pijmath
Pattimura International Journal of Mathematics (PIJMath)
Volume 03, issue 01, pages 001-008, May 2024
E-ISSN: 2830-6791
RESEARCH ARTICLE ◙ *OPEN ACCESS*
DOI: https://doi.org/10.30598/pijmathvol3iss1pp01-08

Application of Sequential Linear Goal Programming Method and Modified Simplex Method for Production Planning Optimization

Eka Desi Kirana Djaelani[1], Venn Yan Ishak Ilwaru[2*], Yopi Andry Lesnussa[3]

[1,2,3] Department of Mathematics, Faculty of Mathematics and Natural Sciences, Universitas Pattimura
Jl. Ir. M. Putuhena, Unpatti Campus - Poka, Ambon, 97233, Maluku, Indonesia

Corresponding author's e-mail: [2]vennilwaru007@gmail.com*

Article History

Received: December 11th, 2023
Revised: March 7th, 2024
Accepted: April 28th, 2024
Published: May 1st, 2024

Keywords

Goal Programming; Linear Programming; Modified Simplex; Production Planning; Sequential Linear Goal Programming; LINGO Software;

ABSTRACT

Production planning is an important thing in company management. Every company aims to seek maximum profit in its business activities, so it must be able to utilize its resources as optimally as possible. This study was conducted to determine whether or not any production planning that has been implemented at Istana Roti Hilyah Bakery is optimal. This research aimed to maximize revenue and profit, minimize production costs and raw material usage, and optimize production quantities using the sequential linear goal programming method and the simplex modification method with the assistance of LINGO software. Based on the study's results, the revenue increased by IDR 60,000, and the profit increased by IDR 66,679. The minimization value of production costs decreased by IDR 6,679, with the production amount of White Bread as many as 60 pcs, Almond Crumble Bread as many as 45 pcs, Chocolate Crumble Bread as many as 50 pcs, Wheat Bran Bread as many as 55 pcs, Sweet Comb Bread as many as 82 pcs and Jam Comb Bread as many as 84 pcs.

[1]*How to cite this article:*
Djaelani E. D. K., Ilwaru V. Y. I., and Lesnussa Y. A., "APPLICATION OF *SEQUENTIAL LINEAR GOAL PROGRAMMING METHOD* AND SIMPLEX MODIFICATION METHOD FOR PRODUCTION PLANNING OPTIMATION," *Pattimura Int. J. Math. (PIJMATH).*, vol. 03, iss. 01, pp. 001-008, May, 2024.

1. Introduction

Along with the development of the times and the rapid development of science, companies that offer products are also increasingly numerous with intense competition. [1]. The times and the rapid development of science also make more various products sold in the market, so it is necessary to have the ability to meet consumer demand promptly as well as product quality and appropriate costs. It makes every company obliged to think about production planning carefully and must have innovation and effort to meet consumer demand, which in this case is production and marketing; they must also have good production planning to maintain the company's financial stability [2].

Production is the process of making raw materials into finished materials that have selling value and can be used in everyday life by consumers[2]. Production planning is a management effort to plan the basics of the production process and material flow, so as to produce the required products in time at the minimum possible cost and organize and analyze the organization and coordination of materials, machinery and equipment, human power and other actions needed [3]. According to (Chowdary and Slomp, 2002) [4], companies should pay attention to consumer demand in production planning and three elements: consumers, products, and manufacturing processes.

The goal of every company, whether engaged in manufacturing or services, is to obtain maximum profit or reduce the most minimal costs. Producing large quantities does not always guarantee maximum profit. Fast business changes require companies to be more adaptable, resilient, able to quickly change direction, and focus attention on consumers [5].

Methods that can be used to solve Goal Programming problems include the *Sequential Linear Goal Programming* Method and the Simplex Modification Method with the assistance of *LINGO software*. LINGO software is widely used to solve maximization and minimization problems by entering data in linear formulas [6]. *Sequential linear goal programming* is a method that can solve problems consisting of two or more variables. It is solved by creating an iteration table. Then, the solution is determined individually, starting from the priority and continuing to the last priority [7]. Modified Simplex is also a method that can solve problems of two or more variables and is solved by making an iteration table. The model variables are placed at the top in the simplex modification method table, starting with the decision variables column and then the negative and positive deviation variables [8].

