Planning For The Number Of Optimal CPO Production Using The Goal Programming Method At PT.Socfindo Kebun Seunagan's Palm Oil Mills

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ABSTRACT

In good management, planning is very influential in implementing production activities. Production planning in the factory is carried out based on the estimated production of crude palm oil (CPO) and Palm Kernel Oil (PKO) for each period. This estimate uses production data in the previous period. But in reality, companies are often confronted with conditions where there is a mismatch of production with the volume of planned production targets. The method used as an optimal solution to determine CPO production is the goal programming method. Data processing is carried out by predicting demand and then processed with LINDO's (linear interactive discrete optimizer). The decision variable is based on the factory's CPO production activities and FFB procurement activities. The target to be achieved from this study is to obtain an optimal production plan as an alternative problem-solving in optimizing unemployed production capacity. The optimal production results are accepted by the goal programming approach for the next period to be the 7th period 362981,875 kg, the 8th period 353489 kg, period-9 301006 kg, period-10 271630, kg, period-11 350043,562 kg, period 12 335153,281 kg. Thus it can be said that the total demand can be fulfilled. The results of comparing forecasting demand and data processing with the goal programming method, production is declared optimal because production can be met.

Keywords: Production planning, production optimization and goal programming

Introduction

Based on the notarial deed of William Leo Number 45 dated December 17, PT. Socfindo Indonesia (SOCFINDO) is a privately owned corporation (BUMS). The same Socfindo factory can produce 24 tons of material each hour. The Socfindo mill creates a number of product derivatives from processed palm oil. While palm oil (CPO) is the primary product, other goods like palm kernels and shells are also produced. With a total of 2 tanks, the daily storage capacity for palm oil is 40 tons. Additionally, the capacity of the two tank units for fixed palm oil storage, also known as storage tanks, is 700 tons. The graph that follows shows weekly production data for the months of September and November.[1]

Practically all businesses and commercial operations involving management and financial form processing intend to profit. It might be argued that the primary objective of purchasing, selling, and production operations is profit. Profit, also known as net income or net earnings, is the difference between total revenue and total costs [2]. After determining the entire cost or total revenue and subtracting all production-related expenses, the net income is produced. Profits can serve as a guide for how a firm or corporation should evolve. Due to having sufficient cash to expand a firm or business, profits will also experience a rapid increase.

Much attention has been paid to production planning and control, incorporating variables like human resources, inventory regulations, and others into a linear model[3]–[6]. 2008 and 2009's Hadiguana. Optimization is a normative strategy that seeks to determine the optimum answer to a conundrum at the greatest or minimum of an objective function. The company needs production optimization to make the best use of its resources and manufacture goods in the desired number and quality to meet its objectives[7]–[9]. Production optimization is the optimal use of scarce production resources. Capital, machinery, equipment, raw materials, auxiliary materials, and labor are the manufacturing factors [10], [11]].

Businesses must focus on three factors instead of just one: customers, products, and manufacturing processes. Companies cannot only be motivated by filling orders, but they only take product-related factors into account [12]–[19]. These three elements can serve as a planning guide. The mathematical technique of goal programming is one approach that can be used to plan CPO manufacturing. The ability of the goal programming method to handle the optimal allocation problem or the optimal combination of numerous competing challenges distinguishes it from the linear programming method. According to [15] in their paper "Production Planning Under Dynamic Product Environment: A Multi-Objective Goal Programming Approach, " goal programming can be used successfully in production planning.". They did this by explaining that the goal programming method has the potential to resolve conflicting aspects between the elements in production planning, namely

consumers, products, and manufacturing processes. As a result of the numerous options presented, the choice made is satisfactory. The magnitude of the decision variable identified in this study was[20]–[26]

Research Methode

This study was carried out in the Palm Oil Factory PT. Socfin Indonesia (SOCFINDO) is situated in the Aceh province's Kab. Nagan Raya. This study was carried out between July and October of 2022. Data on sales for September and October 2022 were gathered for this study. The price of FFB procurement and expenses for two months in September and October 2022 were also recorded. The research subjects participated in each step of converting FFB into CPO. The following are the steps involved in doing this research:

1. CPO demand forecasting for the seventh period (next week). Demand data from September and October are utilized as the basis for forecasting to determine the demand projection for the seventh period. Time series forecasting techniques are used to calculate the data, and the best forecast is chosen by contrasting the forecast errors. The forecast with the smallest inaccuracy is the best one.
2. Function Formulation
    a. Select the optimization result that will serve as the decision variable for production planning at the Palm Oil Mill PT. Socfin Indonesia Kebun Seunagan. This optimization result will be optimized to meet the target criteria and restrictions.
    X1 = Amount of CPO production each month (Tons of CPO)
    X2 = Amount of FFB procured every month (Tons of FFB)
    b. Constraint Function
    1. Constraints on the CPO production target for the 7th period (December). PT. Socfin Indonesia's palm oil mill is designed with an installed capacity of 24 tons of FFB per hour

$$\sum_{i=oktober}^{september} X_1 + \sum_{k=1}^{6} d_k{}^- + d_k{}^+ \leq KP_i \qquad (1)$$

X 1 = Decision variable for total CPO production in month-i
KPi = CPO production target for the 7th period every week-i
i = September-October
dk = positive/negative deviation

2. Availability of Fresh Fruit Bunches (FFB) The target for the availability of fresh fruit bunches or FFB to be achieved is to avoid overproduction of FFB or shortage of FFB in factories during CPO processing.

$$\sum_{i=oktober}^{september} X_1 + \sum_{k=1}^{6} d_k{}^- + d_k{}^+ \leq KTI_i \qquad (2)$$

Where :
X2 = Decision variable for the amount of FFB procurement period-i
KTIi = Availability of period-i FFB
i = September-October
dk = positive/negative deviation.

3. Obstacles to Target FFB Processing In processing FFB into CPO, the company requires that all FFB be processed into CPO.

$$F \sum_{i=oktober}^{september} X_1 + \sum_{k=1}^{6} d_k{}^- + d_k{}^+ \leq KTP_i \qquad (3)$$

Where :
X 1 = CPO production decision variable
X2 = Decision variable for the amount of FFB procurement period-i
F = Yield of CPO (%) from procurement
FFB i = September-October
dk = positive/negative deviation

4. Constraints on Availability of Processing Time Availability of processing time is included in the constraints because the shorter the time needed to produce per ton of CPO will reduce the required production costs.

$$G \sum_{i=oktober}^{september} X_1 + \sum_{k=1}^{6} d_k{}^- + d_k{}^+ \leq H_i \qquad (4)$$

Where :
X1 = CPO production decision variable in month i
G = CPO processing time per ton hour
H = Available processing time period 6 years 2022
i = September-October
dk = positive/negative deviation

5. Analysis of Problem Solving The outcomes of data processing for predicting and figuring out the ideal quantity of goods using the programming methodology are then examined to see comparisons between the Goal Programming strategy and the company's current goals.

6. Determine the function of the Rhs constraint

a.Output after the period or the most recent data from the fourth week of October, which is 32,170,560 with a capacity of 24 tons/hour, represents the quantity of production consumed.

b. All expenses incurred during the production process that total more than Rp. 135,279,480.00 are referred to as production costs.

c. The demand for the product is determined by tabulating calculations using the linear regression approach using a function.

$$Y = 354,033.40 + (-9320.97)X;$$

the coefficient utilized is the outcome, which is the demand for CPO in the time that follows, or 288,786.63 tons.

d. The fundamental data used by the company is the availability of raw materials, which is determined by the daily arrival of FFB from the plantation. The most recent data, which is 1,450,880 e, from the sixth or fourth week of October, is being used. The factory's intended processing capacity in relation to the extraction rate. aims to manufacture every FFB without generating residue so that the processing target employed can be observed to be 0.

