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MULTI-GOAL PROGRAMMING MODEL FOR OPTIMAL PRIORITY IN BUILDING MATERIAL PRODUCTION PLANNING

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Abstract. One of the key factors supporting a company's long-term sustainability is effective production planning. CV Lembah Melintang currently determines its production based primarily on customer demand, which may lead to inefficient resource utilization and difficulty in balancing multiple production objectives. This study aims to develop an optimal production planning model using Multi-Goal Programming (MGP). Historical sales data were first forecast using Winter's Exponential Smoothing to establish production targets, and the resulting forecasts were then incorporated into the MGP model. The model simultaneously considers three objectives: satisfying production demand, minimizing production costs, and maximizing profit under production resource constraints. The optimization model was solved using POM-QM v5 software. The results show that all production goals were successfully achieved with zero deviations, indicating that the proposed production plan satisfied the sales targets while maintaining production costs below the annual limit of IDR 922105662.4 and achieving the targeted annual profit of IDR 564080.764 for the 2024 planning period. These findings demonstrate that the proposed MGP model provides an effective decision-support tool for production planning by balancing multiple operational objectives and improving resource utilization in manufacturing environments.

Keywords: Multi-Goal Programming, Production Planning, Goal Programming, Forecasting, Profit Optimization.

1. Introduction

The industrial sector is one of the most important sectors in developing the national economy, where the industries that are currently emerging are an effort to provide employment opportunities for the community which of course must be well supported by the government [1]. It is not easy for entrepreneurs to start and maintain

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a business, planning is needed so that everything runs smoothly. Production planning is a tactical plan that has the aim of providing optimum decisions based on the resources the company has in meeting demand for the production produced [2]. Therefore, it is very important to carry out careful planning and requires a solution method that can provide optimal solutions.

In the era of the free market which is full of intense and difficult competition, every company is competing to be the best in its field by improving and developing performance in order to achieve effectiveness and efficiency in carrying out production. This is very necessary to maintain the company's existence in the face of increasingly tough competition [3].

One of the determinants of a company's success is good and targeted production planning. Production planning can be said to be a process of determining the number of products that must be produced based on consideration of existing data in accordance with market demand [4]. Fulfilling market demand is also followed by optimal use of available resources. The condition of the resources in question is such as raw materials, labor, machines and other equipment needed in a production process. In preparing production planning, there are many things that must be considered due to good production planning optimization so that the need for the lowest level of costs in carrying out the production process is achieved [5].

CV Lembah Melintang, which is located in the Medan Amplas, North Sumatra is a medium and large business which is engaged in the production of building materials. The building materials produced come from sand, cement and stone as raw materials. Building materials produced include brick, crushed stone, gravel stone, home roster, glass block and ceramic. In the production process, CV Lembah Melintang carries out production planning based on the existing demand and always strives to meet all the market demands required by the community. The market demand that occurs is fluctuating so that in optimizing the amount of production materials, CV Lembah Melintang must always fulfill the stock and need for production goods so that it can survive among the large number of businesses engaged in similar production fields. However, in planning production, CV Lembah Melintang not only pays attention to fulfilling market demand but also pays attention to the costs incurred in one production process so that the profit obtained is maximum.

In the production process, having a clear production planning reference is essential to optimize output and minimize associated production costs. To address such issues, a suitable problem-solving approach is required, such as a linear programming model utilizing the simplex method [6]. The simplex method is a well-known technique within linear programming, particularly effective for solving problems involving multiple variables, and is applicable to real-world scenarios, including production planning ([7], [8]). Analytical results suggest that eliminating certain products and reducing the variety of items, especially those with lower profitability, can lead to increased overall revenue.

