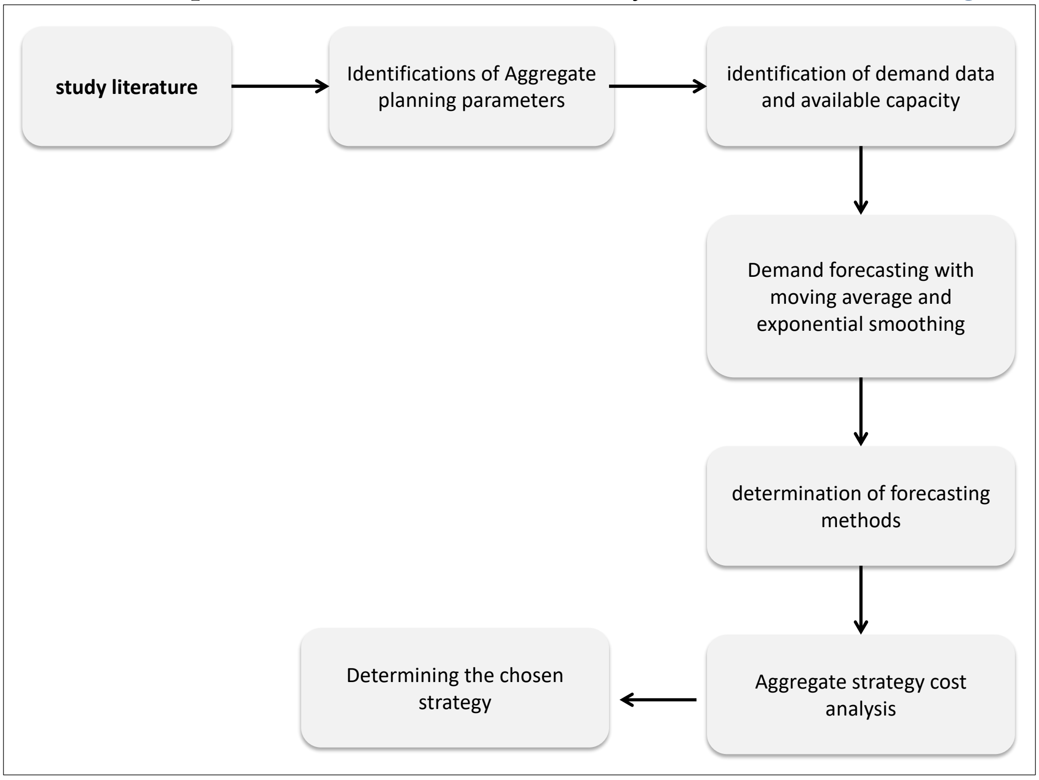


**Figure 2. Research Cycle**

## 4. Results and Discussion

### 4.1. Demand Projections

Forecasting is a methodological process used to estimate future demand by analyzing historical data and applying appropriate statistical models. This study utilizes two forecasting techniques: the moving average method with time windows of 3 and 5 months, and exponential smoothing with smoothing constants (alpha) of 0.1, 0.5, and 0.9. The calculations were conducted using *QM for Windows* software. Historical production demand data from 2021 to 2023 served as the basis for generating demand forecasts for the 2024–2026 period. The results of the forecasting using both methods are presented in **Table 2**.


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**Table 2. Forecasting Using Moving Average and Exponential Smoothing Methods**

| Month | Actual Data | Forecasting MA 3 | Forecasting MA 5 | Forecasting ES 0,1 | Forecasting ES 0, 5 | Forecasting ES 0,9 |
|---|---|---|---|---|---|---|
| January | 5.290 | | | 5.290 | 5.290 | 5.290 |
| February | 4.289 | | | 5.190 | 4.790 | 4.389 |
| March | 7.084 | | | 5.379 | 5.937 | 6.815 |
| April | 9.439 | 5.554 | | 5.785 | 7.688 | 9.177 |
| May | 10.876 | 6.937 | | 6.294 | 9.282 | 10.706 |
| June | 7.589 | 9.133 | 7.396 | 6.424 | 8.435 | 7.901 |
| July | 6.765 | 9.301 | 7.855 | 6.458 | 7.600 | 6.879 |
| August | 4.981 | 8.410 | 8.351 | 6.310 | 6.291 | 5.171 |
| September | 5.032 | 6.445 | 7.930 | 6.182 | 5.661 | 5.046 |
| October | 4.875 | 5.593 | 7.049 | 6.052 | 5.268 | 4.892 |
| November | 4.890 | 4.963 | 5.848 | 5.936 | 5.079 | 4.890 |
| December | 4.910 | 4.932 | 5.309 | 5.833 | 5.319 | 4.908 |
| January | 5.319 | 4.892 | 4.938 | 5.782 | 4.987 | 5.278 |
| February | 4.987 | 5.040 | 5.005 | 5.702 | 6.786 | 5.016 |
| March | 6.786 | 5.072 | 4.996 | 5.810 | 10.323 | 6.609 |
| April | 10.323 | 5.697 | 5.378 | 6.262 | 12.349 | 9.952 |
| May | 12.349 | 7.365 | 6.465 | 6.870 | 8.753 | 12.109 |
| June | 8.753 | 9.819 | 7.953 | 7.059 | 7.594 | 9.089 |
| July | 7.594 | 10.475 | 8.640 | 7.112 | 6.549 | 7.743 |
| August | 6.549 | 9.565 | 9.161 | 7.056 | 5.692 | 6.668 |
| September | 5.692 | 7.632 | 9.114 | 6.920 | 4.987 | 5.790 |
| October | 4.987 | 6.612 | 8.187 | 6.726 | 4.657 | 5.067 |
| November | 4.657 | 5.743 | 6.715 | 6.519 | 5.012 | 4.698 |
| December | 5.012 | 5.112 | 5.896 | 6.369 | 5.121 | 4.981 |
| January | 5.369 | 4.885 | 5.379 | 6.269 | 5.245 | 5.330 |
| February | 4.032 | 5.013 | 5.143 | 6.045 | 4.639 | 4.162 |
| March | 7.643 | 4.804 | 4.811 | 6.205 | 6.141 | 7.295 |
| April | 10.106 | 5.681 | 5.343 | 6.595 | 8.123 | 9.825 |
| May | 6.408 | 7.260 | 6.432 | 6.576 | 7.266 | 6.750 |
| June | 6.630 | 8.052 | 6.712 | 6.582 | 6.948 | 6.642 |
| July | 7.210 | 7.715 | 6.964 | 6.644 | 7.079 | 7.153 |
| August | 6.900 | 6.749 | 7.599 | 6.670 | 6.989 | 6.925 |
| September | 5.849 | 6.913 | 7.451 | 6.588 | 6.419 | 5.957 |
| October | 4.299 | 6.653 | 6.599 | 6.359 | 5.359 | 4.465 |
| November | 4.292 | 5.683 | 6.178 | 6.152 | 4.826 | 4.309 |
| December | 4.656 | 4.813 | 5.710 | 6.003 | 4.741 | 4.621 |
| **Total** | 232.422 | 218.515 | 206.507 | 226.008 | 233.224 | 232.496 |