Results and Discussion

Forecasting

Demand data from the prior period, specifically periods 1 through 6 in September and October, are utilized as the basis for forecasting to determine the demand projection for period 7. Time series forecasting techniques are used to calculate the data, and the best forecast is chosen by contrasting the forecast errors. The forecast with the smallest inaccuracy is the best one.
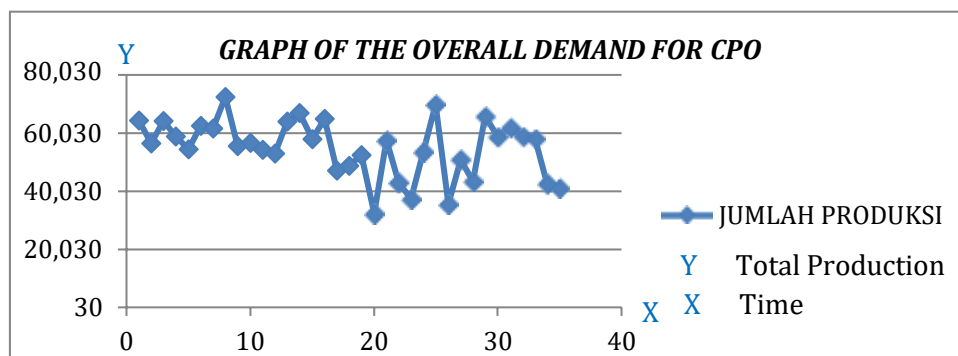

Figure 1. Graph of the overall demand for CPO

Figure 1 displays a graph of the overall demand for CPO production over the course of the previous two months, specifically September and October. Forecasting is done using the value of the demand. A summary of the estimated mistakes of various methodologies can be seen in the table below, based on the outcomes of forecasts using the time series method.

Table 1. SEE for method

Method	SEE
Linear regression	31508,84
Exponential	36232,82

The Linear Regression approach yields the minimal error estimation value from the forecasting computation results.

Now being done to test the theory regarding the smaller SEE of the two forecasting techniques being tested.

$H_0 = SEE_{linear} \leq SEE_{ekspo}$

$H_1 = SEE_{linear} \geq SEE_{ekspo}$

$\alpha = 0,05; v_1 = 6\text{-}2 = 4 ; v_2 = 6\text{-}2 = 4$

Uji statistik : $f_{hitung} = \left(\frac{SEE_{linear}}{SEE_{ekspo}}\right)^2 = \left(\frac{31508,84}{36232,82}\right)^2 = 0,76$

$$f_{tabel} = f_{a;v1;v2} = f_{(0.05;4;4)} = 6,39$$

$$f_{hitung} \leq f_{tabel} \; then \; accepted$$

The forecasting approach is the linear regression method using forecasting functions according to the statistical tests mentioned above.

$$Y = 354.033,40 + (-9320,97)X \tag{5}$$

No out-of-control data in Figure 2 prevent the quadratic method forecasting equation from predicting CPO demand for the seventh period. Table 2 shows the demand for CPO for period 7 using forecasting with the Linear Regression approach. The forecast is made using the linear regression method after choosing the forecasting methodology with the minimum error estimate value approach. Table 2 below lists the outcomes of the CPO demand predictions for period 7.

Table 2. Result of forecasting

Period	Total /period (KG)
Period 7	288786,6
Period 8	279465,6
Period 9	270144,7
Period 10	260823,7
Period 11	251502,7
Period 12	242181,8

Production Planning Using Goal Programming Model, Section

The output that will be optimized to satisfy the target criteria and restrictions is the decision variable. At the PT Socfindo Seunagan Palm Oil Mill, the decision variables for production planning are: X1 = Amount of CPO Production in Each Period (Kg CPO); X2 = Amount of FFB Procured (Kg FFB) The notation and variables utilized to address production planning issues in the formulation of the goal function are as follows:

P1: The achievement of the CPO production target is the primary priority to be produced.

P2: The achievement of targets in order to prevent shortages and excesses in FFB procurement is the fifth priority notation.

P3: The achievement of the aim, which is the fourth priority notation

P4: The achievement of processing time goals is the sixth priority notation.