This means that in order to increase monthly profit, the business might use the results of linear programming techniques in production planning. This study has demonstrated the effectiveness of linear programming techniques as tools for managers seeking to improve operations and profitability and make decisions about the distribution of scarce resources [9]. Production planning that relies solely on customer demand lacks analysis to determine the optimal production quantity needed to maximize profits ([10], [11]). The aim of this study was to optimise production planning in order to optimise firm profit. In this study, goal programming was employed. The four objectives that needed to be optimised were raw material, processing time, profit, and production volume. The six eras of the Horizon plan were configured. LINGO software was utilised to calculate the optimal outcome of goal programming ([12], [13]). The production planning problem is formulated mathematically using the preemptive goal programming approach to support decision-making based on a hierarchy of priorities ([14], [15]). This problem's goal is to create production plans that minimise deviations from each target that must be met while meeting the given limitations. The objectives include producing five varieties of the best-selling bread, as well as determining production costs, profitability, volumes, and raw material availability for bread ([16], [17]).

The Multi-Goal Programming (MGP) method is particularly suitable for this research because the core problem involves making strategic production decisions that must simultaneously satisfy multiple, often conflicting objectives (a characteristic that aligns directly with the strengths of MGP). In the context of CV Lembah Melintang, the production planning process must balance between maximizing total production output, minimizing production costs, and achieving profit targets, all while working under limited resources and operational constraints. Unlike single-objective optimization models, MGP provides a flexible and systematic framework that enables decision-makers to model real-world trade-offs by minimizing the total deviation from multiple pre-set goals. This approach is particularly advantageous in manufacturing environments where no single objective can be optimized without affecting others.

In addition, MGP incorporates deviation variables within its constraint system, allowing the model to quantify how far a proposed solution diverges from each target. This feature is essential in ensuring that each goal, whether economic (e.g., profit) or operational (e.g., production volume), is adequately considered based on its importance. The ability to assign priority scales or weights to each goal also aligns well with the company's need to prioritize strategic objectives without disregarding operational efficiency.

Supporting this rationale, studies such as ([18], [19]) have demonstrated the effectiveness of MGP in multi-objective industrial planning contexts. Furthermore, ([20], [21]) emphasize that MGP is highly applicable for problems involving goal conflicts and limited resources, both of which are present in CV Lembah Melintang's production environment. Therefore, the MGP method is not only methodologically appropriate but also practically relevant for optimizing production planning in this study, enabling a holistic approach that reflects the complex trade-offs inherent in real-world manufacturing decision-making.

In this research, the problem being addressed involves planning the production of building materials where the company, CV Lembah Melintang, must consider multiple objectives at once. These objectives include maximizing production volume, minimizing production costs, and maximizing profit with three goals that are often in conflict with one another. For example, increasing production might raise costs, while reducing costs could potentially lower profit. Because of this complexity, the decision-making process must be able to find a balance between these objectives based on how important each one is to the company.

Although the Goal Programming (GP) method is known for handling problems with more than one objective, it tends to treat all goals more equally unless manual adjustments are made. It also lacks a clear mechanism to control the order of importance or priority between goals unless we use additional structures [22]. This can be limiting when dealing with real-world production planning, where the company might prioritize profit more highly than cost savings or production volume [16].

This is why the Multi-Goal Programming (MGP) method is chosen for this study. MGP is a development of GP, specifically designed to deal with multiple, conflicting goals more effectively. What makes MGP especially suitable is its ability to include a priority scale, so that the most important objectives can be given more weight or handled first in the optimization process. In this case, if maximizing profit is the most important target, MGP allows the model to give it top priority, followed by minimizing costs and maximizing production exactly as intended by the company. Furthermore, MGP uses deviation variables to measure how far the solution is from the target of each goal. The optimization process then focuses on minimizing these deviations, resulting in a solution that is as close as possible to what the company wants to achieve. This makes MGP not only flexible but also realistic and practical, especially when the company already has specific targets for cost, production, and profit. In summary, Multi-Goal Programming is used in this research because it provides a more complete and structured approach than basic Goal Programming. It allows the researcher to formulate and solve complex multi-objective problems with different target values and levels of importance, resulting in a production plan that aligns closely with the company's strategic goals.