Source: Data processed by the authors (2024)


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As shown in **Table 2**, the demand forecasts for the 2024–2026 period were generated using both three-month and five-month moving averages, as well as exponential smoothing with different alpha values. To determine the most suitable forecasting model, this study evaluated the Mean Absolute Deviation (MAD), Mean Squared Error (MSE), and Mean Absolute Percentage Error (MAPE) for each method. These accuracy metrics were calculated using *QM for Windows*, and the comparative results are summarized in **Table 3**.

**Table 3. Accuracy Measures for Forecasting Methods**

| Method | MAD | MSE | MAPE |
|---|---|---|---|
| Moving Average (3-month) | 1,698.72 | 5,156,971 | 24.10% |
| Moving Average (5-month) | 1,768.05 | 5,458,766 | 27.94% |
| Exponential Smoothing (α=0.1) | 1,685.59 | 4,829,616 | 25.41% |
| Exponential Smoothing (α=0.5) | 1,507.80 | 3,989,787 | 21.78% |
| Exponential Smoothing (α=0.9) | 1,323.38 | 3,372,868 | 18.47% |

Based on **Table 3**, it is evident that the Exponential Smoothing method with α = 0.9 produced the most accurate results, with the lowest values across all three accuracy metrics: MAD of 1,323.38, MSE of 3,372,868, and MAPE of 18.47%. These results indicate that this method has the least forecasting bias and highest precision.

Therefore, the Exponential Smoothing method with α = 0.9 is selected as the most appropriate model for forecasting production demand at Van'z Collection for the 2024–2026 period. This model will be used as the basis for further aggregate production planning in subsequent sections of this study.

### 4.2. Cost Components for an Aggregation Strategy

At Van'z Collection, production planning currently follows a mixed strategy in which 75% of the output is produced in-house, while the remaining 25% is outsourced to subcontractors. This arrangement was adopted to address capacity limitations during periods of high demand, as the company was unable to meet production targets within the required time frame through internal resources alone.

However, challenges arise when demand decreases but the same production arrangement continues to be applied. In such cases, production costs tend to increase unnecessarily. This inefficiency is evident when comparing the cost per unit between internally produced items and those outsourced to third-party subcontractors.

**Table 4** presents the detailed cost components and the total production capacity relevant to the company's current aggregate planning strategy.

**Table 4. Cost Components for an Aggregation Strategy**

| Aggregate Calculation Components | Information |
|---|---|
| Number of workers | 15 persons |
| Working hours per day | 8 hours/day |
| Production capacity per person per hour | 2 units |
| Production capacity per person per day | 16 units |
| Overtime hours per day | 5 hours |
| Overtime capacity per person per hour | 2 units |


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| Aggregate Calculation Components | Information |
|---|---|
| Overtime capacity per person per day | 10 units |
| Total overtime capacity per day | 150 units |
| Normal production cost | IDR 10,000 per unit |
| Overtime production cost | IDR 13,000 per unit |
| Recruitment cost | IDR 10,000 per worker |
| Subcontracting (third-party) cost | IDR 15,000 per unit |

Source: Interview with Van'z Collection management (2024)

The data in **Table 4** illustrate the differences in cost structure depending on the production method used. In-house production incurs labor-related costs, while outsourcing adds third-party service fees, which are relatively higher. This information forms the basis for evaluating the effectiveness of various aggregate planning strategies in minimizing total production costs.

### 4.3. Subcontract Method (Van'z Collection Strategy)

This section presents the production planning calculation based on the subcontracting strategy currently applied by Van'z Collection. Under this method, the company allocates 75% of its production to internal employees and outsources the remaining 25% to subcontractors. This model was initially adopted to address production shortfalls during peak demand periods when in-house capacity alone could not meet scheduled targets.

