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Optimization Of Peanut Bread Production Using The Cutting Plane Method at UD. Hj. Eliya Lubis

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Abstract. This research aims to optimize the production of peanut bread at UKM Peanut Roti Hj. Eliya Lubis in Tebing Tinggi City. The main challenges faced are fluctuating raw material prices and unstable consumer demand, which affect the production process. The research uses the cutting plane method to complete an integer linear program to determine optimal production quantities. This method was chosen because it is effective in solving optimization problems with integer results, which are relevant for in-house production. The research results show that the cutting plane method is able to produce better optimal solutions than other methods, such as branch and bound, thereby increasingproduction efficiency and company profits. . Based on the results of management using the cutting plane method, the profit obtained in December 2023 is IDR. 281.734.404,4 by producing 1.248 peanut butter pineapple breads, 2.175 strawberry jams, 595 cappuccino jams, 6.676 chocolate jams, 2.618 red bean breads and 4.020 green beans. The profit earned in January 2024 is IDR. 276.866.635 by producing 371 peanut butter pineapple breads, 111 strawberry jams, 1.605 cappuccino jams, 1.333 chocolate jams, 4.538 red bean breadsand 2.714 green bean breads. In this case, income in January 2024 decreased drastically due to an increase in raw material prices so that consumer demand was difficult to fulfill.

Keywords: *Nut Bread Production, Optimization, Cutting Plane, Integer Linear Program, UKM, Bakery Efficiency*

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1. Introduction

Business competition is getting tighter and more difficult day by day, this can be caused by the increasing number of companies. As a result, every company competes to be at the forefront in its field. Therefore, every company must be able to develop and improve its performance effectively and efficiently. An entrepreneur must be astute in looking for existing business opportunities to be able to compete in business or industrial competition[1].The increasingly rapid development of the business world requires business actors to face very tight competition to be able to grab the attention of consumers. Various strategies are carried out by entrepreneurs to attract consumer interest in their products[2]. One of the main challenges faced is competition from similar businesses which can cause a decrease in

income or even bankruptcy if not handled well[3]. There are also influencing factors such as indirect costs, employee salaries and overhead costs[4]. In determining the number of products that must be produced to get maximum profits by taking into account factors such as raw material prices, product prices and the amount of raw material inventory[5].

In this era of globalization, the number of companies continues to increase, encouraging each company to compete to be at the forefront in its field. Therefore, developing and improving company performance effectively and efficiently is very important[6]. This type of research, starting from the beginning to making the research design, is carried out[7].

in a systematic, planned and structured manner Entrepreneurs are required to be observant in looking for business opportunities and developing new ideas that are in line with current developments[8]. The ability to compete in the business world relies heavily on skills in marketing, production, finance and other management.

One of the business sectors that is growing rapidly is micro, small and medium enterprises (MSMEs)[9]. MSMEs in Indonesia, especially in the North Sumatra region, have experienced significant progress with coaching support from the government. In the culinary sector, for example, there are various specialty food products which are of particular attraction to consumers[10]. One of the typical food products from Tebing Tinggi City is peanut bread, which has been known since 2005 because of the soft taste of green beans and the crunchy skin.

Hj Nut Bakery. Eliya Lubis in Tebing Tinggi City is a famous peanut bread producer with a variety of flavors and consistent quality . However, this shop faces challenges in the form of fluctuating raw material prices and unstable consumer demand, which can hamper the production process. Therefore, it is necessary to optimize production quantities to increase efficiency and profits[11].

Production optimization is an important approach in managing resources efficiently to achieve the expected product quantity and quality[12]. Optimization really needs to be done for SMEs so that they can find out the amount of production of a company based on raw materials and customer demand so that it will affect the level of profits for the company. This research determines the production quantity of a product based on the availability of raw materials and average demand[13]. The existence of these two constraints will determine the amount of peanut bread production. This method is effective in solving integer linear programs and provides optimal solutions in integer form, which is relevant for production in dos[14].