2. Literature Review

2.1. *Single Exponential Smoothing*

This method operates under the assumption that there is no upward trend, or that changes occur only in a horizontal or constant manner. It incorporates additional parameters designed to minimize the impact of random variations. The general form of the model can be expressed as follows ([23], [24]):

$$F_{t+1} = \alpha X_t + (1 - \alpha) F_t. \tag{2.1}$$

2.2. *Double Exponential Smoothing*

This approach is more effective for forecasting data that displays a linear trend or consistent directional change. One of the suitable techniques for this type of data is the double exponential smoothing method. Holt's double exponential smoothing generates forecasts using two smoothing parameters, typically represented as α and β, which range in value from 0 to 1. The general formula used is as follows ([25],

[26]):

$$S_t = \alpha X_t + (1-\alpha)(S_{t-1} + b_{t-1}), \tag{2.2}$$

$$b_t = \gamma(S_t - S_{t-1}) + (1-\gamma)(b_{t-1}), \tag{2.3}$$

$$F_{t+m} = S_t + b_t m. \tag{2.4}$$

2.3. *Winter's Exponential Smoothing*

This forecasting technique is suitable for data patterns that exhibit seasonality. When the data is stationary, methods such as moving average and single exponential smoothing are appropriate. However, if the data follows a linear trend, the double exponential smoothing method is more suitable [27]. This approach is built upon three key components: trend, stationarity, and seasonality, which are represented through a set of equations [28]:

$$S_t = \alpha\left(\frac{X_t}{I_{t-L}}\right) + (1-\alpha)(S_{t-1} + b_{t-1}), \tag{2.5}$$

$$I_t = \beta\left(\frac{X_t}{S_t}\right) + (1-\gamma) b_{t-1}, \tag{2.6}$$

$$F_{t+m} = (S_t + b_t m) I_{t-L+m}. \tag{2.7}$$

2.4. *Multi-Goal Programming Model*

The patterns of multi goal programming models expressed as: ([20], [29], [30]).

$$\text{Minimize } Z = \sum_{i=1}^{m}\left(d_i^+ + d_i^-\right). \tag{2.8}$$

Subject to:
Goal constrains:

$$\sum_{j=1}^{n} a_{ij}X_j - d_i^+ + d_i^- = g_i, \text{ for } i = 1, 2, \cdots, m. \tag{2.9}$$

System constrains:

$$\sum_{j=1}^{n} a_{ij}X_j = b_i, \text{ for } i = m+1, \cdots, p, \tag{2.10}$$

$$X_j \geq 0, \tag{2.11}$$

$$d_i^+, d_i^- \geq 0. \tag{2.12}$$

Symbolically written:

Z : Objective function,
a_{ij} : Coefficient associated with j^{th} variable in i^{th} goal/constraint,
b_i : Right hand side value of i^{th} constraint,
d_i^- : Negative deviational variation from i^{th} goal (under achievement),

d_i^+ : Positive deviational variation from i^{th} goal (over achievement),
g_{kj} : Coefficient of the ordinary constraint function,
X_j : Decision variable j.

2.5. *Objective function of multi-goal programming model for priority*

Objective function of multi-goal programming model for priority using the equation [20] and [31]:

$$\text{Min } Z = \sum_{\substack{i=1 \\ k=1}}^{m} P_k \left(d_i^+ + d_i^-\right), \tag{2.13}$$

where there are m goals, p system constraints and n decision variables.

3. Methods

This study was conducted at CV Lembah Melintang, located in Medan Amplas, North Sumatera, with the research objects drawn from the company's operations. The data utilized consists of secondary data collected from January to December 2024, sourced directly from CV Lembah Melintang. The research process follows the flow outlined in Figure 1, and each step will be described in detail throughout the explanation.

Data obtained from CV Lembah Melintang will be processed with steps:

(1) Data related to sales history and production capacity is obtained from CV Lembah Melintang. This includes historical sales of various building materials like bricks, stone, ceramics, etc. Make a sales forecast to determine boundaries sales volume targets, production costs and targets profits that will be used to create a goal programming model. The forecasting method used will according to the data pattern. To find out the data pattern then the data plot will be done first with Minitab 18 software assistance. If the data tends to stationary then it will use Eq. (2.1), if patterned trend then it will use Eq. (2.4) and if it has a seasonal pattern, it will use Eq. (2.7) in its sales forecasting.