Istana Roti Hilyah Bakery is an industry that produces several types of bread in Batu Merah, Ambon City, Maluku. The bakery owner wants the right solution to find out how to optimize the business that is currently being carried out. The owner of this bakery wants to maximize revenue and profit, minimize production costs, minimize the use of raw materials, and optimize production targets.

Several studies on goal programming optimization problems have been done before. Among them is research on optimizing production in bread companies through a goal programming approach [9], optimization of peanut bread production planning using the goal programming method [10], and optimization of RoPi (Roti Bikin Hepi) product planning using the simplex modification method [11].

Based on the reasons mentioned earlier, good production planning is needed to create an optimum production condition, which will cause a company to work at an optimal capacity using the company's resources. Goal programming is one form of development that solves linear programming and has more than one objective function. [12]. This program is a development of Linear Programming or linear programs that can only solve one objective function. [13]. The approach used by Goal Programming is to minimize the deviation between the goals set and the effort to be made within target constraints [14].

2. Research Methods

The data used in this study were secondary data obtained from Istana Roti Hilyah Bakery, Batu Merah, Ambon, in 2022. The data was obtained as Bread Type Data, Production Target Data for Each Type of Bread, Raw Material Availability and Price Data, Raw Material Composition Data for Bread, and Selling Price Data for each Type of Bread. The following are the research stages used in this study:

a. Starting Research
b. Determining the Case Study
c. Retrieving Data
d. Analyzing and processing Data
e. Creating a Goal Programming Model
f. Solution of goal programming model using sequential linear goal programming method and modified simplex method
g. Discussion and Conclusion

2.1 Goal Programming

Goal Programming was first introduced by A. Charnes and W. M. Cooper in 1961. Then, it was developed by Tamiz et al. [15] and Ignizio [16] so that the goal programming method can be used operationally. Goal programming

is a method developed from linear programming. However, it is different from linear programming because the goal function of the goal programming method is to minimize the deviation of each goal so that the results achieved can be optimal without ignoring other goals [17]. In everyday life, the problem faced is not only one but can be more than one and has many objectives. Therefore, this goal programming method can be used for problems with many goals. [18].
The basic concept of Goal Programming is whether or not the goal can be achieved. A goal will be expressed in an optimization that provides a result as close as possible to the goal. Therefore, the goal of programming is to minimize the deviation of each target to be achieved. [19]. Goal programming is used to optimize the allocation of time and costs in business management. Solving goal programming is done in stages or preemptively [20].
[21] The general form of Goal Programming can be written as follows:

Objective Function: Minimize

$$Z = \sum_{i=1}^{M} d_i^+ + d_i^- \quad (1)$$

Obstacles

$$\sum_{j=1}^{n} a_{ij} x_j - d_i^+ + d_i^- = b_i \quad (2)$$

Nonnegative constraints

$$x_j, d_i^-, d_i^+ \geq 0 \quad (3)$$

2.2 Sequential Linear Goal Programming Method

The sequential linear goal programming method is often called *preemptive goal programming*. *Preemptive goal programming is* used when the goal function requires a sequence of objectives so that the priority level will be carried out on the deviation variables. The first step in using the *sequential linear goal programming* method starts by determining one goal considered the most important of the other goals and placing the goal function as the top priority. The primary goal is considered much more important than the secondary goal, and the secondary goal is much more important than the third goal. This means that lower-order objectives will only be completed if the higher-order objectives have been completed. In this case, the goal ordering system can be written as follows:

$$P_1 > P_2 > \cdots > P_K \quad (4)$$

The general form of the sequential linear goal programming method is:

$$\min z = \sum_{i=1}^{m} P_k (d_i^+ + d_i^-) \quad (5)$$

The following is the algorithm for solving the sequential linear goal programming method [22]:

a. K = Number of Priorities
b. Starting from k = 1
c. Determining the decision model formulation for the k-th priority
d. Solving the decision model using the simplex method.
e. Determining $k = k + 1$if k > K, then go to step 6; if k < K, then return to step 3
f. Obtaining optimal solution result x^*. Stop