However, the application of this method even during periods of low demand has led to elevated production costs. The cost differential between internally produced units and subcontracted units becomes significant under such conditions. **Table 5** provides detailed monthly calculations of production planning, labor capacity, subcontracting volume, and associated costs from 2024 to 2026.

**Table 5. Subcontract Method Planning and Cost Estimation (2024–2026)**

| Year | Month | Working Days | Prod. Planning | Prod. Capacity | Subcontract | Salary (IDR) | Subcontract Cost (IDR) | Total Cost (IDR) |
|---|---|---|---|---|---|---|---|---|
| 2024 | January | 27 | 5,290 | 3,968 | 1,323 | 39,675,000 | 19,837,500 | 59,512,500 |
| | February | 25 | 4,389 | 3,292 | 1,097 | 32,918,250 | 16,459,125 | 49,377,375 |
| | March | 26 | 6,815 | 5,111 | 1,704 | 51,108,825 | 25,554,413 | 76,663,238 |
| | April | 26 | 9,177 | 6,882 | 2,294 | 68,824,133 | 34,412,066 | 103,236,199 |
| | May | 27 | 10,706 | 8,030 | 2,677 | 80,295,375 | 40,147,688 | 120,443,063 |
| | June | 25 | 7,901 | 5,926 | 1,975 | 59,255,295 | 29,627,648 | 88,882,943 |
| | July | 27 | 6,879 | 5,159 | 1,720 | 51,589,275 | 25,794,638 | 77,383,913 |
| | August | 27 | 5,171 | 3,878 | 1,293 | 38,780,678 | 19,390,339 | 58,171,016 |
| | September | 25 | 5,046 | 3,784 | 1,261 | 37,844,063 | 18,922,031 | 56,766,094 |
| | October | 27 | 4,892 | 3,669 | 1,223 | 36,690,653 | 18,345,326 | 55,035,979 |
| | November | 26 | 4,890 | 3,668 | 1,223 | 36,676,568 | 18,338,284 | 55,014,851 |
| | December | 26 | 4,908 | 3,681 | 1,227 | 36,810,158 | 18,405,079 | 55,215,236 |
| 2025 | January | 27 | 5,278 | 3,958 | 1,319 | 39,584,265 | 19,792,133 | 59,376,398 |
| | February | 24 | 5,016 | 3,762 | 1,254 | 37,620,675 | 18,810,338 | 56,431,013 |
| | March | 26 | 6,609 | 4,957 | 1,652 | 49,567,568 | 24,783,784 | 74,351,351 |
| | April | 26 | 9,952 | 7,464 | 2,488 | 74,637,008 | 37,318,504 | 111,955,511 |
| | May | 27 | 12,109 | 9,082 | 3,027 | 90,819,450 | 45,409,725 | 136,229,175 |
| | June | 25 | 9,089 | 6,816 | 2,272 | 68,164,695 | 34,082,348 | 102,247,043 |
| | July | 27 | 7,743 | 5,808 | 1,936 | 58,075,973 | 29,037,986 | 87,113,959 |
| | August | 27 | 6,668 | 5,001 | 1,667 | 50,013,345 | 25,006,673 | 75,020,018 |
| | September | 25 | 5,790 | 4,342 | 1,447 | 43,422,338 | 21,711,169 | 65,133,506 |
| | October | 27 | 5,067 | 3,800 | 1,267 | 38,004,488 | 19,002,244 | 57,006,731 |


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| Year | Month | Working Days | Prod. Planning | Prod. Capacity | Subcontract | Salary (IDR) | Subcontract Cost (IDR) | Total Cost (IDR) |
|---|---|---|---|---|---|---|---|---|
| | November | 26 | 4,698 | 3,524 | 1,175 | 35,235,195 | 17,617,598 | 52,852,793 |
| | December | 26 | 4,981 | 3,735 | 1,245 | 37,354,523 | 18,677,261 | 56,031,784 |
| 2026 | January | 27 | 5,330 | 3,998 | 1,333 | 39,976,200 | 19,988,100 | 59,964,300 |
| | February | 24 | 4,162 | 3,121 | 1,040 | 31,213,620 | 15,606,810 | 46,820,430 |
| | March | 26 | 7,295 | 5,471 | 1,824 | 54,711,615 | 27,355,808 | 82,067,423 |
| | April | 26 | 9,825 | 7,369 | 2,456 | 73,686,668 | 36,843,334 | 110,530,001 |
| | May | 27 | 6,750 | 5,062 | 1,687 | 50,622,668 | 25,311,334 | 75,934,001 |
| | June | 25 | 6,642 | 4,981 | 1,660 | 49,814,768 | 24,907,384 | 74,722,151 |
| | July | 27 | 7,153 | 5,365 | 1,788 | 53,648,978 | 26,824,489 | 80,473,466 |
| | August | 27 | 6,925 | 5,194 | 1,731 | 51,939,900 | 25,969,950 | 77,909,850 |
| | September | 25 | 5,957 | 4,467 | 1,489 | 44,674,740 | 22,337,370 | 67,012,110 |
| | October | 27 | 4,465 | 3,349 | 1,116 | 33,485,723 | 16,742,861 | 50,228,584 |
| | November | 26 | 4,309 | 3,232 | 1,077 | 32,319,570 | 16,159,785 | 48,479,355 |
| | December | 26 | 4,621 | 3,466 | 1,155 | 34,659,960 | 17,329,980 | 51,989,940 |
| **Total Cost** | | | | | | **1,660,175,978** | **997,180,429** | **2,675,396,406** |

Source: Data processed by the author (2024)

Based on the subcontracting model employed by Van'z Collection, the total production cost for the projected period (2024–2026) amounts to IDR 2,675,396,406. Of this, IDR 1,660,175,978 accounts for internal employee-related costs, and IDR 997,180,429 corresponds to subcontracting expenditures.