(2) Create MGP formulation with:

(a) Define production quantities for each type of building material as decision variables:

X_1 : Amount of brick production,
X_2 : Amount of crushed stone production,
X_3 : Amount of gravel stone production,
X_4 : Amount of home roster,
X_5 : Amount of glass block,
X_6 : Amount of ceramic.

These are the variables that will be optimized in the model.

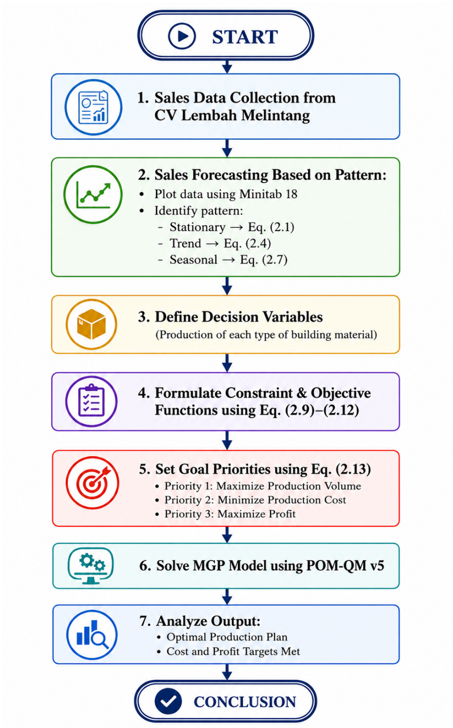

Figure. 1. Integrated Framework of Forecasting and Multi-Goal Programming

(b) Formulate constraints and objective functions.
Use Eqs (2.9)-(2.12) to define:
Constraints: Limits on resources, materials, capacity, or budget.
Objective functions: Functions to maximize or minimize goals (cost, profit, volume).

(c) Set Goal Priorities
Use Eqs. (2.13) to define goal prioritization in the MGP model:
Priority 1 : Maximizing production volume,
Priority 2 : Minimizing production costs,
Priority 3 : Maximizing profit targets from sales.
This is crucial in MGP as it determines how the model resolves conflicts between goals.

(d) Solve the model using POM-QM v5
Input all model components into the POM-QM v5 software, which will calculate the optimal production plan that satisfies all objectives according to the priority order.

(e) Analyze Output
The recommended production amount for each item to achieve all goals optimally.

4. Results and Discussion

4.1. *Data Descriptions*

To assist in formulating the production planning model, this study makes use of past sales data for different types of building materials. This dataset offers valuable information on monthly sales trends and is essential for performing forecasting, determining target benchmarks, and developing the multi-goal programming model. The sales records, covering the period from January to December 2024, were sourced from CV Lembah Melintang. A summary of the building materials sales is shown in Table 1.

Table 1. Data of Building Material Sales in 2025

No	Month	Product Type (piece)						Amount
		X_1	X_2	X_3	X_4	X_5	X_6	
1	January	21500	24500	455	440	400	1289	48584
2	February	21800	22433	465	456	320	1280	46754
3	March	23500	24300	556	478	350	1276	50460
4	April	26800	22560	387	450	340	1266	51803
5	May	28000	21000	434	420	380	1258	51492
6	June	29800	25000	445	435	335	1278	57293
7	July	27500	26500	342	430	350	1280	56402
8	August	27000	27650	390	398	385	1265	57088
9	September	26500	23680	520	448	365	1255	52768
10	October	28100	24850	434	420	378	1248	55430
11	November	28500	26580	385	400	395	1225	57485
12	December	27900	25850	550	420	380	1230	56330
	Total	316900	294903	5363	5195	4378	15150	641889

Source: CV Lembah Melintang (Data 2025)

Based on Table 1, the monthly sales data for several types of building materials produced by CV Lembah Melintang during the period of January to December 2025. The materials included are bricks, crushed stone, gravel, home rosters, glass blocks, and ceramics. The sales figures are recorded in units and will be used as the basis for forecasting and production planning in this research.