2.3 Modified Simplex Method

The modified simplex method is one of the alternative methods that can be used to solve goal programming problems containing three or more decision variables. In the modified simplex table for goal programming, the model variables are placed at the top, starting with the column of decision variables, then negative deviation variables and positive deviation variables. [8]. The following is the algorithm for solving the modified simplex method:

a. Formulating the initial table Modified Simplex
b. Checking if $C_j - Z_j \geq 0$, then the optimal solution is obtained, and Step 6 is performed. $C_j - Z_j \leq 0$, then proceed to Step 3
c. Specifying the key column. The selected key column has the $C_j - Z_j$, and the key row has the smallest positive value. Determining the key row value is done by dividing the value b_i by the ratio in the key.
d. Creating the next simplex modification table. Transforming the variable rows
e. Returning to Step 2
f. Obtaining optimal solution result. Stop

3. Results and Discussion

The initial step of this production planning formulation model is to collect all data related to the objectives to be achieved in production planning. Before obtaining the optimal solution, the steps taken are to form a mathematical model of the problem in the form of goal programming by determining the decision variables, constraint functions, and objective functions that must be resolved. The decision variables in this problem are six bread types, denoted in the form of notation x_j with j = 1, 2, 3, 4, 5, 6. The decision variables for optimizing bread productivity are:

X_1 = White Bread
X_2 = Almond Crumble Bread
X_3 = Chocolate Crumble Bread
X_4 = Wheat Bran Bread
X_5 = Sweet Comb Bread
X_6 = Jam Comb Bread

The next step is to mathematically model the objective function and constraint function until the optimal function is obtained to produce the deviation value by adding priority to the constraint function. The objective function of this problem is that the deviation variables can be minimized according to the priority level set by Istana Roti Hilyah Bakery so that it can be modelled as follows:

$$\left.\begin{array}{c} p_1: \min\ (d_7^- + d_8^-) \\ p_2: \min\ (d_9^+) \\ p_3: \min(\sum_{i=10}^{21} d_i^+) \\ p_4: \min(\sum_{i=22}^{27} d_i^-) \end{array}\right\} \quad (6)$$

Substitute **Eq. (6)** into **Eq. (5)** to form the goal programming model in the **Eq. (7)**, below:

$$\min z = \sum_{i=1}^{4} P_k(d_i^+ + d_i^-) \text{ untuk } i = 7, 8, \dots, 27 \quad (7)$$

The constraint functions in this model are revenue costs, profit costs, production costs, bread raw materials, and the production amount of each product with the following constraint functions:

(i) Priority 1 (p_1)

In this priority, the objective is to maximize revenue and profit. The revenue and profit targets can be seen in **Table 1** and **Table 2**, with the deviation variables that must be minimized are d_7^- and d_8^-.

Table 1. Revenue Data for Each Type of Bread

No.	Type of Bread	Selling Price (IDR)	Income Limit (IDR)
1	White Bread	18.000	
2	Almond Crumble Bread	23.000	
3	Chocolate Crumble Bread	21.000	6.420.000
4	Wheat Bran Bread	15.000	
5	Sweet Comb Bread	15.000	
6	Jam Comb Bread	15.000	

Data Source: *Istana Roti Hilyah Bakery, Ambon*

Table 2. Profit Data for Each Type of Bread

No.	Type of Bread	Selling Price (IDR)	Profit (IDR)	Profit Limit (IDR)
1	White Bread	18.000	4.578	
2	Almond Crumble Bread	23.000	4.718	
3	Chocolate Crumble Bread	21.000	4.993	1.658.760
4	Wheat Bran Bread	15.000	4.289	
5	Sweet Comb Bread	15.000	4.404	
6	Jam Comb Bread	15.000	4.664	

Data Source: *Istana Roti Hilyah Bakery, Ambon*

(i) Priority 2 (p_2)

The goal of this priority is to minimize production costs. Production cost data can be seen in **Table 3**, with variable deviations that must be minimized as d_9^+.

Table 3. Production Cost Data for Each Type of Bread

No.	Type of Bread	Production cost (IDR)	Production Cost Limit (IDR)
1	White Bread	13.422	
2	Almond Crumble Bread	18.282	
3	Chocolate Crumble Bread	16.007	4.761.240
4	Wheat Bran Bread	10.711	
5	Sweet Comb Bread	10.596	
6	Jam Comb Bread	10.336	

Data Source: *Istana Roti Hilyah Bakery, Ambon*

(ii) Priority 3 (p_3)

The goal to achieve this priority is to minimize using raw materials. Data on the composition of raw materials for each type of bread and the availability of raw materials can be seen in **Table 4**, with the deviation variables that must be minimized as $\sum_{i=10}^{21} d_i^+$.

