## Optimization of Production Benefits Through the Linear Program Graph Method: A Case Study Zentha Meubel

### Hersiyati Palayukan

Pendidikan Matematika, FKIP, Universitas Kristen Indonesia Toraja
E-mail : hersiyati@ukitoraja.ac.id

**Abstract**

Production at Zentha Meubel is experiencing constraints due to the availability of wooden planks and the time spent making cabinets and tables. Meanwhile, the company wants to get optimal profit. To solve this problem, this study aims to utilize a linear graphical method program to optimize production profits at Mr. Andarias' Zentha Meubel. This research is a qualitative research type of phenomenology. The process carried out in optimizing the production is collecting data by interview and observation. Furthermore, a mathematical model is made and then optimizes the production profit using the graphical method. The results with the graph method show that production at Zentha furniture will achieve optimal results if it produces 15 units of cabinets with a profit of Rp. 18,750,000. The results of the optimization calculation using the graph method will increase the profit of Rp. 2,250,000.

**Keywords:** Linear Programming; Graph Method; Profit Optimization

## INTRODUCTION

In everyday life, many people need household items that include all items such as cupboards and desks. This product functions as a place to store goods, a place to study, and so on. Seeing this opportunity, a small company, one of which is Zentha Meubel, produces cabinets and tables. In producing cabinets and tables, the Zentha Meubel company has limited resources. Limited resources are indeed often a problem for many companies, especially in determining production strategies (Tannady, 2017). Limitations experienced by these companies, such as the quantity of production of cabinets and tables, depending on the availability of the main material (boards/wood) and the time it takes to make cabinets and tables. Meanwhile, in production, it is expected that the product that is made will get optimal profit through a production plan in order to maximize profits (Merlyana & Bahtiar, 2008); Taha, 2003).

Planning in terms of production certainly has an important role in the industrial world (Sinaga, 2016). The planning is related to fulfilling product demand, quality, use of existing sources, and profits (Anwar & Afrizalmi, 2015). The observation results show that the Zentha Meubel company is still less able to analyze the availability of raw materials, namely how many cabinets and tables should be produced to get maximum results without reducing the supply of raw materials needed. Other information obtained that the problem experienced by the company Zentha Meubel is how to determine the amount of production that should be made to get maximum income by taking into account the predetermined working time/hours. In producing the company's cabinets and desks, Zentha Meubel needs

to adjust the time spent in producing cabinets and tables with the amount of production it makes each month.

Many people think that the higher a person's skills, the higher his knowledge. However, in reality in the field there are still companies that have not carried out proper production planning (Hilman, 2019; Indah & Sari, 2020), especially in producing cabinets and tables through simple observations, it is obtained that some MSMEs also do not understand the application of mathematics. Due to someone's lack of knowledge, the place of production has not applied mathematics. The furniture business owner makes cupboards and tables only by following his instincts. The problem experienced in producing cabinets and tables is a lack of understanding or ignorance of using limited basic materials in order to get optimal benefits by calculating the time (working hours) required.

Based on the description above, the Zentha Meubel company will produce the number of cabinets and tables that are not made to obtain optimal profit. Therefore, one solution to solve the above problems is to apply mathematics. Mathematical science is one of the important sciences that uses a mindset with reasonable (logical) proof, helping humans to prevent and understand problems that occur in various fields such as optimization problems in the production of cabinets and tables above.

The mathematical science that will help someone in solving the above problems is a linear program. A linear program is a method or method in mathematics that is used in allocating limited resources in order to achieve the desired goal, such as how to produce a limited material but the income obtained from this business is increasing or obtaining optimal benefits (Purba, 2012). With the linear program, the small company has good decision-making techniques in solving the problems it faces in allocating limited resources among various interests as optimally as possible. According to Prawirosentono (2007) problem-solving methods in linear programming can be done in 4 ways, namely: 1) Graphs (Graphical Approach), 2) Mathematics (Mathematical Approach), 3) Algebra (Algebra Approach), 4) Simplex Method (Simplex Method). The method used in this research is Graph (Graphical Approach). The graph method is one of the methods in linear programming that will help someone solve the problem of profit from production, namely by using the graph method which is carried in the form of linear equations and inequalities. The graphing method is a technique for solving linear programs that only involve two-variable linear equations to get the maximum possible benefit. This graphical method is one of the simpler methods because it tends to be easier to understand than other linear programming methods. Solving linear programs using the graphical method in this study using the corner point test.

According to Ba'ru & Remme (2019), the linear program is a method that can be used in solving the optimization problem of a linear model in various constraints or objectives. Linear programs are designed to assist humans in planning the allocation of resources used in achieving goals. The concept of linear programming is based on the concept of linear equations and the linear inequality system of real numbers so that these properties are widely used as a guide in solving a linear programming problem. A linear program is a general model that can be used in solving the allocation of finite resources optimally.