$d_1, d_2, d_3, d_4, d_5, d_6$, **Negative deviations** signify production that is fewer than the goal number of requests set.

$d_{13}, d_{14}, d_{15}, d_{16}\ d_{17}d_{18}$ This negative variance suggests that the FFB processing target should be exceeded.

$d_7, d_8, d_9, d_{10}\ d_{11}d_{12}$ These are both negative and positive variations from FFB's excesses and shortages.

$d_{19}, d_{20}, d_{21}, d_{22}d_{23}d_{24}$ is a negative deviation representing a set processing hour's level of fulfillment

It is possible to describe the production planning model as goal programming:

1. Objective Function

Minimize Z, by: $\text{MIN } Z = P_1 d_1 + P_2 D_{13} + P_3 (d_7 + d_7) + P_4 d_{19}$

2. Constraint Function

a. Constraints on the CPO production target for September - October each period (period). The constraint function is:

$X_{1\ periode\ 1} + d_1 - d_1 = 360.948$

$X_{1\ periode\ 2} + d_2 - d_2 = 353.489$

$X_{1\ periode\ 3} + d_3 - d_3 = 301.006$

$X_{1\ periode\ 4} + d_4 - d_4 = 271.630$

$X_{1\ periode\ 5} + d_5 - d_5 = 319.293$

$X_{1\ periode\ 6} + d_6 - d_6 = 322.094$

b. Constraints Target Availability of Fresh Fruit Bunches (FFB)

The constraint function is:

$X_{2\ periode\ 1} + d_7 - d_7 = 1.571.350$

$X_{2\ periode\ 2} + d_8 - d_8 = 1.567.620$

$X_{3\ periode\ 3} + d_9 - d_9 = 1.370.012$

$X_{4\ periode\ 4} + d_{10} - d_{10} = 1.206.060$

$X_{5\ periode\ 5} + d_{11} - d_{11} = 1.515.340$

$X_{6\ periode\ 6} + d_{12} - d_{12} = 1.450.880$

c. FFB Processing Target Constraints

The constraint function is:

$$0,231\, X_{2\,periode\,1} + d_{13} - d_{13} = 0$$
$$0,231\, X_{2\,periode\,2} + d_{14} - d_{14} = 0$$
$$0,231\, X_{2\,periode\,3} + d_{15} - d_{16} = 0$$
$$0,231\, X_{2\,periode\,4} + d_{17} - d_{17} = 0$$
$$0,231\, X_{2\,periode\,5} + d_{18} - d_{18} = 0$$
$$0,231\, X_{2\,periode\,6} + d_{19} - d_{19} = 0$$

d. Processing Time Availability Constraints

The constraint function is:
$$0,40\, X_{1\,periode\,1} + d_{20} - d_{20} = 360.948$$
$$0,40\, X_{1\,periode\,2} + d_{21} - d_{21} = 353.489$$
$$0,40\, X_{1\,periode\,3} + d_{22} - d_{22} = 301.006$$
$$0,40\, X_{1\,periode\,4} + d_{23} - d_{23} = 271.630$$
$$0,40\, X_{1\,periode\,5} + d_{24} - d_{24} = 319.293$$
$$0,40\, X_{1\,periode\,6} + d_{25} - d_{25} = 322.094$$

3.3 Output From LINDO Programming,

For negative deviations (dk -), the production planning model in the form of a target programming formulation with the LINDO program is replaced by DB, and for positive deviations (dk +), by DA. The outcomes of FFB procurement with goal programming and CPO production planning are listed below.

According to an analysis of the outcomes from goal programming, which are shown in Table 3, the greatest production level of 362981.875 kg of CPO was attained in period 7. The large amount of FFB purchased this month, 1571350 kg of FFB, had an impact on the high production of CPO.

Table 3. Production planning in December (7th period)

Period	production (Kg)	procurement FFS (Kg)
Period 7	362981,875	1571350
Period 8	353489	1567620
Period 9	301006	1370012
Period 10	271630,	1206060
Period 11	350043,562	1515340
Period 12	335153,281	1450880

Analysis of each production planning objective in each month from period 7 to the next period can be seen in table 4. Following.