Table 4. Raw Material Composition for Each Type of Bread and Raw Material Availability

No.	Raw Material Type of Bread (gr)	Type of Bread						Raw Material Availability/Day (gr)
		X_1	X_2	X_3	X_4	X_5	X_6	
1	Wheat Flour	500	450	450	300	300	300	140.000
2	Egg	2	2	2	1	2	1	650
3	Granulated Sugar	25	45	45	20	80	30	16.000
4	Brown Sugar	-	-	-	45	-	-	2.500
5	Yeast	10	10	10	8	8	8	3.500
6	Bread Softener	4	4	4	2	2	2	1.500
7	Butter	45	45	45	30	30	30	14.000
8	Salt	8	6	6	4	4	4	2.000
9	Almond	-	55	-	-	-		2.500
10	Chocolate	-	-	50	-	-	-	2.500
11	Jam	-	-	-	-	-	35	3.000
12	Coconut	-	-	-	60	-	-	3.500

Data Source: *Istana Roti Hilyah Bakery, Ambon*

(iii) Priority 4 (p_4)

In this priority, the objective is to optimize the production target. The production target data for each type of bread can be seen in **Table 5**, with the deviation variables that must be minimized as $\sum_{i=22}^{27} d_i^-$.

Table 5. Production Target of Each Type of Bread

No.	Type of Bread	Production Quantity (Per Day)
1	White Bread	60
2	Almond Crumble Bread	60
3	Chocolate Crumble Bread	60
4	Wheat Bran Bread	60
5	Sweet Comb Bread	60
6	Jam Comb Bread	60

Data Source: *Istana Roti Hilyah Bakery, Ambon*

Based on **Table 1** - **Table 5**, the form of the goal programming model below is obtained:

Minimize: $Z = P_1(d_7^- + d_8^-) + P_2 d_9^+ + P_3 \sum_{i=10}^{21} d_i^+ + P_4 \sum_{i=22}^{27} d_i^-$

With constraints:

$$18000x_1 + 23000x_2 + 21000x_3 + 15000x_4 + 15000x_5 + 15000x_6 + d_7^- - d_7^+ = 6420000$$
$$4578x_1 + 4718x_2 + 4993x_3 + 4289x_4 + 4404x_5 + 4664x_6 + d_8^- - d_8^+ = 1658760$$
$$13422x_1 + 18282x_2 + 16007x_3 + 10711x_4 + 10596x_5 + 10336x_6 + d_9^- - d_9^+ = 4761240$$
$$500x_1 + 450x_2 + 450x_3 + 300x_4 + 300x_5 + 300x_6 + d_{10}^- - d_{10}^+ = 140000$$
$$2x_1 + 2x_2 + 2x_3 + 1x_4 + 2x_5 + 1x_6 + d_{11}^- - d_{11}^+ = 650$$
$$25x_1 + 45x_2 + 45x_3 + 20x_4 + 80x_5 + 30x_6 + d_{12}^- - d_{12}^+ = 16000$$
$$45x_4 + d_{13}^- - d_{13}^+ = 2500$$
$$10x_1 + 10x_2 + 10x_3 + 8x_4 + 8x_5 + 8x_6 + d_{14}^- - d_{14}^+ = 3500$$
$$4x_1 + 4x_2 + 4x_3 + 2x_4 + 2x_5 + 2x_6 + d_{15}^- - d_{15}^+ = 1500$$
$$45x_1 + 45x_2 + 45x_3 + 30x_4 + 30x_5 + 30x_6 + d_{16}^- - d_{16}^+ = 14000$$
$$8x_1 + 6x_2 + 6x_3 + 4x_4 + 4x_5 + 4x_6 + d_{17}^- - d_{17}^+ = 2000$$
$$55x_2 + d_{18}^- - d_{18}^+ = 2500$$

$$
\begin{aligned}
50x_3 + d_{19}^- - d_{19}^+ &= 2500 \\
35x_6 + d_{20}^- - d_{20}^+ &= 3000 \\
60x_4 + d_{21}^- - d_{21}^+ &= 3500 \\
x_1 + d_{22}^- - d_{22}^+ &= 60 \\
x_2 + d_{23}^- - d_{23}^+ &= 60 \\
x_3 + d_{24}^- - d_{24}^+ &= 60 \\
x_4 + d_{25}^- - d_{25}^+ &= 60 \\
x_5 + d_{26}^- - d_{26}^+ &= 60 \\
x_6 + d_{27}^- - d_{27}^+ &= 60 \\
x_i, d_i^-, d_i^+ &\geq 0 \\
i &= 1, 2, \dots, 27
\end{aligned}
$$

