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BREAK-EVEN POINT ANALYSIS IN PRODUCTION CAPACITY PLANNING OF COLD PAVING HOT MIX ASBUTON AT THE FABRICATION UNIT OF PT ASPHALT KARYA NUSANTARA USING AN AGGREGATE PLANNING APPROACH

I Made Suartika[1], Arif Mulyanto[2], Jilaan Rifda[3]

[1*]Industrial Engineering Study Program, Department of Mechanical and Industrial Engineering, Faculty of Engineering, University of Mataram, Jl. Majapahit no. 62 Mataram, NTB, 83125, Indonesia
[2,3]Mechanical Engineering Study Program, Department of Mechanical and Industrial Engineering, Faculty of Engineering, University of Mataram, Jl. Majapahit no. 62 Mataram, NTB, 83125, Indonesia

*Corresponding author
E-mail addresses: imadesuartika@unram.ac.id
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ABSTRACT

PT Asphalt Karya Nusantara is a company that produces Cold Paving Hot Mix Asbuton (CPHMA) for road maintenance and repair needs. Fluctuating demand requires the company to conduct proper production capacity planning to control costs and achieve production targets. This study aims to determine the optimal production planning strategy using the Aggregate Planning approach, determine the Break-Even Point (BEP) value, and analyze the relationship between both in identifying the most profitable production strategy. The study uses actual data from January 2024 to December 2025, covering production, sales, inventory, fixed cost, and variable cost data. Demand forecasting compared the Single Exponential Smoothing (SES) and Moving Average methods, while production strategies were evaluated using Level Strategy and Chase Strategy. BEP analysis was calculated in units, monetary value (IDR), and time. The SES method with α = 0.3 was selected as the best forecasting model (MAD = 4,053; MSE = 39,121,111; MAPE = 449%), projecting an average demand of 1,411 sacks/month for 2026. In 2024, BEP was achieved at 22,310 sacks with break-even revenue of IDR 1,115,526,206 and a payback period of 3 months 10 days, generating a profit of IDR 327,066,069. In 2025, BEP rose to 30,847 sacks while production was only 22,744 sacks, resulting in a loss of IDR 10,754,124. Level Strategy was selected as the optimal strategy with total availability of 57,332 sacks, surpassing BEP by a surplus of 26,485 sacks. The integration of BEP and Aggregate Planning produces a comprehensive and measurable production decision-making framework. The company is advised to implement Level Strategy in 2026 with monthly actual demand deviation monitoring, and to develop market diversification to reduce dependence on government projects.

Keywords: *Break Even Point, Aggregate planning, Demand forecasting, Capacity production*

1. Introduction

Infrastructure development in Indonesia has experienced rapid growth during the last decade as part of the government's effort to improve national connectivity and economic development. The expansion of road networks has increased the demand for road construction materials, particularly asphalt, which plays an important role in pavement construction and maintenance. According to data from the Ministry of Public Works and Housing, Indonesia requires approximately 1.06 million tons of asphalt annually to support road construction and maintenance activities. However, most national asphalt demand is still fulfilled through imported asphalt products, causing high dependency on foreign

supplies and fluctuations in asphalt prices that affect construction costs and infrastructure stability [1]. This condition highlights the necessity of utilizing domestic resources to reduce dependence on imported asphalt and strengthen the national construction industry.

Indonesia possesses abundant natural asphalt reserves known as Buton Asphalt (Asbuton), which are estimated to reach approximately 677 million tons located on Buton Island. These reserves have the potential to supply national asphalt demand for more than one hundred years [2]. To support the utilization of domestic asphalt resources, the Indonesian government issued regulations encouraging the use of Asbuton-based materials in road construction and maintenance projects. One innovation resulting from the development of Asbuton technology is Cold Paving Hot Mix Asbuton (CPHMA), which is an asphalt mixture produced through a hot mixing process but can be applied at ambient temperature. CPHMA offers several advantages such as easier transportation, lower energy consumption, better storage flexibility, and environmentally friendly application compared to conventional hot mix asphalt [3].

The implementation of CPHMA technology has attracted significant attention because it provides an alternative solution for road maintenance in remote areas with limited access to Asphalt Mixing Plant (AMP) facilities. In addition, CPHMA products can be packaged in sacks or jumbo bags, allowing long-term storage and easier distribution to project locations. These advantages make CPHMA suitable for road maintenance projects requiring practical and efficient pavement materials [4]. Consequently, the development of the CPHMA industry has become increasingly important in supporting sustainable infrastructure development and increasing the utilization of local resources in Indonesia.