Table 2. Cost of Production (In IDR)

No	Type Product	Cost of Raw Material	Cost of Live Work	Overheads Cost	Total Cost Production
1	X_1	650	400	50	1100
2	X_2	1200	650	50	1900
3	X_3	8500	4000	500	13000
4	X_4	28000	6000	400	34400
5	X_5	35000	6000	600	41600
6	X_6	45000	8000	600	53600

Source: CV Lembah Melintang (Data 2025)

In Table 2, the production costs for each type of building material manufactured by CV Lembah Melintang. The costs are listed in Indonesian Rupiah (IDR) and represent the cost required to produce one unit of each material, including bricks, crushed stone, gravel, home rosters, glass blocks, and ceramics. This data is essential for constructing the cost constraint in the multi-goal programming model used in this research.

4.2. *Forecasting Result of Building Materials*

In this section presents the forecasted sales volume for each type of building material produced by CV Lembah Melintang, calculated using the Winter's Exponential Smoothing method as described in Eqs (2.5)-(2.7). This forecasting method considers trend and seasonal components, making it suitable for data with recurring seasonal patterns. The forecasted values serve as the sales volume targets in the construction of the multi-goal programming model.

Table 3. Sales Forecasting Results for Each Type of Product in 2025

No	Month	Product Type (piece)						Amount
		X_1	X_2	X_3	X_4	X_5	X_6	
1	January	19233.45	23048.49	456.8	460.73	384.72	1312.04	44896.233
2	February	20215.08	21512.77	466.275	471.02	311.52	1296.02	44272.68
3	March	22463.91	23692.19	556.927	487.72	344.32	1285.91	48830.982
4	April	26266.96	22302.53	387.29	454.29	337.46	1270.68	51019.21
5	May	27995.29	20994.18	433.997	420.23	379.89	1258.42	51482.015
6	June	30253.17	25211.23	444.731	432.14	336.79	1275.03	57953.098
7	July	28229.25	26895.07	341.641	424.87	353.34	1274.47	57518.642
8	August	27922.17	28183.75	389.471	391.77	389.77	1257.8	58534.731
9	September	27522.19	24198.17	519.198	439.98	370.14	1246.81	54296.493
10	October	29231.53	25419.38	433.297	412.06	383.58	1239.42	57119.267
11	November	29632.59	27182.6	384.381	392.47	400.78	1216.62	59209.446
12	December	28945.6	26403.96	549.159	412.48	385.26	1222.02	57918.478
	Total	317911.1893	295044.321	5363.1674	5199.775	4377.5887	15155.233	643051.27

4.3. *Processing With Multi-Goal Programming Model*

In this section, the working process of the MGP model will be explained in detail:

(1) Determination of demand target constraints
In meeting market demand, the deviation value the negative and positive of the request target constraint must be minimized due to a shortage of production quantities resulting in an inability to fulfill them customer demand and excess production quantities will cause inventory costs to increase is getting bigger and the production costs incurred are not can be solved. So the objective function must beminimized.

The objective function is:

$$\text{Min } Z = \sum_{i=1}^{6} \left(d_i^- + d_i^+\right),$$

with the constraint function for each product are:

$$\begin{aligned}
X_1 + d_1^- - d_1^+ &= a_{1k},\\
X_2 + d_2^- - d_2^+ &= a_{2k},\\
X_3 + d_3^- - d_3^+ &= a_{3k},\\
X_4 + d_4^- - d_4^+ &= a_{4k},\\
X_5 + d_5^- - d_5^+ &= a_{5k},\\
X_6 + d_6^- - d_6^+ &= a_{6k}.
\end{aligned}$$