Based on calculations using LINGO software, the results obtained by the sequential linear goal programming method and the simplex modification method provide recommendations to Istana Roti Hilyah Bakery so that the production planning carried out can be optimized while still paying attention to the order of priority. These results can be seen in **Table 6** below:

Table 6. Optimal Production Planning Solution Based on LINGO Software Output

Priority	Goal	d_i^+	d_i^-	Target	Optimal	Description
1	Goal 7	60.000	0	6.420.000	6.480.000	Achieved
	Goal 8	66.679	0	1.658.760	1.725.000	
2	Goal 9	0	6.679	4.761.240	4.754.561	Achieved
3	Goal 10	0	950	140.000	139.050	Achieved
	Goal 11	0	37	650	613	
	Goal 12	0	45	16.000	15.955	
	Goal 13	0	25	2.500	2.475	
	Goal 14	0	182	3.500	3.318	
	Goal 15	0	438	1.500	1.062	
	Goal 16	0	395	14.000	13.605	
	Goal 17	0	66	2.000	1.934	
	Goal 18	0	25	2.500	2.475	
	Goal 19	0	0	2.500	2.500	
	Goal 20	0	60	3.000	2.940	
	Goal 21	0	200	3.500	3.300	
4	Goal 22	0	0	60	60	Not Achieved
	Goal 23	0	15	60	45	
	Goal 24	0	10	60	50	
	Goal 25	0	5	60	55	
	Goal 26	22	0	60	82	
	Goal 27	24	0	60	84	

Based on the results and analysis of the two-goal programming solution methods described in **Table 6**, it can be concluded that:

1. The objective of maximizing revenue and profit has been met, with a negative deviation value of 0. (d_7^- dan d_8^-) The positive deviation value for revenue (d_7^+) is worth 60,000, and the positive deviation value for profit (d_8^+) is 66,679. It means an additional revenue of IDR 60,000 and a profit of IDR 66,679.
2. The goal of minimizing production costs, which include raw material costs and labour costs, so as not to exceed the limit has been met, with a positive deviation value of 6,679. (d_9^+) value of 6,679. It means that there is a reduction in production costs of IDR 6,679.
3. The goal of minimizing the use of raw materials not to exceed the availability limit has been met, with a positive deviation value of ($\sum_{i=10}^{21} d_i^+$), which is 0.
4. The goal of optimizing the amount of bread production with the availability and cost of raw materials to get maximum revenue and profit has not been met because there are negative deviation values that are not equal to 0. The negative deviation values include d_{23}^-=15, d_{24}^-=10 and d_{25}^-=5. The positive deviation values that are not zero are d_{26}^+=22 and d_{27}^+=24. It means that to achieve all the desired goals, the company must produce White Bread (x_1) as many as 60 pcs, Almond Crumble Bread (x_2) as many as 45 pcs, Chocolate Crumble Bread (x_3) as many as 50 pcs, Wheat Bran Bread as many as (x_4) 55 pcs, sweet comb bread (x_5) 82 pcs and jam comb bread (x_6) as many as 84 pcs.

4. Conclusion

Based on the results of the research that has been carried out, it can be concluded that:

1. The revenue obtained by Istana Roti Hilyah Bakery was IDR 6,480,000, and the profit was IDR 1,725,439. This value means there was an increase in revenue and profit compared to before using the *sequential linear goal programming* method and simplex modification. Revenue increased by IDR 60,000, and profit increased by IDR 66,679.
2. The production cost of Istana Roti Hilyah Bakery before using the *sequential linear goal programming* method and simplex modification was IDR 4,761,240, and after using the two methods, the production cost was IDR 4,754,561; this means that there was a decrease in costs of IDR .6,679. Furthermore, the goal of minimizing the use of raw materials so as not to exceed the limits of availability/stock of raw materials has also been fulfilled.
3. The optimal production planning that Istana Roti Hilyah Bakery must carry out to achieve all its priority objectives is to produce 60 pcs of White Bread, 45 pcs of Almond Crumble Bread, 50 pcs of Chocolate Crumble Bread, 55 pcs of Wheat Bran Bread, 82 pcs of sweet comb bread.