This strategy, while useful in managing production surges, reveals a cost inefficiency when maintained during periods of stable or declining demand. Consequently, this analysis highlights the importance of reassessing the continued application of subcontracting and exploring alternative aggregation strategies to optimize cost-effectiveness in future production cycles.

### 4.4. Working Hours Control Strategy

This strategy focuses on regulating employee working hours to address excess demand not through subcontracting but by increasing employee working hours, including overtime. **Table 6** presents the calculation of required overtime hours based on projected production demand for the period 2024 to 2026. The calculation first determines forecasted demand and compares it to existing production capacity. This comparison identifies months with either production surpluses or shortfalls. The production planning based on the working hours control strategy is detailed below.

**Table 6. Production Planning Based on Working Hours Control Strategy**

| Year | Month | Working Days | Prod. Planning | Prod. Capacity | Subcontract | Salary (IDR) | Subcontract Cost (IDR) | Total Cost (IDR) |
|---|---|---|---|---|---|---|---|---|
| 2024 | January | 27 | 5,290 | 6,480 | – | 52,900,000 | – | 52,900,000 |
| | February | 25 | 4,389 | 6,000 | – | 43,891,000 | – | 43,891,000 |
| | March | 26 | 6,815 | 6,420 | 575 | 62,400,000 | 8,167,650 | 70,567,650 |
| | April | 26 | 9,177 | 6,480 | 2,937 | 62,400,000 | 44,048,265 | 106,448,265 |
| | May | 27 | 10,706 | 6,000 | 4,226 | 64,800,000 | 63,390,750 | 128,190,750 |
| | June | 25 | 7,901 | 6,480 | 1,901 | 60,000,000 | 28,510,590 | 88,510,590 |
| | July | 27 | 6,879 | 6,000 | 399 | 64,800,000 | 5,978,550 | 70,778,550 |
| | August | 27 | 5,171 | 6,480 | – | 51,707,570 | – | 51,707,570 |
| | September | 25 | 5,046 | 6,000 | – | 50,485,750 | – | 50,485,750 |
| | October | 27 | 4,892 | 6,480 | – | 48,920,870 | – | 48,920,870 |
| | November | 26 | 4,890 | 6,420 | – | 48,902,090 | – | 48,902,090 |
| | December | 26 | 4,908 | 6,420 | – | 49,080,210 | – | 49,080,210 |
| 2025 | January | 27 | 5,278 | 6,480 | – | 52,779,020 | – | 52,779,020 |
| | February | 24 | 5,016 | 5,760 | – | 50,160,900 | – | 50,160,900 |


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| Year | Month | Working Days | Prod. Planning | Prod. Capacity | Subcontract | Salary (IDR) | Subcontract Cost (IDR) | Total Cost (IDR) |
|---|---|---|---|---|---|---|---|---|
| | March | 26 | 6,609 | 6,240 | 369 | 62,400,000 | 5,535,135 | 67,935,135 |
| | April | 26 | 9,952 | 6,480 | 3,712 | 62,400,000 | 55,674,015 | 118,074,015 |
| | May | 27 | 12,109 | 6,000 | 5,629 | 62,400,000 | 84,438,900 | 146,838,900 |
| | June | 25 | 9,089 | 6,480 | 3,089 | 64,800,000 | 46,329,390 | 111,129,390 |
| | July | 27 | 7,743 | 6,000 | 1,263 | 60,000,000 | 18,951,945 | 78,951,945 |
| | August | 27 | 6,668 | 6,480 | 188 | 64,800,000 | 2,826,690 | 67,626,690 |
| | September | 25 | 5,790 | 6,000 | – | 57,896,450 | – | 57,896,450 |
| | October | 27 | 5,067 | 6,480 | – | 50,672,650 | – | 50,672,650 |
| | November | 26 | 4,698 | 6,240 | – | 46,980,260 | – | 46,980,260 |
| | December | 26 | 4,981 | 6,240 | – | 49,806,030 | – | 49,806,030 |
| 2026 | January | 27 | 5,330 | 6,480 | – | 64,800,000 | – | 64,800,000 |
| | February | 24 | 4,162 | 6,000 | – | 41,618,160 | – | 41,618,160 |
| | March | 26 | 7,295 | 6,420 | 3,272 | 62,400,000 | 49,073,730 | 111,473,730 |
| | April | 26 | 9,825 | 6,480 | 1,590 | 64,800,000 | 23,847,870 | 88,647,870 |
| | May | 27 | 6,750 | 6,000 | 792 | 62,400,000 | 11,879,790 | 74,279,790 |
| | June | 25 | 6,642 | 6,480 | 694 | 64,800,000 | 10,412,985 | 75,212,985 |
| | July | 27 | 7,153 | 6,000 | – | 60,000,000 | – | 60,000,000 |
| | August | 27 | 6,925 | 6,480 | 374 | 64,366,200 | 5,604,950 | 69,971,150 |
| | September | 25 | 5,957 | 6,000 | – | 59,494,660 | – | 59,494,660 |
| | October | 27 | 4,465 | 6,480 | – | 44,640,470 | – | 44,640,470 |
| | November | 26 | 4,309 | 6,420 | – | 43,092,050 | – | 43,092,050 |
| | December | 26 | 4,621 | 6,420 | – | 46,213,200 | – | 46,213,200 |
| **Total Cost** | | | | | | **2,014,882,140** | **464,671,205** | **2,488,678,745** |

Source: Data processed by the author (2024)

The demand forecast for 2024 to 2026 is listed in column four of **Table 6**. Production capacity, listed in column five, is calculated by multiplying the number of working days per month by the daily production capacity (240 pieces). The comparison between forecasted demand and available capacity reveals the production surplus or deficit for each month, as shown in column six.