(2) Production Cost Constraints
The objective of minimizing production costs is represented by a positive deviation value, which indicates an excess over the targeted cost limit.
The objective function is:

$$\text{Min } Z = d_7^+,$$

with the model constraint function formulated:

$$1100X_1 + 1900X_2 + 13000X_3 + 34400X_4 + 41600X_5 + 53600X_6 + d_7^- - d_7^+ = b_k.$$

(3) Profit target constraints
CV Lembah Melintang seeks to maximize its profits; therefore, any profit value falling below the target represented by a negative deviation will be minimized.
The objective function is:

$$\text{Min } Z = d_8^-,$$

with function model constraints:

$$785X_1 + 650X_2 + 10550X_3 + 8500X_4 + 28500X_5 + 26450X_6 + d_8^- - d_8^+ = c_k.$$

(4) The objective function of the model
Based on the constraint functions and the determination of priority scales, the objective function for the goal programming model in this study is formulated using the multi-goal programming approach, as represented by Eq. (2.13). The following objective functions are applied to support the production planning optimization.
The following objective functions are applied to support the production planning optimization.

$$\text{Min } Z = P_1 \sum_{i=1}^{6} \left(d_i^- + d_i^+\right) + P_2 d_7^+ + P_3 d_8^-.$$

Referring to the model above, the monthly objective function used to optimize production planning covering market demand targets, production cost limits, and profit goals is presented in Table 4 below.

Table 4. The Objective Function of The Model in Years

Month	Constrains		
	Demand Target (Priority 1)	Production Cost (Priority 2)	Profit Target (Priority 3)
January	$X_1 + d_1^- - d_1^+ = 19233.45$	$1100X_1 + 1900X_2+$	$785X_1 + 650X_2+$
	$X_2 + d_2^- - d_2^+ = 23048.49$	$13000X_3 + 34400X_4+$	$10550X_3 + 8500X_4+$
	$X_3 + d_3^- - d_3^+ = 456.8$	$41600X_5 + 53600X_6+$	$28500X_5 + 26450X_6+$
	$X_4 + d_4^- - d_4^+ = 460.73$	$d_7^- - d_7^+ = 63125205$	$d_8^- - d_8^+ = 38965550$
	$X_5 + d_5^- - d_5^+ = 384.72$		
	$X_6 + d_6^- - d_6^+ = 1312.04$		
February	$X_1 + d_1^- - d_1^+ = 20215.08$	$1100X_1 + 1900X_2+$	$785X_1 + 650X_2+$
	$X_2 + d_2^- - d_2^+ = 21512.77$	$13000X_3 + 34400X_4+$	$10550X_3 + 8500X_4+$
	$X_3 + d_3^- - d_3^+ = 466.275$	$41600X_5 + 53600X_6+$	$28500X_5 + 26450X_6+$
	$X_4 + d_4^- - d_4^+ = 471.02$	$d_7^- - d_7^+ = 78750250$	$d_8^- - d_8^+ = 48650865$
	$X_5 + d_5^- - d_5^+ = 311.52$		
	$X_6 + d_6^- - d_6^+ = 1296.02$		
March	$X_1 + d_1^- - d_1^+ = 22463.91$	$1100X_1 + 1900X_2+$	$785X_1 + 650X_2+$
	$X_2 + d_2^- - d_2^+ = 23692.19$	$13000X_3 + 34400X_4+$	$10550X_3 + 8500X_4+$
	$X_3 + d_3^- - d_3^+ = 556.927$	$41600X_5 + 53600X_6+$	$28500X_5 + 26450X_6+$
	$X_4 + d_4^- - d_4^+ = 487.72$	$d_7^- - d_7^+ = 74550880$	$d_8^- - d_8^+ = 45546885$
	$X_5 + d_5^- - d_5^+ = 344.32$		
	$X_6 + d_6^- - d_6^+ = 1285.91$		
$\vdots$	$\vdots$	$\vdots$	$\vdots$
December	$X_1 + d_1^- - d_1^+ = 28945.6$	$1100X_1 + 1900X_2+$	$785X_1 + 650X_2+$
	$X_2 + d_2^- - d_2^+ = 26403.96$	$13000X_3 + 34400X_4+$	$10550X_3 + 8500X_4+$
	$X_3 + d_3^- - d_3^+ = 549.159$	$41600X_5 + 53600X_6+$	$28500X_5 + 26450X_6+$
	$X_4 + d_4^- - d_4^+ = 412.48$	$d_7^- - d_7^+ = 84340865$	$d_8^- - d_8^+ = 50544865$
	$X_5 + d_5^- - d_5^+ = 385.26$		
	$X_6 + d_6^- - d_6^+ = 1222.02$		