PT Asphalt Karya Nusantara is one of the companies engaged in the production of Cold Paving Hot Mix Asbuton products in the Nusa Tenggara region. Since its establishment, PT Asphalt Karya Nusantara has supplied CPHMA products for several government and private road projects in eastern Indonesia. However, the company faces significant challenges related to fluctuating product demand caused by seasonal infrastructure projects, budget realization schedules, market competition, and changes in government policies. These fluctuating demand conditions create uncertainty in determining production capacity and production planning strategies.

Uncertainty in market demand can lead to several operational problems. Excessive production capacity may result in idle capacity, increasing operational costs and reducing company profitability. On the other hand, insufficient production capacity may cause product shortages and the inability to fulfill market demand, resulting in lost business opportunities. Therefore, companies require an effective production planning system capable of balancing production capacity, inventory levels, workforce utilization, and operational costs in order to maintain production efficiency and business sustainability [5].

One of the important approaches that can be used to support production planning decisions is Break-Even Point (BEP) analysis. Break-Even Point analysis is a managerial accounting method used to determine the minimum production or sales volume required for a company to cover all operational costs. At the break-even point, total revenue equals total cost, meaning that the company neither earns profit nor experiences loss [6]. BEP analysis is strongly influenced by fixed costs, variable costs, selling prices, and production quantities. Fixed costs include expenses that remain constant regardless of production volume, such as equipment depreciation, salaries, and factory operational costs, while variable costs change proportionally with production quantity, including raw materials, fuel, labor, and packaging costs [7].

The application of Break-Even Point analysis provides several important benefits for manufacturing companies. Through BEP analysis, companies can determine minimum production targets, evaluate pricing strategies, estimate profitability, and identify operational risks associated with production activities [8]. Previous studies have shown that BEP analysis can improve managerial decision-making and assist companies in controlling production costs more effectively. Wijana et al. [9] reported that BEP analysis successfully determined the minimum sales target required to achieve profitability in the food industry. Similarly, Siswandi [10] applied BEP analysis to evaluate the production feasibility of electric bicycles and found that production volume significantly affects company profitability.

In addition to BEP analysis, production capacity planning can also be conducted using the Aggregate Planning approach. Aggregate Planning is a medium-term production planning method aimed at balancing production capacity with fluctuating market demand through adjustments in workforce levels, inventory, and production rates [11]. Aggregate Planning helps companies allocate resources more efficiently while minimizing operational costs and maintaining service levels. The

method is widely used in manufacturing industries to support strategic production decision-making under uncertain market conditions.

Two common strategies in Aggregate Planning are Level Strategy and Chase Strategy. Level Strategy maintains a relatively constant production quantity throughout the planning period regardless of demand fluctuations. This strategy emphasizes production stability and efficient workforce utilization but may increase inventory levels during periods of low demand. In contrast, Chase Strategy adjusts production quantities according to actual market demand in each period, reducing inventory accumulation but increasing operational adjustment costs due to frequent production changes [12]. The selection of an appropriate strategy depends on production characteristics, market demand patterns, storage capacity, and company operational objectives.

Several previous studies have investigated the implementation of Aggregate Planning in manufacturing industries. Nugraha [13] found that Level Strategy generated lower production costs in plastic packaging production because the company possessed adequate storage capacity and stable production facilities. Hernadewita et al. [14] reported that Aggregate Planning combined with forecasting methods significantly improved production efficiency and minimized inventory costs. However, Silvia and Juwita [15] concluded that Chase Strategy was more suitable for industries with highly fluctuating and short-term demand patterns. These differences indicate that the effectiveness of Aggregate Planning strategies depends on industrial characteristics and operational conditions.

Although numerous studies have discussed Break-Even Point analysis and Aggregate Planning separately, research integrating both approaches in the Cold Paving Hot Mix Asbuton industry remains very limited. Most previous studies focused only on production forecasting or operational cost analysis without integrating financial feasibility analysis and production planning into a comprehensive decision-making framework. Furthermore, empirical studies related to the production capacity planning of CPHMA products in Indonesia are still scarce. Therefore, further research is required to develop a production planning model capable of integrating forecasting, Aggregate Planning, and Break-Even Point analysis to improve operational efficiency and company profitability.