This research is expected to make a significant contribution in helping SME entrepreneurs face intense business competition by managing resources more effectively and efficiently[15]. It is also hoped that the results of this research can become a reference for entrepreneurs in implementing production optimization methods to increase the competitiveness and sustainability of their businesses[16].

2. Methods

This research employs a quantitative approach with a descriptive research design aimed at optimizing peanut bread production at Hj Nut Bakery Shop. Eliya Lubis utilizes the cutting plane method. The study was conducted at Hj Nut Bakery Shop located in Tebing Tinggi City, North Sumatra. The data utilized comprises both primary and secondary sources. Primary data were gathered through direct observation and interviews with shop owners and employees concerning production processes, raw material quantities, labor inputs, and consumer demand. Secondary data were sourced from literature, journals, books, and internal documents such as production and financial reports.

Data collection techniques included observation, structured interviews, and documentation. Observations involved direct monitoring of the peanut bread production process at the shop. Structured interviews were conducted with owners and employees to gain deeper insights into production constraints and optimization needs. Documentation involved gathering production reports, financial statements, and records of raw material purchases[17].

Data analysis employed the cutting plane method to optimize peanut bread production. This research uses the cutting plane method because the data obtained is not in the form of whole numbers or fractions, therefore in this study it is more suitable to use the cutting plane method with the addition of new constraints/gomory[18]. The cutting plane method is an algorithm that is included in the exact method[19]. PL problems can be found in various fields and can be used to help make decisions to choose the most appropriate alternative and the best solution[20]. Integer Programming is a mathematical model that allows the results of solving cases in linear programming in the form of integers[21].The aim of this research is to determine the optimal production amount for each production in order to obtain maximum profits. The research method used is the Linear Programming method. The steps for the cutting plane method in solving integer linear programming problems are as follows:

1. Solve the integer linear programming problem using the simplex method by ignoring the integer requirements.
2. If the solution to Step (1) contains fractional variables, do the following steps
3. Select any row of the optimum simplex table in column bi which contains fractions. If there are several variables that have fractional values, the row containing the largest fraction is selected, this is chosen so that iteration is faster.
4. Suppose that row i is the selected row and the equation formed in row i is:

$$\sum_{j=1}^{n} a_{ij} x_j = b_i$$

with additional constraints:

$$S_{gi} - \sum_{j=1}^{n} f_{ij} x_j = -f_i$$

Where
Sgi: Additional obstacle (gamory) i
fij : Fractional part in aij
fi : Fractional part in bi

5. Then solve it using the dual simplex method with the selected equation placed on the last row.

In this research, software can also be used so that the values obtained in manual calculations are valid. This POM QM software will help determine manual values with the software to be balanced/equal. The steps are:

1. The first step that must be taken is to first open the POM QM software.
2. After that, select linear programming, after entering then make settings based on the data we have, how many rows and columns there are.
3. Then enter the data we have.
4. After that, press solve, then select the literacy menu then solution list. Then several iteration tables will appear.

Analytical steps included identifying decision variables, formulating a linear programming model, applying the cutting plane method, and validating the model. Decision variables encompassed raw material quantities, labor, and consumer demand. The linear programming model was formulated to optimize peanut bread production, and the cutting plane method was applied to achieve optimal solutions in integer form. Model validation included comparing optimization results with actual production data and evaluating model performance under real conditions[19].

3. Results and discussion

This research was conducted at UD. Umega Hj bean bread. Eliya Lubis which is located in Tebing Tinggi City, Jln. Gen. Sudirman No.297 C (PLN Complex. T.Tinggi) North Sumatra Province. UD. Umega Hj bean bread. Eliya Lubis has 6 flavors of peanut bread that they produce every day. Before

carrying out the UD selector production process. Umega Hj bean bread. Eliya Lubis first prepares the raw materials that will be used during the production process. Each flavor of peanut bread definitely requires different amounts of raw materials. The raw materials needed in the process of making this peanut bread are in the table below:

Tablo 1. Table of Raw Materials Needed in Desember 2023

Bahan Baku	Varian Rasa						Persediaan
	RK. Strow	RK. Nanas	RK. Cappu	RK. Coklat	Rk. Merah	RK. Hijau	
Tepung terigu	7000	6000	6500	9000	10500	8500	65000
Gula	4500	3500	4000	6000	7000	6500	35000
Kacang Hijau	3500	2000	3000	5500	0	4500	20000
Telur	500	400	450	750	800	650	3000
Minyak	800	700	850	1000	1500	900	18000
Selai strow	600	0	0	0	0	0	600
Selai Nanas	0	400	0	0	0	0	500
Selai Cappu	0	0	500	0	0	0	500
Selai Coklat	0	0	0	1000	0	0	1500
Kacang merah	0	0	0	0	6500	0	7000

The mathematical model for completing this research is the following formula which is the result of human interpretation of a reality expressed in the form of mathematical notations so that it can be completed systematically. According to Nur and Abdal (2016), the variable xi (i = 1.2, … , m) represents the basic variable and the variable xj (j = 1.2, … , n) represents the non-basic variable.

Objective Function

Maximize:

$$Z = c_1x_1 + c_2x_2 + c_3x_3 + c_4x_4 + c_5x_5 + c_6x_6 \qquad 1.1$$

With constraints:

$$a_11x_1 + a_12x_2 + a_13x_3 + a_14x_4 + a_15x_5 + a_16x_6 + S_7 = I_1$$
$$a_21x_1 + a_22x_2 + a_23x_3 + a_24x_4 + a_25x_5 + a_26x_6 + S_8 = I_2$$
$$a_31x_1 + a_32x_2 + a_33x_3 + a_34x_4 + a_35x_5 + a_36x_6 + S_9 = I_3$$
$$a_41x_1 + a_42x_2 + a_43x_3 + a_44x_4 + a_45x_5 + a_46x_6 + S_{10} = I_4$$
$$a_51x_1 + a_52x_2 + a_53x_3 + a_54x_4 + a_55x_5 + a_56x_6 + S_{11} = I_5$$
$$a_61x_1 + a_62x_2 + a_63x_3 + a_64x_4 + a_65x_5 + a_66x_6 + S_{12} = I_6$$
$$a_71x_1 + a_72x_2 + a_73x_3 + a_74x_4 + a_75x_5 + a_76x_6 + S_{13} = I_7$$

Information:

: Maximum profit
: Number of sales of green bean bread
: Number of sales of pineapple jam peanut bread
: Number of strawberry jam peanut bread
: Number of cappuccino nut patties
: Number of chocolate nut breads
: Number of black/red bean patties
: Benefits of each product

Table 2. Results with the simplex In Desember 2023

Basic	Z	X1	X2	X3	X4	X5	X6	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	NK
Z	1	0	0	0	0	0	0	0	0,0939	0,0358	21,8352	0	0	0	0,1798	-3,1505	-1,3269	9552,4342
S1	0	0	0	0	0	0	0	1	0,9546	0,3704	-24,6284	0	0	0	-0,1836	1,8754	2,5072	48743,4517
X3	0	0	0	1	0	0	0	0	-0,004	0,0023	0,0205	0	0	0	-0,0012	-0,0018	0,01	-20,6249
X1	0	1	0	0	0	0	0	0	-0,0019	0,0012	0,0102	0	0	0	-0,0016	-0,0008	0,0051	-10,8173
X6	0	0	0	0	0	0	1	0	0,013	-0,00018	-0,0119	0	0	0	0,00014	0,00032	-0,00099	13,401
S5	0	0	0	0	0	0	0	0	0,2209	0,0453	-3,8207	1	0	0	-0,2213	2,2965	83,5844	-19091,768
S6	0	0	0	0	0	0	0	0	-1,14	-0,72	-6,12	0	1	0	0,96	0,48	-3,06	7090,38
S7	0	0	0	0	0	0	0	0	0,0394	0,4803	-3,7171	0	0	1	0,1595	0,599776	2,681428	3239,9711
X2	0	0	1	0	0	0	0	0	-0,00098	-0,0012	0,0092	0	0	0	-0,0003	-0,0014	-0,0067	-6,8499
X4	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0,001	0	1,5
X5	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0,0001	1,0769