Reference

[1] D. Sutrisno, A. Sahari, and D. Lusiyanti, "Aplikasi Metode Goal Programming Pada Perencanaan Produksi Klappertaart Pada Usaha Kecil Menengah (Ukm) Najmah Klappertaart," [Application of Goal Programming Method on Klappertaart Production Planning at Small and Medium EnteIDR rises (SMEs) Najmah Klappertaart] *J. Ilm. Mat. Dan Terap.*, vol. 14, no. 1, pp. 25–38, 2017, doi: 10.22487/2540766x.2017.v14.i1.8351.

[2] N. Laila, Sutrisno, and E. H. H. Yan, "Perencanaan Produksi Menggunakan Goal Programming," [Production Planning Using Goal Programming] *Spektrum Ind.*, vol. 14, no. 2, pp. 109–230, 2016.

[3] V. Devani, "OPTIMASI PERENCANAAN PRODUKSI DENGAN MENGGUNAKAN METODE GOAL PROGRAMMING Vera Devani Fakultas Sains dan Teknologi Latar Belakang Perencanaan produksi merupakan salah satu hal yang penting dalam perusahaan Perencanaan produksi berhubungan dengan penentuan," [OPTIMATION OF PRODUCTION PLANNING BY USING GOAL PROGRAMMING METHODS Vera Devani Faculty of Science and Technology Background Production planning is one of the important things in the company Production planning is related to the determination] *J. Sains dan Teknol. Ind.*, vol. 11, pp. 84–91, 2014.

[4] B. V Chowdary and J. Slomp, "Production Planning under Dynamic Product Environment : A Multi-objective Goal Programming Approach," 2002.

[5] H. Sasmita, "IMPLEMENTASI UNTUK OPTIMASI BIAYA PRODUKSI DAN TARGET PENJUALAN (TOKO ROTI TIGA BINTANG) MENGGUNAKAN METODE Goal Programming," [IMPLEMENTATION FOR OPTIMIZATION OF PRODUCTION COST AND SALES TARGET (TIGA BINT ROTI SHOP) USING Goal Programming METHOD] *KERNEL J. Ris. Inov. Bid. Inform. dan Pendidik. Inform.*, vol. 1, no. 1, pp. 82–93, 2021, doi: 10.31284/j.kernel.2020.v1i1.1193.

[6] Q. F. Dar, T. R. Padi, and A. M. Tali, "Mixed input and output orientations of data envelopment analysis with linear fractional programming and least distance measures," *Stat. Optim. Inf. Comput.*, vol. 4, no. 4, pp. 326–341, 2016, doi: 10.19139/soic.v4i4.225.

[7] F. Matematika, D. A. N. Ilmu, P. Alam, and U. S. Utara, "Analisis Metode Grafik, Sequential Linear Goal Programming, Dan Modified Simplex Untuk Menyelesaikan Masalah Goal Programming," [Analysis of Graph Method, Sequential Linear Goal Programming, and Modified Simplex to Solve Goal Programming Problems] 2021.

[8] E. dkk Safitri, "Penyelesaian Program Goal Menggunakan Metode Simpleks Modifikasi dan Metode Dual Simpleks," [Goal Program Solving Using Modified Simplex Method and Dual Simplex Method*] Sains Mat. dan Stat.*, vol. 3, no. 1, pp. 10–19, 2017.

[9] L. A. Noviyanti, D. A. Rachmawati, and I. R. Sutejo, "Digital Repository Universitas Jember Digital Repository Universitas Jember," *Ef. Penyul. Gizi pada Kelompok 1000 HPK dalam Meningkat. Pengetah. dan Sikap Kesadaran Gizi*, vol. 3, no. 3, pp. 69–70, 2017.

[10] E. I. Wahyuni, S. Meutia, and D. Irwansyah, "Optimasi Perencanaan Produksi Roti Kacang Dengan Menggunakan Metode Goal Programming Di Ud. Umega Hj Eliya Lubis Kota Tebing Tinggi," [Optimization of Bean Bread Production Planning Using the Goal Programming Method at Ud. Umega Hj Eliya Lubis Tebing Tinggi City] *Ind. Eng. J.*, vol. 11, no. 2, 2022, doi: 10.53912/iej.v11i2.950.