Based on these conditions, this study aims to analyze the Break-Even Point in production capacity planning of Cold Paving Hot Mix Asbuton using the Aggregate Planning approach at the fabrication unit of PT Asphalt Karya Nusantara. The study also aims to determine the most effective production strategy by integrating demand forecasting, Aggregate Planning, and BEP analysis. The results of this study are expected to provide practical recommendations for PT Asphalt Karya Nusantara in optimizing production capacity, improving operational efficiency, reducing production costs, and increasing profitability. In addition, this study is expected to contribute to the development of production management literature, particularly in the field of CPHMA manufacturing industries and sustainable asphalt technology development in Indonesia.

2. Materials and Method

This study was conducted at the fabrication unit of PT Asphalt Karya Nusantara located in East Lombok, West Nusa Tenggara, Indonesia. The company is engaged in the production of Cold Paving Hot Mix Asbuton (CPHMA), which is widely used for road maintenance and pavement rehabilitation projects. The research focused on analyzing production capacity planning using the Break-Even Point (BEP) and Aggregate Planning approaches in order to determine the most efficient and profitable production strategy for the company. The study utilized actual company operational data collected during the January 2024 to December 2025 period. The data included monthly production data, product demand data, sales data, inventory data, fixed cost data, variable cost data, and production capacity information.

The production system of CPHMA at PT Asphalt Karya Nusantara utilizes an Asphalt Mixing Plant (AMP) with a production capacity of 120 tons/day. The production process begins with the preparation of raw materials consisting of coarse aggregates, fine aggregates, Buton Asphalt (Asbuton), and additive materials according to the predetermined mix design composition. The aggregates are heated to reduce moisture content and improve adhesion with asphalt materials. After the heating process, the aggregates are mixed with Asbuton and additives in the mixing unit at temperatures ranging from 140–165°C until a homogeneous mixture is obtained. The mixture is then cooled so that the product

can be applied at ambient temperature without requiring reheating. Finally, the finished CPHMA products are packaged into polyethylene sacks and distributed to project locations.

The data collection process involved obtaining historical operational data directly from the company documentation and production records. The collected data consisted of monthly production quantities, product sales volumes, inventory levels, fixed operational costs, variable production costs, labor costs, packaging costs, fuel consumption, electricity usage, and product selling prices. These data were then tabulated and processed to support forecasting analysis, Aggregate Planning calculations, and Break-Even Point evaluation.

Demand forecasting was conducted to estimate future product demand and support production planning decisions. Forecasting analysis was performed using two forecasting methods, namely Single Exponential Smoothing (SES) and Moving Average (MA). The forecasting results were evaluated using forecasting error indicators consisting of Mean Absolute Deviation (MAD), Mean Square Error (MSE), and Mean Absolute Percentage Error (MAPE). The forecasting results obtained from both methods were compared to determine the most accurate forecasting approach for CPHMA production planning. The selected forecasting model was then used to estimate product demand for the 2026 production planning period.

Production capacity planning was analyzed using the Aggregate Planning approach. Aggregate Planning is a medium-term production planning method aimed at balancing production capacity with fluctuating market demand while minimizing operational costs. Two Aggregate Planning strategies were evaluated in this study, namely Level Strategy and Chase Strategy. Level Strategy maintains a relatively constant production quantity throughout the planning period regardless of fluctuations in market demand. This strategy emphasizes stable workforce utilization and continuous production operations. However, the strategy may result in higher inventory levels during periods of low demand. In contrast, Chase Strategy adjusts production quantities directly according to demand fluctuations in each period. Although this strategy minimizes inventory accumulation, it requires more frequent production adjustments and may increase operational costs associated with workforce and production changes.

The selection of the optimal Aggregate Planning strategy was based on several evaluation criteria, including total production cost, production stability, inventory level, operational efficiency, and company profitability. The strategy producing the lowest operational cost and the most stable production performance was selected as the optimal production planning strategy for PT Asphalt Karya Nusantara.