The value Z= 9552.4342 can be obtained with the values X1= 48743.4517, X6= 13.4010, X4=1.5, X5= 1.0769. If there are still non-integer values for the Decision variable, then continue using the cutting plane method by adding a new constraint called gomory to produce a solution in the form of an integer number. The following is the use of POM QM Software in solving the simplex method in December 2023:

	cj-zj		0	0	0	-750	0	0	0	0
Iteration 10										
0	slack 1	22.128,47...	0	0	0	-1.607,63...	0	0	1	0
0	slack 2	5.506,9444	0	0	0	-2.090,27...	0	0	0	1
0	slack 10	8.322,9167	0	0	0	-135,4167	0	0	0	0
4000	X2	1,25	0	1	0	0	0	0	0	0
0	slack 5	13.118,75	0	0	0	-131,25	0	0	0	0
4800	X1	1	1	0	0	0	0	0	0	0
0	slack 9	1.500	0	0	0	1.000,0	0	0	0	0
4500	X3	1	0	0	1	0	0	0	0	0
5000	X6	2,4444	0	0	0	1,2222	0	1	0	0
6000	X5	0,1042	0	0	0	0,0208	1	0	0	0
	zj	27.147,22...	4800	4000	4500	6236,11	6000	5000	0	0
	cj-zj		0	0	0	-736,1111	0	0	0	0

Figure 1. Completion using the simpleks method

Figure 1

The solution obtained using the simplex method still has non-integer values, so new constraints are added.

Table 3. Results using the Cutting Plane in Desember 2023

Basic	Z	X1	X2	X3	X4	X5	X6	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	Sgi	NK
Z	1	0	0	0	0	0	0	0	1,746185577	0	0,001474643	0	0	0	0,025185083	6141003043/-46950451	-0,02586	0	527037,753
S1	0	0	0	0	0	0	1	0	24445791153/539074474913	0	-33,90931299	0	0	0	0,077606985	454,768226	1/200	0	3225191,271
X3	0	0	0	1	0	0	0	0	113900/-700753	1	-7,48302897	0	0	0	0,207485275	1,223252701	-5,1275	0	876,222
X1	0	1	0	0	0	0	0	0	1145,593824	0	0,001052625	0	0	0	-0,006917667	0,000616216	14241/20000	0	1761,548
X6	0	0	0	0	0	0	0	1	-0,012985524	0	7864200542500/-830514679763	0	0	0	326350239747700033/-7393383000	0,000106562	11/10000	0	364644,268
S5	0	0	0	0	0	0	0	0	8198432017000/-7864200542	0	81882868565839/-393210027125	0	0	0	-19,00491556	3,088198843	19/4000	0	131563,955
S6	0	0	0	0	0	0	0	0	-11,52173641	0	3,798819112	0	1	0	183675700327/-265270048150	228209889/-78642005	-2,94	0	8,62093
S7	0	0	0	0	0	0	0	0	0,089915945	0	4802727722549/-1966050135625	0	0	1	0,147492659	0,01195284	143/200	0	15-May
X2	0	0	1	0	0	0	0	0	0,001026296	0	0,032890334	0	0	0	Jan-00	144009264	0	0	256,670628
X4	0	0	0	0	1	0	0	0	0	0	482031/37492372500	0	0	0	0	1/10000	1076/3195372656	0	01-Jan
X5	0	0	0	0	0	1	0	0	2,45750418	0	1,273326883	0	0	0	452973499908259/-4414671138000	1	1/10000	0	116,253691
Sgi	0	0	0	0	0	0	0	0	13/1000	0	448279989421/5443892487000	##	0	0	7/50000	Jan-25	01-Oct	1/10	401/2000

Based on the results of management using the cutting plane method, the profit obtained in January 2024 is IDR. by produc 527.037.751, the total production of various flavour of bread in the conversation in Desember was: Ing pineapple peanut butter bread 2.566 units, strawberry jam 1.761 units, cappuccino jam 876 units, chocolate jam 4.315 units, red bean 1.162 units and 3.664 units green bean.