(5) Calculation Model

Based on the data analysis conducted using POM-QM v5 software, the optimal solution was successfully obtained. This optimal value is identified through the deviation variables (d_i^+ and d_i^-), which indicate the differences between the actual outcomes and the predefined targets specifically in terms of production volume, production costs, and profit goals. The deviation values for each of these targets from January to December 2025 are presented as follows.

Table 5. Deviations Between Production Targets and Optimal Solution

No	Month	Cost of Production			
		Target	d_i^-	d_i^+	Optimal Solution
1	January	44896.2334	0	0	44890.2334
2	February	44272.67998	0	0	44270.67998
3	March	48830.98175	0	0	48730.98175
4	April	51019.20976	0	0	51009.20976
5	May	51482.01499	0	0	51462.01499
6	June	57953.09819	0	0	57943.09819
7	July	57518.64212	0	0	57518.64212
8	August	58534.7306	0	0	58524.7306
9	September	54296.49274	0	0	54296.49274
10	October	57119.26729	0	0	57119.26729
11	November	59209.44562	0	0	59209.44562
12	December	57918.47797	0	0	57818.47797
	Total	643051.2744			642793.2744

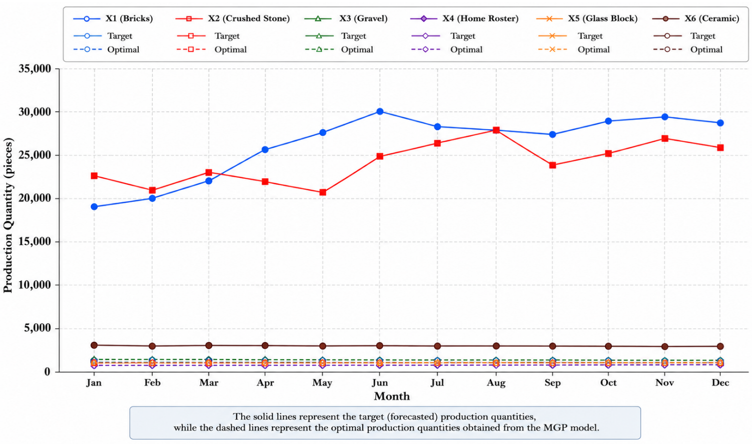

Figure. 2. Comparison Between Target and Optimal Production Quantities

The optimization results presented in Table 5 show that both negative and positive deviation variables (d_i^+, d_i^-) are equal to zero for all production targets. Figure 2 further illustrates that the optimal production quantities closely follow the monthly production targets throughout the planning period. The overlap between the target and optimal values indicates that the Multi-Goal Programming (MGP) model successfully satisfies the production targets without underproduction or overproduction. This result suggests that the forecasted demand, available production capacity, production cost limits, and profit targets are well balanced, enabling the optimization model to satisfy all objectives simultaneously. Therefore, no conflict occurred among the production goals during the planning period.

From a managerial perspective, these findings indicate that CV Lembah Melintang is capable of meeting market demand while maintaining production costs within the planned budget. The optimal production plan also minimizes the risk of excess inventory and shortages, allowing the company to utilize its production resources more efficiently. Consequently, the MGP model can serve as an effective decision-support tool for determining monthly production quantities under multiple operational objectives.