Break-Even Point (BEP) analysis was conducted to determine the minimum production quantity required for the company to avoid financial losses. The analysis integrated fixed costs, variable costs, selling prices, and production quantities to evaluate company profitability. The Break-Even Point in units was calculated using Equation (1).

$$BEP\ (X) = \frac{FC}{p-c} \tag{1}$$

where (BEP) is the break-even point in units, (FC) is the fixed cost (IDR), (p) is the selling price per unit (IDR/unit), and (c) is the variable cost per unit (IDR/unit). The BEP analysis was used to determine the minimum production volume required to cover all operational costs and achieve profitability. Demand forecasting using the Single Exponential Smoothing method was calculated using Equation (2).

$$F_{t+1} = \alpha X_t + (1-\alpha)F_t \tag{2}$$

where $F_{t+1}$is the forecast value for the next period, $\alpha$is the smoothing constant, $X_t$is the actual demand value, and $F_t$is the forecast value in the current period.

Forecasting performance was also evaluated using Mean Absolute Deviation (MAD), Mean Square Error (MSE) and Mean Absolute Percentage Error (MAPE) to ensure the forecasting model produced consistent and reliable demand predictions. The forecasting results obtained from these evaluation indicators were used as the basis for determining future production capacity planning.

The overall research procedure included data collection, demand forecasting analysis, Aggregate Planning evaluation, production cost calculation, Break-Even Point analysis, and determination of the

optimal production strategy. The integration of forecasting methods, Aggregate Planning, and Break-Even Point analysis was intended to develop a comprehensive production planning framework capable of improving operational efficiency, optimizing production capacity, reducing production costs, and increasing company profitability at PT Asphalt Karya Nusantara.

3. Results and Discussion

The production demand of Cold Paving Hot Mix Asbuton (CPHMA) at PT Asphalt Karya Nusantara experienced significant fluctuations during the 2024–2025 period, driven by seasonal infrastructure projects, government budget realization, weather conditions, and road maintenance activities in the Nusa Tenggara region. These fluctuations created uncertainty in determining optimal production capacity and inventory management, posing challenges to operational efficiency and profitability. Therefore, forecasting analysis was conducted using historical demand data from January 2024 to December 2025, comparing two methods — Single Exponential Smoothing (SES) and Moving Average (MA) showed at the Figure 1 and 2 — evaluated through MAD, MSE, and MAPE error indicators to identify the most accurate approach for supporting production planning decisions.