Table 4. Production planning

Period	Production (Kg)	Request (Kg)	Description
Period 7	362981,875	288786,6	Reached
Period 8	353489	279465,6	Reached
Period 9	301006	270144,7	Reached
Period 10	271630,	260823,7	Reached
Period 11	350043,562	251502,7	Reached
Period 12	335153,281	242181,8	Reached

Based on table 4. it is known that the specified target was achieved as a whole.

Table 5 shows the relationship between the decision variables and the target of FFB procurement. The target to prevent excess or shortage of FFB procurement is to minimize the lower and upper deviation of the target.

Table 5. Relationship between the decision variables and the target of FFB procurement

Period	Procurement FFS (Kg)	Need TTS (Kg)	Description
Period 7	1571350	1571350	Achieved
Period 8	1567620	1567620	Achieved
Period 9	1370012	1370012	Achieved
Period 10	1206060	1206060	Achieved
Period 11	1515340	1515340	Achieved
Period 12	1450880	1450880	Achieved

Table 5 shows that the target of preventing shortages and overprocurement of FFB at factories can be achieved.

LINDO Output Sensitivity Analysis

After processing the data with the Lindo program, a sensitivity analysis must be conducted.

Table 6. Sensitivity analysis production

Period	Current value	Allowable increase (Kg)	Permissible reduction (Kg)
Period 7	360948	2033.859	INFINITY
Period 8	353489	INFINITY	353334.343
Period 9	301006	15466.780	300868.562
Period 10	271630	INFINITY	271507.093
Period 11	319293	30750.548	INFINITY
Period 12	322094	13059.289	INFINITY

Table 6 Demonstrates that for periods 8 and 10, the sensitivity analysis of CPO output can be increased indefinitely. However, for other months, it can only be increased to the numbers shown in table 6. While additional months' periods are only permitted with a value as given in table 6 above, declines in periods 7, 11, and 12 can be lowered to an infinite value.

Table 7. Sensitivity analysis Procurement FFS

Period	Current value	Allowable increase (Kg)	Permissible reduction (Kg)
Period 7	1571350	INFINITY	8804.586
Period 8	1567620	INFINITY	1567620
Period 9	1370012	INFINITY	66955.75
Period 10	1206060	INFINITY	1206060
Period 11	1515340	INFINITY	133119.25
Period 12	1450880	INFINITY	56533.718

The processed LINDO findings are displayed in Table 7 along with the monthly scalability of the FFB availability limitations. The allowed increments are either infinite or limitless for periods 7 through 12. While the table above shows the values that may be raised each month during the period.

Table 8. Sensitivity analysis clock value

Period	Current clock value	Allowable increase (Hours)	Permissible reduction (Hours)
Period 7	*62,9*	14.843	INFINITY
Period 8	61,86	14.734	INFINITY
Period 9	54,98	12.421	INFINITY
Period 10	49,16	10.843	INFINITY
Period 11	60,92	13.5	INFINITY
Period 12	58,28	13.031	INFINITY

The limitations on availability are shown in Table 8 above. Every month, there is the option to both lengthen and shorten the processing time for FFB into CPO. Table 8 above shows the total increase permitted for the period. Based on examining the outcomes of the computation of the allowed reduction for each limitless time (Infinity).

Conclusion

Based on the analysis of the debate, it can be deduced that the seventh period (362981.875 kg), the eighth period (353489 kg), the ninth period (301006 kg), the seventh period (362981.562 kilograms), and the twelfth period (335153.281 kg) will produce the most CPO. As a result, it may be argued that all requests can be satisfied. The production level can meet the level of demand in subsequent periods, thus, the production shortfall in this period is made up by using CPO production from the prior period, which was higher than the stipulated objective. The seventh quarter saw the highest production volume, 362981.875 kg of CPO. This month's high CPO production was influenced.

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