These findings are consistent with Hasbiyati et al. [16], who reported that Goal Programming effectively balances multiple production objectives in manufacturing systems. Likewise, Alam [14] showed that priority-based optimization provides better production planning by considering several conflicting goals simultaneously. Compared with Wang et al. [11], which employed a stochastic goal programming approach, the proposed MGP model offers a simpler implementation while still producing an optimal production plan that satisfies demand, cost, and profit targets.

Table 6. Deviations Between Production Cost Constraints with Optimal Solution

No	Month	Production Quantity			
		Target	d_7^-	d_7^+	Optimal Solution
1	January	63125205	0	0	63125194
2	February	78750250	0	0	78750242
3	March	74550880	0	0	74550868
4	April	73456540	0	0	74550885
5	May	88567450	0	0	88567443
6	June	76560875	0	0	76560877
7	July	80250765	0	0	80250766
8	August	69250850	0	0	68250849.4
9	September	68245650	0	0	68245644
10	October	78125455	0	0	78125467
11	November	86786540	0	0	86786548
12	December	84340865	0	0	84340879
	Total	922011325			922105662.4

The results shown in Table 6 indicate that the production cost constraint is also fully satisfied throughout the planning period. The zero-deviation value for the production cost goal indicates that the total production expenditure never exceeds the predefined annual budget of IDR 922105662.4. This demonstrates that the optimization model is capable of producing an economically feasible production plan while maintaining operational efficiency.

More importantly, these findings suggest that the proposed production schedule effectively allocates available resources without creating unnecessary production expenses. The optimization process simultaneously considers production volume requirements and production costs, thereby preventing inefficient allocation of raw materials, labor, and manufacturing resources. Consequently, the company can maintain production continuity while preserving financial sustainability.

Table 7. Deviations Between Profit Targets with Optimal Solutions

No	Month	Profit			
		Target	d_8^-	d_8^+	Optimal Solution
1	January	38965550	0	0	38965550
2	February	48650865	0	0	48650865
3	March	45546885	0	0	45546885
4	April	45678650	0	0	45678650
5	May	54320650	0	0	54320650
6	June	46890540	0	0	46890540
7	July	48765480	0	0	48765480
8	August	44560564	0	0	44560564
9	September	40250560	0	0	40250560
10	October	46345290	0	0	46345290
11	November	53560865	0	0	53560865
12	December	50544865	0	0	50544865
	Total	564080764			564080764

The results presented in Table 7 show that the profit target was successfully achieved in every month, with zero negative deviation. This indicates that the proposed Multi-Goal Programming (MGP) model effectively satisfies the three production objectives, namely meeting demand, minimizing production costs, and achieving the targeted annual profit of IDR 564,080,764. The zero deviation confirms that the production plan is feasible and well aligned with the company's available resources and operational capacity.

These findings are consistent with previous studies by Hasbiyati et al. [16] and Alam [14], which demonstrated that priority-based Goal Programming can effectively optimize production planning under multiple objectives. Compared with the stochastic goal programming model proposed by Wang et al. [11], the proposed MGP model provides a simpler and more practical approach that can be implemented using POM-QM v5 while still producing optimal solutions. Therefore, the proposed model can serve as an effective decision-support tool for improving production planning and resource utilization in manufacturing companies.

5. Conclusion

The proposed Multi-Goal Programming (MGP) model successfully optimized production planning at CV Lembah Melintang by simultaneously achieving three production objectives: meeting monthly demand, maintaining production costs within the annual budget limit of IDR 922105662.4, and attaining the annual profit target of IDR 564080.764. The optimization results produced zero deviations for all objectives, indicating that the proposed production plan effectively balances production volume, operational costs, and profitability.

This study demonstrates that the MGP approach provides an effective decision-support framework for production planning involving multiple conflicting objectives. By integrating demand forecasting with priority-based optimization, the proposed model enables more realistic production planning and efficient resource utilization. Therefore, the model can assist manufacturing companies in improving production efficiency while maintaining financial performance. Future research may extend the proposed model by incorporating demand uncertainty, transportation and inventory costs, and probabilistic or robust optimization approaches to better represent real-world production environments.

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