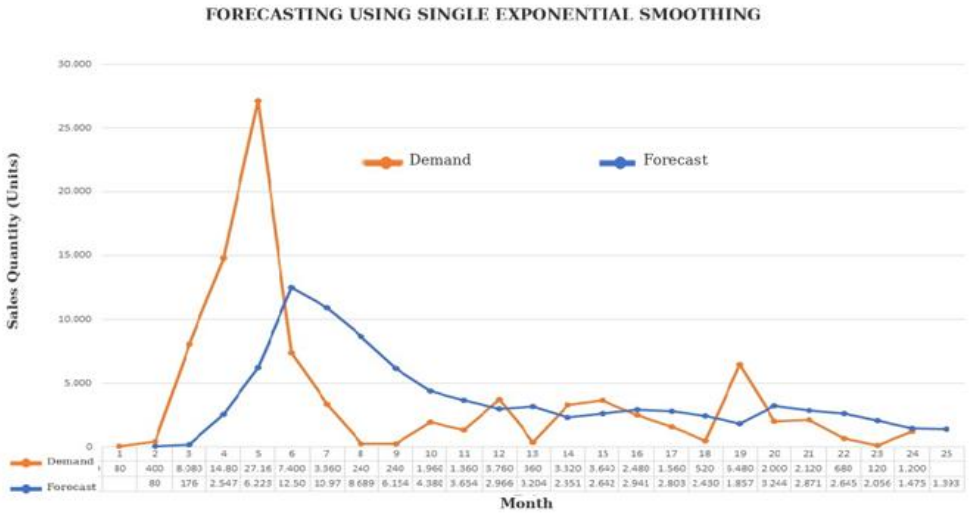


Figure 1 Chart of single exponential smoothing methods

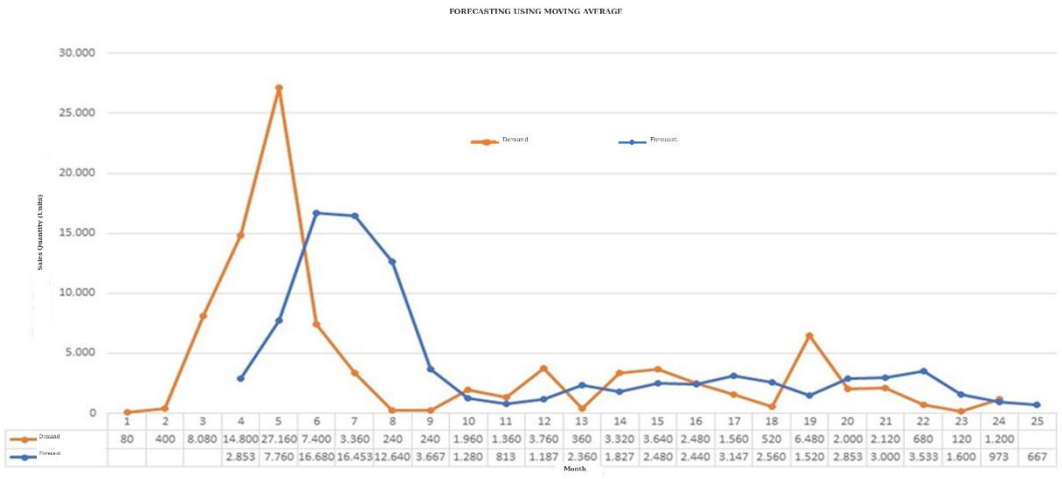


Figure 2 Chart of moving average methods

The comparison results demonstrated that the Single Exponential Smoothing method produced lower forecasting error values than the Moving Average method. The SES method with a smoothing constant of $\alpha = 0.3$ generated MAD, MSE, and MAPE values of 4,053; 39,121,111; and 449%, respectively. These results indicate that the SES method was more capable of capturing fluctuating demand patterns compared to the Moving Average method. The forecasting results projected that the average demand for CPHMA products in 2026 would reach approximately 1,411 sacks per month. This projection indicates that demand for CPHMA products is expected to remain relatively stable with moderate fluctuations during the planning period. The forecasting results provide important information for the company in determining production targets, inventory requirements, and production capacity allocation for future operations. Similar findings were reported by Hernadewita et al. [12], who concluded that accurate forecasting methods significantly improve production planning effectiveness and reduce operational inefficiencies in manufacturing industries.

The forecasting results were then used as the basis for Aggregate Planning analysis. Aggregate Planning was conducted to determine the most efficient production strategy capable of balancing production capacity with projected market demand while minimizing operational costs. Two Aggregate Planning strategies were evaluated in this study, namely Level Strategy and Chase Strategy. Each strategy was analyzed based on production quantity, inventory level, workforce utilization, operational flexibility, and total production cost. The Level Strategy maintained a relatively constant production quantity throughout the planning period regardless of market demand fluctuations. This strategy emphasizes production stability and continuous workforce utilization. The implementation of Level Strategy reduced production interruptions and allowed the company to utilize machinery and labor resources more efficiently. Stable production activities also minimized setup adjustments and operational disruptions during the production process. However, the Level Strategy generated relatively higher inventory levels during periods of lower demand because production quantities remained constant even when market demand decreased.

Despite the increase in inventory levels, the Level Strategy generated lower overall operational costs than the Chase Strategy. This condition occurred because stable production operations reduced workforce adjustment costs, overtime expenses, and machine setup costs. Similar results were reported by Nugraha [13], who found that Level Strategy produced lower production costs in manufacturing industries with stable storage capacity and continuous production systems. The findings indicate that maintaining stable production activities can improve operational efficiency and reduce production instability. In contrast, the Chase Strategy adjusted production quantities according to actual market demand in each period. This strategy aimed to minimize inventory accumulation by synchronizing production directly with demand fluctuations. Although the Chase Strategy successfully reduced inventory levels, the strategy generated higher operational costs due to frequent production adjustments. Production rate changes required adjustments in workforce allocation, machine operation schedules, and production planning activities, increasing operational complexity and reducing production stability.

Frequent production adjustments under the Chase Strategy also increased the risk of operational inefficiency because the company had to respond rapidly to demand fluctuations. These conditions created additional operational burdens related to labor scheduling, equipment utilization, and production coordination. The results of this study differ from the findings of Silvia and Juwita [14], who reported that Chase Strategy was more suitable for industries with highly fluctuating short-term demand patterns. The difference in results may be caused by differences in industrial characteristics, production systems, and operational conditions between the industries studied. The comparison between Level Strategy and Chase Strategy showed that the Level Strategy generated more stable operational performance and lower total production costs for PT Asphalt Karya Nusantara. Therefore, the Level Strategy was identified as the most suitable Aggregate Planning strategy for CPHMA production planning. The selected strategy was capable of maintaining production continuity while reducing operational uncertainty caused by fluctuating market demand.