For example, in January 2024, the forecasted demand is 5,290 units, while production capacity is 6,480 units, resulting in a surplus of 1,190 units. In this case, no overtime is required. Conversely, in March 2024, with a forecasted demand of 6,815 units and a capacity of 6,240 units, there is a shortfall of 575 units. To meet this demand, four days of overtime are needed, resulting in an overtime cost of IDR 7,468,630. Similar calculations were applied to subsequent months through December 2026.

The number of working days in **Table 6** is derived from the official calendar for 2024–2026. Production planning figures are calculated by multiplying the number of employees by daily production capacity and the number of working days. Overtime costs are calculated only when there is a production shortfall and are derived by multiplying the deficit by IDR 5,000 (the unit cost of labor overtime).

The total cost of implementing the working hours control strategy at Van'z Collection is IDR 2,488,678,745. Of this, regular employee salary accounts for IDR 2,014,882,140, and overtime labor costs total IDR 464,671,205.

This strategy offers a key benefit by providing additional earnings to employees through overtime compensation. However, it also presents a drawback in the form of increased workload, as employees are required to work beyond standard hours. This may lead to fatigue, which can compromise product quality. These concerns are consistent with research by Okta and Perdana, who found that excessive overtime negatively affects employee productivity, the longer the overtime, the lower the productivity level (Okta & Perdana, 2024). Similarly, Balqis emphasizes


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that excessive working hours can lead to fatigue and stress, which ultimately reduce overall performance (Balqis, 2024).

### 4.5. Labor Control Strategy

Labor control refers to a structured managerial approach aimed at evaluating and optimizing labor cost efficiency. The following analysis presents the results of aggregate workforce planning at Van'z Collection for the period 2024–2026. In this strategy, labor adjustment is carried out by aligning forecasted demand with available production capacity, using monthly working day calendars for the specified period.

The adjustment process involves two key scenarios. When demand exceeds capacity, the company increases its workforce through recruitment, which incurs costs such as search, selection, and interview expenses. Conversely, when capacity exceeds demand, the company reduces the workforce through layoffs, generating termination costs. Table 7 outlines the monthly workforce requirements under this strategy.

**Table 7. Workforce Requirements**

| Year | Month | Working Days | Production Planning | Capacity Planning | Production Shortage | Capacity/Employee |
|---|---|---|---|---|---|---|
| | January | 27 | 5,290 | 6,480 | – | 432 |
| | February | 25 | 4,389 | 6,000 | – | 400 |
| | March | 26 | 6,815 | 6,240 | 575 | 416 |
| | April | 26 | 9,177 | 6,240 | 2,937 | 416 |
| | May | 27 | 10,706 | 6,480 | 4,226 | 432 |
| | June | 25 | 7,901 | 6,000 | 1,901 | 400 |
| 2024 | July | 27 | 6,879 | 6,480 | 399 | 432 |
| | August | 27 | 5,171 | 6,480 | – | 432 |
| | September | 25 | 5,046 | 6,000 | – | 400 |
| | October | 27 | 4,892 | 6,480 | – | 432 |
| | November | 26 | 4,890 | 6,240 | – | 416 |
| | December | 26 | 4,908 | 6,240 | – | 416 |
| 2025 | January | 27 | 5,278 | 6,480 | – | 432 |
| | February | 24 | 5,016 | 5,760 | – | 384 |
| | March | 26 | 6,609 | 6,240 | 369 | 416 |
| | April | 26 | 9,952 | 6,240 | 3,712 | 416 |
| | May | 27 | 12,109 | 6,480 | 5,629 | 432 |
| | June | 25 | 9,089 | 6,000 | 3,089 | 400 |
| | July | 27 | 7,743 | 6,480 | 1,263 | 432 |
| | August | 27 | 6,668 | 6,480 | 188 | 432 |
| | September | 25 | 5,790 | 6,000 | – | 400 |
| | October | 27 | 5,067 | 6,480 | – | 432 |
| | November | 26 | 4,698 | 6,240 | – | 416 |
| | December | 26 | 4,981 | 6,240 | – | 416 |
| 2026 | January | 27 | 5,330 | 6,480 | – | 432 |
| | February | 24 | 4,162 | 5,760 | – | 384 |
| | March | 26 | 7,295 | 6,240 | 1,055 | 416 |
| | April | 26 | 9,825 | 6,240 | 3,585 | 416 |
| | May | 27 | 6,750 | 6,480 | 270 | 432 |