[11] E. Purwanti and D. Pramestari, "Optimisasi Perencanaan Produksi RoPi (Roti Bikin Hepi) Menggunakan Linear Programming Metode Simpleks Pada Franchise RoPi Cabang Depok - Cibinong," [Optimization of RoPi (Roti Bikin Hepi) Production Planning Using Linear Programming Simplex Method at RoPi Franchise Depok - Cibinong Branch] *J. IKRAITH-TEKNOLOGI*, vol. 6, no. 1, pp. 28–38, 2022, [Online]. Available: https://journals.upi-yai.ac.id/index.php/ikraith-teknologi/article/view/1659

[12] B. P. Silalahi, S. E. Pertiwi, H. Mayyani, and N. Aliatiningtyas, "Aplikasi Zero-One Goal Programming Dalam Masalah Pemilihan Proyek Pemasaran," *BAREKENG J. Ilmu Mat. dan Terap.*, vol. 14, no. 3, pp. 435–446, 2020, doi: 10.30598/barekengvol14iss3pp435-446.

[13] S. Program, F. Matematika, D. Sains, U. Matematika, S. Kristen, and I. Wacana, "Optimasi Perencanaan Produksi Kayu Lapis PT. XXX Menggunakan Metode Goal Programming Y A Titilias, L Linawati □ , H A Parhusip," [Optimization of PT XXX Plywood Production Planning Using Goal Programming Method Y A Titilias, L Linawati □ , H A Parhusip*] J. MIPA*, vol. 41, no. 1, pp. 13–19, 2018, [Online]. Available: http://journal.unnes.ac.id/nju/index.php/JM

[14] M. Anis and S. Nandiroh, "Optimasi Perencanaan Produksi Dengan Metode Goal Programming," [Optimization of Production Planning with Goal Programming Method] *J. Ilm. Tek. Ind.*, vol. 5, no. 3, pp. 133–143, 2007.

[15] M. Tamiz, D. Jones, and C. Romero, "Goal programming for decision making: An overview of the current state-of-the-art,"

Eur. J. Oper. Res., vol. 111, no. 3, pp. 569–581, 1998, doi: 10.1016/S0377-2217(97)00317-2.
[16] J. Ignizio, *Introduction to Linear Goal Programming*. 2011. doi: 10.4135/9781412984669.
[17] I. Hasbiyati, R. Desri, and M. D. H. Gamal, "Pre-Emptive Goal Programming Method for Optimizing Production Planning," *BAREKENG J. Ilmu Mat. dan Terap.*, vol. 17, no. 1, pp. 0065–0074, 2023, doi: 10.30598/barekengvol17iss1pp0065-0074.
[18] Z. Zahedi and I. W. A. E. Putera, "Program Aplikasi Optimalisasi Perencanaan Produksi dengan Metode Goal Programming (Kasus CV. G)," [Production Planning Optimization Application Program with Goal Programming Method (CV. G Case)] *ComTech Comput. Math. Eng. Appl.*, vol. 1, no. 1, p. 100, 2010, doi: 10.21512/comtech.v1i1.2176.
[19] U. C. Orumie and D. Ebong, "A Glorious Literature on Linear Goal Programming Algorithms," *Am. J. Oper. Res.*, vol. 04, no. 02, pp. 59–71, 2014, doi: 10.4236/ajor.2014.42007.
[20] A. Yahia-Berrouiguet and K. Tissourassi, "Application of goal programming model for allocating time and cost in project management: A case study from the company of construction seror," *Yugosl. J. Oper. Res.*, vol. 25, no. 2, pp. 283–289, 2015, doi: 10.2298/YJOR131010010Y.
[21] Eiselt, H. A., & Sandblom, C. L. "*Linear programming and its applications"* Springer Science & Business Media, 2007.
[22] G. Tadele Mohammed, "The Modified Sequential Linear Goal Programming Method for Solving Multiple Objectives Linear Programming Problems," *Pure Appl. Math. J.*, vol. 5, no. 1, p. 1, 2016, doi: 10.11648/j.pamj.20160501.11.