In addition to Aggregate Planning analysis, this study also evaluated company profitability using Break-Even Point (BEP) analysis. Break-Even Point analysis was conducted to determine the minimum production quantity required for the company to cover all operational costs and avoid financial losses. The analysis integrated fixed costs (FC), variable costs (VC), production quantities (X), and selling prices (p) to evaluate the financial feasibility of production activities (Figure 3).

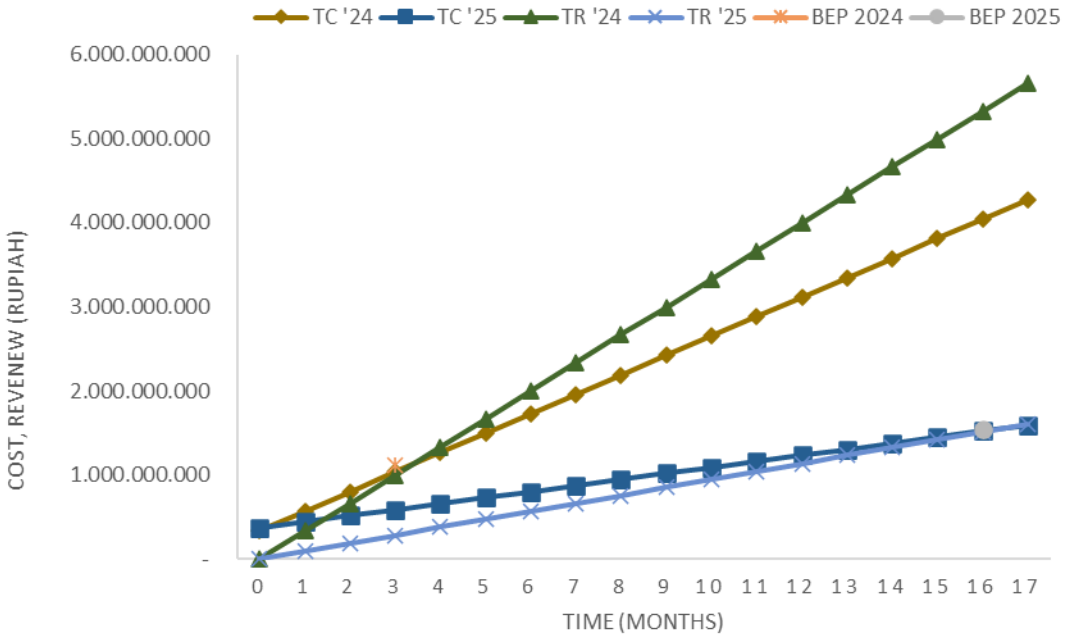


Figure 3 Chart of Break Event Point PT. Asphalt Karya Nusantara

The results showed that during 2024 the company successfully achieved the break-even condition at 22,310 sacks with break-even revenue of IDR 1,115,526,206. The company required approximately 3 months and 10 days to recover total operational costs and begin generating profit. Under these conditions, PT Asphalt Karya Nusantara generated a total profit of IDR 327,066,069 during 2024. These results indicate that the company successfully maintained production activities above the minimum profitability threshold. However, different operational conditions occurred during 2025. The Break-Even Point increased significantly to 30,847 sacks due to rising production costs and unstable market demand. At the same time, actual production volume only reached 22,744 sacks, which was lower than the required BEP quantity. Consequently, the company experienced a financial loss of IDR 10,754,124 because total production revenue was insufficient to cover total operational costs.

The increase in BEP value was primarily caused by increases in fixed costs and variable costs associated with the production process. Fixed costs included factory operational expenses, machinery depreciation, and employee salaries, while variable costs included raw materials, fuel, electricity, packaging, and direct labor costs. Increases in raw material prices and operational expenses significantly affected company profitability because higher production volumes were required to achieve the break-even condition. Similar findings were reported by Wijana et al. [9], who stated that production cost increases directly affect the minimum sales quantity required to maintain company profitability. The relationship between production volume and company profitability demonstrates the importance of accurate production planning in manufacturing industries. Production quantities below the BEP threshold result in financial losses because total revenue cannot cover total operational costs. Conversely, production quantities exceeding the BEP threshold contribute directly to company profitability and operational sustainability. Therefore, determining appropriate production targets is essential for maintaining business stability and minimizing operational risks.