Table 4. Table of Raw Materials Needed in January 2024

Bahan Baku	Varian Rasa						Persediaan
	RK. Strow	RK. Nanas	RK. Cappu	RK. Coklat	Rk. Merah	RK. Hijau	
Tepung terigu	9000	8000	8500	11500	12000	10000	80000
Gula	6500	5500	6000	9000	10000	8500	40000
Kacang Hijau	4500	3000	4000	6500	0	5500	25000
Telur	880	700	800	1200	1700	950	6000
Minyak	2500	1500	2000	3500	4000	3000	36000
Selai strow	900	0	0	0	0	0	0
Selai Nanas	0	650	0	0	0	0	0
Selai Cappu	0	0	800	0	0	0	0
Selai Coklat	0	0	0	1500	0	0	0
Kacang merah	0	0	0	0	8000	0	0

Table 5. Results with the simplex In January 2024

Basic	Z	X1	X2	X3	X4	X5	X6	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	NK
Z	1	0	0	0	0	0	0	0,9466	0	0	0,02565	-1,4968	0	0	0,0017	-10,3067	-1,7414	59501,0824
X6	0	0	0	0	0	0	1	0,01087	0	0	-0,09215	-0,0156	0	0	-0,0067	0,0054	0,005	144,05315
S2	0	0	0	0	0	0	0	-15,3125	1	0	123,025	20,6425	0	0	9,3326	4641,755	-6,8725	-208979,42
S3	0	0	0	0	0	0	0	8,6875	0	1	65,075	5,6275	0	0	5,5145	-4,49	0,7105	-87909,788
X2	0	0	1	0	0	0	0	-0,0025	0	0	0,019	0,0023	0	0	0,0018	-0,0013	-0,0011	-17,5735
X1	0	1	0	0	0	0	0	-0,00975	0	0	0,0855	-0,01535	0	0	0,0047	-0,0057	-0,00475	-14466540
S6	0	0	0	0	0	0	0	8,775	0	0	-76,95	-4,815	1	0	-4,2585	5,13	4,275	12,6940,386
S7	0	0	0	0	0	0	0	1,625	0	0	12,35	-1,495	0	1	-1,1799	0,845	0,715	12422,596
X3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0,00125	0	0	1,25
X4	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0,0006	0	1,3333
X5	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0,0001	1,125

The value Z= 59501,0824 can be obtained with the values X3= 1,25, X6= 144,05315, X4=1,3333, X5= 1,125. If there are still non-integer values for the Decision variable, then continue using the cutting plane method by adding a new constraint called gomory to produce a solution in the form of an integer number. The following is the use of POM QM Software in solving the simplex method in January 2024:

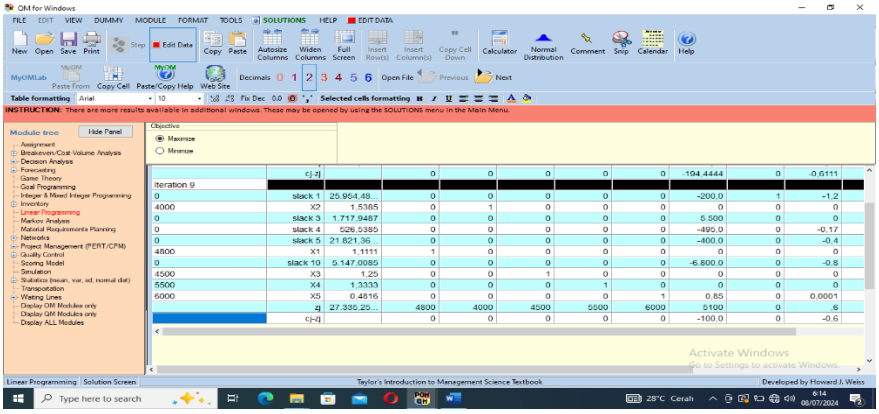

Figure 2. Completion using the simpleks method

Figure 2

The solution obtained using the simplex method still has non-integer values, so new constraints are added.