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| Year | Month | Working Days | Production Planning | Capacity Planning | Production Shortage | Capacity/Employee |
|---|---|---|---|---|---|---|
| | June | 25 | 6,642 | 6,000 | 642 | 400 |
| | July | 27 | 7,153 | 6,480 | 673 | 432 |
| | August | 27 | 6,925 | 6,480 | 445 | 432 |
| | September | 25 | 5,957 | 6,000 | – | 400 |
| | October | 27 | 4,465 | 6,480 | – | 432 |
| | November | 26 | 4,309 | 6,240 | – | 416 |
| | December | 26 | 4,621 | 6,240 | – | 416 |

Source: Data processed by the author (2024)

From **Table 7**, workforce needs are determined based on the number of working days, forecasted demand, and available production capacity. Column three indicates working days per month from 2024 to 2026, while column four presents production planning based on previously discussed demand forecasts. Column five reflects capacity, calculated by multiplying the number of working days by the daily capacity of 240 units, based on 15 workers producing 16 units each per day. The resulting labor gap (column six) is calculated as the difference between forecasted demand and existing capacity. When a shortage is identified, additional labor is recruited according to the deficit divided by the capacity per employee.

The cost implications of this labor adjustment strategy are summarized in **Table 8**.

**Table 8. Total Cost Labor Strategy**

| No | Labor Needs | Hiring | Firing | Employee | Cost of Employee/Month (IDR) | Total Cost (IDR) |
|---|---|---|---|---|---|---|
| 1 | 15 | – | – | 15 | 4,320,000 | 64,800,000 |
| 2 | 15 | – | – | 15 | 4,000,000 | 60,000,000 |
| 3 | 16 | 1 | – | 16 | 4,160,000 | 66,560,000 |
| 4 | 22 | 5 | – | 22 | 4,160,000 | 91,520,000 |
| 5 | 25 | 3 | – | 25 | 4,320,000 | 108,000,000 |
| 6 | 20 | – | 5 | 20 | 4,000,000 | 80,000,000 |
| 7 | 16 | – | 4 | 16 | 4,320,000 | 69,120,000 |
| 8 | 15 | – | 1 | 15 | 4,320,000 | 64,800,000 |
| 9 | 15 | – | – | 15 | 4,000,000 | 60,000,000 |
| 10 | 15 | – | – | 15 | 4,320,000 | 64,800,000 |
| 11 | 15 | – | – | 15 | 4,160,000 | 62,400,000 |
| 12 | 15 | – | – | 15 | 4,160,000 | 62,400,000 |
| 13 | 15 | – | – | 15 | 4,320,000 | 64,800,000 |
| 14 | 15 | – | – | 15 | 3,840,000 | 57,600,000 |
| 15 | 16 | 1 | – | 16 | 4,160,000 | 66,560,000 |
| 16 | 24 | 7 | – | 24 | 4,160,000 | 99,840,000 |
| 17 | 28 | 4 | – | 28 | 4,320,000 | 120,960,000 |
| 18 | 23 | – | 5 | 23 | 4,000,000 | 92,000,000 |
| 19 | 18 | – | 5 | 18 | 4,320,000 | 77,760,000 |
| 20 | 16 | – | 2 | 16 | 4,320,000 | 69,120,000 |
| 21 | 15 | – | 1 | 15 | 4,000,000 | 60,000,000 |
| 22 | 15 | – | – | 15 | 4,320,000 | 64,800,000 |
| 23 | 15 | – | – | 15 | 4,160,000 | 62,400,000 |
| 24 | 15 | – | – | 15 | 4,160,000 | 62,400,000 |


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| No | Labor Needs | Hiring | Firing | Employee | Cost of Employee/Month (IDR) | Total Cost (IDR) |
|---|---|---|---|---|---|---|
| 25 | 15 | – | – | 15 | 4,320,000 | 64,800,000 |
| 26 | 15 | – | – | 15 | 3,840,000 | 57,600,000 |
| 27 | 18 | 3 | – | 18 | 4,160,000 | 74,880,000 |
| 28 | 24 | 6 | – | 24 | 4,160,000 | 99,840,000 |
| 29 | 16 | – | 8 | 16 | 4,320,000 | 69,120,000 |
| 30 | 17 | 1 | – | 17 | 4,000,000 | 68,000,000 |
| 31 | 17 | – | – | 17 | 4,320,000 | 73,440,000 |
| 32 | 16 | – | 1 | 16 | 4,320,000 | 69,120,000 |
| 33 | 15 | – | – | 15 | 4,000,000 | 60,000,000 |
| 34 | 15 | – | – | 15 | 4,320,000 | 64,800,000 |

Source: Data processed by the author (2024)

As shown in **Table 8**, cost components include monthly wages, recruitment costs for additional employees, and layoff expenses when reducing staff. The total cost incurred for workforce adjustments over the three-year period is IDR 2,579,040,000. These costs are influenced by the hiring required to meet excess demand and terminations when demand drops below available capacity.

The main drawback of this strategy is the lead time required to recruit new employees. Although Indonesia currently experiences a labor surplus and garment-related tasks are relatively easy to master, often requiring only two weeks to a month of training, the onboarding process still entails delays. However, the strategy offers notable advantages, including supporting national efforts to reduce unemployment and providing job opportunities for underserved populations.

Moreover, this flexible approach to workforce management allows the company to balance production capacity more efficiently and potentially reduce operational costs in the long term. Nevertheless, the process must be conducted carefully, especially in terms of layoffs, to comply with labor regulations and legal protections in Indonesia (Ekström & Tolonen-Weckström, 2025). As noted by Kıcır, the cyclical process of terminating and rehiring workers has emerged as a strategic topic in the field of human resource development (Kıyık Kıcır, 2024). While this approach offers cost-saving opportunities, it also reduces the pool of high-quality candidates due to limited transparency in the recruitment process.