The integration of forecasting analysis, Aggregate Planning, and Break-Even Point analysis successfully generated a comprehensive production planning framework for PT Asphalt Karya Nusantara. The forecasting analysis provided projected future demand information, Aggregate Planning determined the most efficient production strategy, and BEP analysis evaluated financial feasibility and profitability performance. The integration of these analytical approaches enabled the company to optimize production capacity while minimizing operational costs and financial risks. The Level Strategy generated total product availability of 57,332 sacks, exceeding the Break-Even Point requirement by

approximately 26,485 sacks. This condition demonstrates that the selected strategy was capable of maintaining production stability while ensuring company profitability above the minimum break-even threshold. The surplus production capacity also provided flexibility for the company to respond to unexpected increases in market demand during the production planning period.

Furthermore, the results of this study indicate that production planning decisions should not only focus on production quantities but also consider operational costs, market demand fluctuations, inventory management, and profitability targets simultaneously. The integration of forecasting, Aggregate Planning, and BEP analysis provides a more comprehensive and effective managerial decision-making framework compared to implementing each analysis separately. From a managerial perspective, the findings of this study provide important implications for PT Asphalt Karya Nusantara and similar manufacturing industries. Companies are recommended to implement accurate forecasting systems and continuously evaluate production planning strategies to respond effectively to market demand changes. In addition, periodic monitoring of production costs and operational efficiency is necessary to maintain profitability and reduce operational risks in highly competitive industrial environments.

Overall, the results demonstrate that the implementation of Level Strategy combined with accurate forecasting methods and Break-Even Point analysis can improve production efficiency, operational stability, and financial performance in the CPHMA industry. Therefore, PT Asphalt Karya Nusantara is recommended to implement the Level Strategy for future production planning while continuously improving forecasting accuracy, production efficiency, and operational cost management to strengthen competitiveness in the national asphalt industry.

Table 1 Comparison of aggregate planning strategies

Strategy	Production characteristic	Advantage	Disadvantage
Level strategy	Constant production quantity	Stable production system, lower operational cost, efficient workforce utilization	Higher inventory level
Chase strategy	Production follows demand fluctuations	Lower inventory level and more responsive to market demand	Higher production adjustment cost and operational instability

The comparison between Level Strategy and Chase Strategy indicates that production planning decisions significantly affect operational performance and company profitability. The implementation of Level Strategy at PT Asphalt Karya Nusantara was considered more effective because the company operates a continuous production system that requires stable machine utilization and workforce allocation. Stable production activities reduce production interruptions, improve equipment efficiency, and minimize operational adjustment costs. Although the strategy generates relatively higher inventory levels, the resulting operational stability provides long-term advantages for maintaining production continuity and meeting future market demand.

The higher inventory levels produced by the Level Strategy can also function as safety stock to anticipate sudden increases in market demand. In the road construction industry, project implementation schedules often change unexpectedly due to weather conditions, budget realization, and project administration processes. Therefore, maintaining adequate product availability becomes an important factor in supporting company responsiveness and customer satisfaction. The existence of sufficient inventory allows the company to fulfill urgent project demands without experiencing production delays or shortages in product supply. In contrast, the Chase Strategy tends to create higher operational pressure because production quantities must continuously adjust according to demand fluctuations. Frequent production adjustments increase the complexity of production scheduling and workforce management. In addition, sudden changes in production rates may reduce machine efficiency and increase maintenance requirements due to inconsistent operational loads. These conditions may negatively affect production stability and operational sustainability, particularly in manufacturing industries with continuous production systems such as CPHMA production.

The findings of this study also indicate that forecasting accuracy has an important role in determining the success of production planning strategies. Accurate forecasting results enable the

company to estimate future demand more effectively and reduce uncertainty in production decision-making. Conversely, inaccurate forecasting may lead to excessive inventory accumulation or insufficient production quantities, both of which can negatively affect operational efficiency and profitability. Therefore, continuous evaluation of forecasting performance is necessary to improve planning accuracy and production efficiency. Another important finding from this study is the strong relationship between production costs and Break-Even Point values. Increasing operational costs directly increase the minimum production quantity required to achieve profitability. This condition demonstrates that cost control is a critical factor in maintaining company financial performance. Efficient management of raw materials, energy consumption, labor utilization, and operational expenses can help reduce production costs and lower the Break-Even Point threshold. Consequently, the company can achieve profitability at lower production volumes and reduce the risk of financial losses during periods of low demand.