Table 6. Results using the Cutting Plane in January 2024

Basic	Z	X1	X2	X3	X4	X5	X6	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	Sgi	NK
Z	1	0	0	0	0	0	0	-96,32341456	0	0	10711975549987883/164966439	4443303522757/274220650000	0	0	2751286508731761/3402432804	0	-0,02586	0	281734,044
X6	0	0	0	0	0	0	1	-49,3745897	1	0	-771,9372475	353841855686/948527925	0	0	10070363527939/680486560875	0	1/200	0	218,75
S2	0	0	0	0	0	0	0	80/4090077	0	1	9764062/4499990847	101200/1499969499	0	0	21444896/562355875	1	-5,1275	0	61,437145
S3	0	0	0	0	0	0	0	5987606591881/19995932000	0	0	974816676065551/18146308290	45839903047581/1099776260	0	0	6614144710341386 1/28250502678	0	14241/20000	0	2074411069
X2	0	0	1	0	0	0	0	1124645335/494899317	0	0	938912441434/5443892487	1216065499/604876943	0	0	1113216801323/680486560875	0	11/10000	0	801,032
X1	0	1	0	0	0	0	0	131973151200/11442671351	0	0	533457729997/72585233160	81926373870/1512192357500	0	0	696977843551/226828853625000	0	19/4000	0	144661430,2
S6	0	0	0	0	0	0	0	-2,334271074	0	0	-66,70648852	-57,54233478	1	0	-107,8763719	0	171/40	0	4,020709
S7	0	0	0	0	0	0	0	65/13	0	0	247/20	-0,505	0	1	-0,8021	0	143/200	0	29-Mar
X3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	5/40000	0	0	0	1,25
X4	0	0	0	0	1	0	0	66/511259625	0	0	482031/37492372500	506/124974575	0	0	0	0.	1076/3195372656	0	07-Feb
X5	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1/10000	0	2,618318
Sgi	0	0	0	0	0	0	0	623164241/49489957000	0	0	448279989421/5443892487000	31170285707/725852331160	0	0	3706201371840/85060820109375	0	1/200	1./10	9,050107

Based on the results of management using the cutting plane method, the profit obtained in January 2024 is IDR. 281.734.404,4. the total production of various flavour of bread in the conversation in Desember was: By producing 801 units pineapple peanut butter bread, 344 units strawberry jam, 595 units cappuccino jam, chocolate jam 6.676 units, red bean 2.683 units and 2.187,5 units green bean.

4. Conclusions

Based on the results of management using the cutting field method, the profit obtained in December 2023 is IDR. 52,703,775 Based on the total production of various flavors of peanut bread in December, there were: 2,566 units of peanut butter pineapple bread, 1,761 units of strawberry jam, 876 units of cappuccino jam, 4,315 units of chocolate jam, 1,162 units of red bean butter and peanut butter. red as many as 3,664 units. unit of green beans. Then, as a result of management using the cutting field method, the profit obtained in January 2024 is IDR. 28,173,440,440. The total production of various flavors of bread in December was: By producing 801 units of peanut butter pineapple bread, 344 units of strawberry jam, 595 units of cappuccino jam, 6,676 units of chocolate jam, 2,683 units of red bean butter and 2,187 units of green bean jam. .5 units. Based on the results of research conducted using the cutting plane method, the profits and production quantities produced from direct company data are very different. If the company carries out calculations using methods such as cutting planes, the company's profits and book keeping will certainly not experience problems regarding calculating profits and production quantities for each product produced.

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