### 4.6. Subcontracting Strategy

The subcontracting strategy aligns closely with the current approach adopted by Van'z Collection. However, the primary distinction lies in the optimization of internal resources before engaging external parties. Within the framework of aggregate planning, subcontracting is activated only when forecasted demand exceeds in-house production capacity. If the company's existing resources are sufficient to meet production targets, subcontracting is not employed.

As the term suggests, this strategy delegates excess production to external companies that adhere to Van'z Collection's quality standards and production requirements. The analysis presented in **Table 9** calculates the total subcontracting costs incurred between 2024 and 2026.


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**Table 9. Total Cost Subcontract Strategy**

| Year | Month | Working Days | Production Planning | Production Capacity | Subcontract | Employ Salary/Month (IDR) | Cost of Subcontract (IDR) | Total Cost/Month (IDR) |
|---|---|---|---|---|---|---|---|---|
| | January | 27 | 5,290 | 6,480 | – | 52,900,000 | – | 52,900,000 |
| | February | 25 | 4,389 | 6,000 | – | 43,891,000 | – | 43,891,000 |
| | March | 26 | 6,815 | 6,420 | 575 | 62,400,000 | 8,167,650 | 70,567,650 |
| | April | 26 | 9,177 | 6,480 | 2,937 | 62,400,000 | 44,048,265 | 106,448,265 |
| | May | 27 | 10,706 | 6,000 | 4,226 | 64,800,000 | 63,390,750 | 128,190,750 |
| | June | 25 | 7,901 | 6,480 | 1,901 | 60,000,000 | 28,510,590 | 88,510,590 |
| **2024** | July | 27 | 6,879 | 6,000 | 399 | 64,800,000 | 5,978,550 | 70,778,550 |
| | August | 27 | 5,171 | 6,480 | – | 51,707,570 | – | 51,707,570 |
| | September | 25 | 5,046 | 6,000 | – | 50,485,750 | – | 50,485,750 |
| | October | 27 | 4,892 | 6,480 | – | 48,920,870 | – | 48,920,870 |
| | November | 26 | 4,890 | 6,420 | – | 48,902,090 | – | 48,902,090 |
| | December | 26 | 4,908 | 6,420 | – | 49,080,210 | – | 49,080,210 |
| | January | 27 | 5,278 | 6,480 | – | 52,779,020 | – | 52,779,020 |
| | February | 24 | 5,016 | 5,760 | – | 50,160,900 | – | 50,160,900 |
| | March | 26 | 6,609 | 6,240 | 369 | 62,400,000 | 5,535,135 | 67,935,135 |
| | April | 26 | 9,952 | 6,480 | 3,712 | 62,400,000 | 55,674,015 | 118,074,015 |
| | May | 27 | 12,109 | 6,000 | 5,629 | 62,400,000 | 84,438,900 | 146,838,900 |
| | June | 25 | 9,089 | 6,480 | 3,089 | 64,800,000 | 46,329,390 | 111,129,390 |
| **2025** | July | 27 | 7,743 | 6,000 | 1,263 | 60,000,000 | 18,951,945 | 78,951,945 |
| | August | 27 | 6,668 | 6,480 | 188 | 64,800,000 | 2,826,690 | 67,626,690 |
| | September | 25 | 5,790 | 6,000 | – | 57,896,450 | – | 57,896,450 |
| | October | 27 | 5,067 | 6,480 | – | 50,672,650 | – | 50,672,650 |
| | November | 26 | 4,698 | 6,240 | – | 46,980,260 | – | 46,980,260 |
| | December | 26 | 4,981 | 6,240 | – | 49,806,030 | – | 49,806,030 |
| | January | 27 | 5,330 | 6,480 | – | 64,800,000 | – | 64,800,000 |
| | February | 24 | 4,162 | 6,000 | – | 41,618,160 | – | 41,618,160 |
| | March | 26 | 7,295 | 6,420 | 3,272 | 62,400,000 | 49,073,730 | 111,473,730 |
| | April | 26 | 9,825 | 6,480 | 1,590 | 64,800,000 | 23,847,870 | 88,647,870 |
| | May | 27 | 6,750 | 6,000 | 792 | 62,400,000 | 11,879,790 | 74,279,790 |
| | June | 25 | 6,642 | 6,480 | 694 | 64,800,000 | 10,412,985 | 75,212,985 |
| **2026** | July | 27 | 7,153 | 6,000 | – | 60,000,000 | – | 60,000,000 |
| | August | 27 | 6,925 | 6,480 | 374 | 64,366,200 | 5,604,950 | 69,971,150 |
| | September | 25 | 5,957 | 6,000 | – | 59,494,660 | – | 59,494,660 |
| | October | 27 | 4,465 | 6,480 | – | 44,640,470 | – | 44,640,470 |
| | November | 26 | 4,309 | 6,420 | – | 43,092,050 | – | 43,092,050 |
| | December | 26 | 4,621 | 6,420 | – | 46,213,200 | – | 46,213,200 |
| **Total Cost** | | | | | | **2,014,882,140** | **464,671,205** | **2,488,678,745** |

Source: Data processed by the author (2024)

This strategy ensures that the company utilizes its internal capacity to the fullest before outsourcing production. When production requirements exceed available capacity, the unmet demand is transferred to subcontractors. Accordingly, this approach optimizes internal resources while accommodating market fluctuations. Based on the figures in **Table 9**, the total cost incurred from the subcontracting strategy amounts to IDR 2,488,678,745, which comprises subcontracting costs of IDR 464,671,205 and labor costs of IDR 2,014,882,140.