The integration of forecasting analysis, Aggregate Planning, and Break-Even Point analysis provides a comprehensive managerial framework for production planning and operational decision-making. Forecasting analysis helps estimate future market demand, Aggregate Planning determines the most efficient production strategy, and Break-Even Point analysis evaluates the financial feasibility of production activities. The integration of these methods enables the company to optimize production capacity while maintaining operational efficiency and profitability simultaneously. The results of this study contribute not only to the operational improvement of PT Asphalt Karya Nusantara but also to the development of production management practices in the asphalt manufacturing industry. The research demonstrates that integrating financial analysis with production planning can improve decision-making quality and support sustainable industrial operations. This integrated approach can also be applied to other manufacturing industries experiencing fluctuating demand patterns and operational cost uncertainty. From an industrial perspective, the implementation of efficient production planning strategies is increasingly important due to growing competition in the national asphalt industry. Companies are required to improve operational efficiency, maintain product quality, and optimize production capacity in order to remain competitive in the market. Therefore, the application of forecasting methods, Aggregate Planning, and Break-Even Point analysis can become an important managerial tool for supporting strategic planning and long-term business sustainability.

Overall, the findings indicate that the Level Strategy combined with accurate forecasting and effective cost management provides the best operational performance for PT Asphalt Karya Nusantara. The strategy successfully maintained production stability, minimized operational costs, and ensured production quantities remained above the Break-Even Point threshold. Consequently, the company was able to improve profitability and strengthen its operational sustainability in the Cold Paving Hot Mix Asbuton industry.

4. Conclusion

This study analyzed the production capacity planning of Cold Paving Hot Mix Asbuton (CPHMA) at PT Asphalt Karya Nusantara using the integration of demand forecasting, Aggregate Planning, and Break-Even Point (BEP) analysis. Based on the forecasting evaluation results, the Single Exponential Smoothing (SES) method with a smoothing constant of $\alpha = 0.3$ was selected as the most appropriate forecasting model because it produced the lowest forecasting error values compared to the Moving Average method. The forecasting results projected that the average CPHMA demand in 2026 would reach approximately 1,411 sacks per month, indicating the necessity for effective production planning to meet future market demand. The Aggregate Planning analysis showed that the Level Strategy provided better operational performance compared to the Chase Strategy. The Level Strategy generated lower operational costs, more stable production activities, and more efficient workforce utilization despite producing higher inventory levels during periods of low demand. In contrast, the Chase Strategy required frequent production adjustments that increased operational costs and reduced production stability. Therefore, the Level Strategy was identified as the most suitable production planning strategy for PT Asphalt Karya Nusantara. The Break-Even Point analysis demonstrated that the company successfully achieved profitability in 2024 by reaching the break-even point at 22,310 sacks with break-even revenue of IDR 1,115,526,206 and a payback period of approximately 3 months

and 10 days. However, in 2025 the company experienced financial losses because actual production volume was lower than the required break-even production quantity. The increase in BEP value was mainly influenced by rising production costs and fluctuating product demand. These findings indicate that production volume, operational costs, and market demand significantly affect company profitability and production sustainability. The integration of forecasting analysis, Aggregate Planning, and Break-Even Point analysis successfully produced a comprehensive production planning framework for PT Asphalt Karya Nusantara. The implementation of the Level Strategy generated total product availability exceeding the BEP requirement, demonstrating that the selected strategy was capable of maintaining operational stability while ensuring profitability. Therefore, the company is recommended to implement the Level Strategy for future production planning while continuously monitoring demand fluctuations, forecasting accuracy, and production cost changes in order to improve operational efficiency and strengthen competitiveness in the national asphalt industry.

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Nomenclature

FC	= Fixed Cost (IDR)
c	= Variable cost per unit product (IDR/Unit)
p	= Selling price per unit product (IDR/Unit)
F_t	= Forecast value at period t
F_{t+1}	= Forecast value at period t+1
α	= Smoothing constant
X_t	= Demand at period t
BEP	= Break-Even Point
CPHMA	= Cold Paving Hot Mix Asbuton
MAD	= Mean Absolute Deviation
MSE	= Mean Square Error
MAPE	= Mean Absolute Percentage Error
SES	= Single Exponential Smoothing
MA	= Moving Average

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