One of the key advantages of this strategy is its short-term flexibility. The company can meet spikes in demand without investing in additional machinery or hiring permanent staff, both of which would increase fixed costs and require substantial capital. Furthermore, this approach enables collaboration with smaller companies that have surplus capacity, contributing to local economic support.


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Nonetheless, this strategy also presents challenges. Effective subcontracting requires partnerships with reliable firms that meet production standards. Poor subcontractor selection can lead to quality inconsistencies and elevated costs. As Bingöl et al. emphasized, accurate and strategic subcontractor selection is critical, as it directly impacts the firm's operational credibility. Identifying suitable subcontractors often requires time and financial investment, making cooperative partnerships essential to streamline this process (Bingol et al., 2024).

While subcontracting offers immediate relief from internal capacity constraints, it introduces potential risks, including delivery delays and failures to meet product specifications (Mahmoudi & Javed, 2022). Therefore, firms must implement rigorous monitoring and quality assurance mechanisms when employing this strategy to ensure consistency and minimize reputational risk.

### 4.7. Comparison of Production Planning Before and After Using the Aggregate Planning Method

Based on the calculation results, a cost comparison was conducted between the current production planning method used by Van'z Collection and the aggregate planning strategies analyzed in this study. The comparison is presented in **Table 10**.

**Table 10. Aggregate Strategy Cost Comparison**

| Strategy | Total Cost |
|---|---|
| Van'z Collection Current Strategy | IDR 2,675,356,406 |
| Working Hours Control Strategy | IDR 2,728,067,957 |
| Labor Control Strategy | IDR 2,579,040,000 |
| Subcontracting Strategy | IDR 2,488,678,745 |

As shown in **Table 10**, the subcontracting strategy incurs the lowest total cost among the compared alternatives. Specifically, the total production cost under this strategy amounts to IDR 2,488,678,745, consisting of employee salary expenses of IDR 2,014,882,140 and subcontracting costs of IDR 464,671,205.

These findings indicate that cost efficiency can be improved by optimizing the internal resources of Van'z Collection. Currently, Van'z Collection has not adopted a formal aggregate production planning method, which limits its ability to identify the most cost-effective planning approach. As a result, production planning is carried out without a structured evaluation of capacity, labor, and subcontracting strategies.

The application of the aggregate planning method offers a systematic framework to optimize production resources and minimize total costs. This method enables companies to forecast demand, allocate resources efficiently, and compare alternative strategies under various scenarios. However, it is important to note that production planning based on forecasting remains inherently uncertain. The actual production process may deviate from the forecasted plan due to unforeseen market fluctuations or operational disruptions.

Despite these uncertainties, implementing aggregate planning provides a valuable decision-making tool for small and medium-sized enterprises seeking to enhance production efficiency and reduce operational costs. Future research may focus on integrating real-time production data and adaptive planning mechanisms to refine the accuracy and responsiveness of aggregate planning models.


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## 5. Conclusion

This study analyzed production planning at Van'z Collection, a garment manufacturing business that adopts a make-to-order production system. Under this system, production is initiated only after receiving customer orders, making demand unpredictable and variable across different periods. Consequently, demand forecasting plays a crucial role in determining efficient production strategies. This research applied both the moving average and exponential smoothing methods to forecast demand based on historical sales data from 2021 to 2023.

To determine the forecasting method with the highest accuracy, three metrics were used: Mean Absolute Deviation (MAD), Mean Squared Error (MSE), and Mean Absolute Percentage Error (MAPE). Among the two models, the exponential smoothing method with an alpha value of 0.9 proved to be the most accurate, yielding a MAD of 1,323.379, an MSE of 3,372,868, and a MAPE of 18.47%. These results indicate lower forecasting bias and greater predictive reliability.

The study also compared Van'z Collection's existing production strategy with three aggregate planning strategies: working hours control, labor control, and subcontracting. The findings show that the subcontracting strategy resulted in the lowest overall production planning cost, IDR 2,488,678,745, compared to Van'z Collection's current approach, which incurs a cost of IDR 2,675,356,406. The cost advantage of the subcontracting strategy lies in its ability to address fluctuating demand without the need to expand internal capacity or commit to long-term labor contracts.

Given these findings, the subcontracting strategy is recommended for implementation. However, for the strategy to be effective, the company must: (1) select subcontractors with proven capabilities in quality and timely delivery, (2) closely monitor subcontracting costs to avoid escalating production expenses that could affect pricing competitiveness, and (3) engage with vendors that demonstrate sound financial standing to mitigate the risk of order disruptions due to capital constraints, especially during peak demand periods.

Based on the results, several practical recommendations can be made. First, Van'z Collection should adopt a structured production planning process grounded in aggregate planning principles. Doing so will enable the company to meet customer demand more effectively while minimizing production costs. Second, the firm should evaluate multiple production control strategies, including working hours, labor management, and subcontracting, to determine the most appropriate approach for each demand cycle. Finally, improved production planning will not only reduce operational costs but also enhance resource optimization, thereby improving overall profitability and competitiveness in the market.

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## 7. Declaration of Conflicting Interests

The authors have declared no potential conflicts of interest regarding this article's research, authorship, and/or publication.


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