There are three main ingredients in linear programming, namely the objective function, the set of constraints, and the set of non-negative constraints (Chiang & Wainwright, 2005). Linear programs are part of mathematics that is widely used in various fields, namely in the fields of economy, agriculture, industry, and trade with the intention of calculating the profit a person gets. The linear program discusses the constraints that occur, such as available resources. The constraint function is a limit to the available capacity. To solve the problem, optimization is needed to achieve a balance value of a goal. To optimize a goal to be achieved, we make the value of a function from several variables a maximum or minimum value by paying attention to existing limitations or constraints.

Completion of linear programs can be done using the graphical method ((Hartama et al., 2020). The graphic method is one of the methods used in solving optimization problems in linear programs. The graphical method is used to solve problems where there are only two decision variables. someone in understanding the meanings that arise in a linear program. According to Ba'ru & Remme (2019), solving optimization problems that contain two variables can be done using the graph method. The amount of optimal solution can be found at an extreme point in a feasible area The extreme point is the intersection of at least two constraint lines, while the feasible area is the area on the graph that contains the points and satisfies all problem constraints (a collection of all feasible solutions).

As for the steps to solve linear program problems with the graph method (Arief, 2014): 1) Determine the decision variables of the problem, 2) Determine the objective function and express it in a mathematical model in the form of an equation with the general form $f(x, y) = ax + by$ or $z = ax + by$, 3) Identify the constraints and express them in a mathematical model in the form of a two-variable linear inequality, 4) Draws all identified constraint functions on one coordinate axis, 5) Find the area of the set of solutions that satisfies all linear inequalities, 6) Determine the coordinates in the area of the set of solutions, and 7) Substitute these points that have been obtained into the objective function to determine the optimum value.

An optimization problem is a problem in determining the variable value of an optimal function (maximum or minimum) by looking at existing limitations such as factors that affect the production process. Several studies have utilized linear programming in production optimization problems including the application of linear programs to optimize production quantities (Christian, 2013); (Marzukoh, 2017) and benefits (Kelvin & Jobiliong, 2015; Supriyadi et al., 2017); (Hasmi, 2018). In addition, several researchers have used graphic methods to optimize the benefits of PT Mega Karya Helmet products (Kelvin & Jobiliong, 2015), optimization of production at the House of Leather Bandung (Nur'safara, 2015), based on the existing constraints at the Zentha Meubel Store to be able to solve the problem. Optimization problems with the constraints that exist on the Zentha Furniture then use a linear design technique with the graph method.

**RESEARCH METHOD**
In this study, the approach used by the researcher is a qualitative approach with the intention of studying and understanding more deeply the optimization of the production benefits of cabinets and tables at Zentha Meubel through a linear graphical method program. The type of qualitative research carried out is

phenomenology with the aim of this research, the researcher pays attention to the data and focuses on the phenomenon under study by conducting in-depth interviews to extract clearer and more accurate data. In this qualitative research, the presence of researchers is needed, namely acting as an instrument and collecting data in research. The presence of researchers in this study is very important and the main thing is because the researchers themselves will collect or analyze the data that has been obtained in the study and report the results of the research. The research location is located at Zentha Meubel Jalan. Tikualu / Ariang, Makale City, Tana Toraja Regency, South Sulawesi Province. Researchers conducted research at these locations because of the suitability of the selected topic and interesting to get a clearer source of information.

The data sources used by researchers in this study are :

1.  Primary data or data directly (original source) obtained by researchers from the research location
2.  Secondary data or data indirectly obtained by a researcher such as books, the internet, journals, and other sources are used as input to support this research.

The data collection technique used by researchers is through in-depth interviews (interviews) and observations. The data analysis was carried out, namely describing the data obtained in the field by providing a description of the situation understudy in the form of a narrative description. The data analysis used by researchers is descriptive quantitative. The data analysis tool used is the graph method using the corner point test.

**RESULTS AND DISCUSSION**

Based on the results of an interview with Mr. Andarias as the owner of the furniture production site, it was found that the company was founded in 2006 The industry was named Zentha Meubel. The products produced at Zentha Furniture are 2-door cabinets and ½ Biro table.

The main type of material (wooden planks) used in the production is agathis wood planks obtained from the surrounding area and Luwu with a price of Rp. 85,000 / sheet with a length of 4 meters, a width of 25 cm and a thickness of 2 cm. The results of the interview also showed that each month the Zentha Meubel company produces 9 units of 2-door cabinets and 15 units of bureau ½ tables with each production price of Rp. 3,100,000 / unit of cupboard and Rp. 1,100,000 / unit of table. The monthly income earned by the company is IDR 44,000,000.

In the production process, Mr. Andarias as the owner of Zentha Meubel employs 6 employees with a salary for each employee, namely for 3 employees Rp. 3,500,000 / person and 3 other employees Rp. 1,200,000 / person. The expenses other than employee salaries that are incurred by the company each month are the cost of wood planks for making furniture Rp. 12,750,000 and Rp. 1,000,000 for other necessities. The maximum monthly net profit obtained by Mr. Andarias is IDR 16,500,000. The net profit obtained from each of these products is Rp. 1,250,000 / unit of 2-door cupboard and Rp. 350,000 / unit of desk ½ the bureau.

In addition, an important point obtained from the results of interviews and observations is that in producing a 2-door wardrobe it takes 10 pieces of wooden planks / unit and in producing a ½ table bureau it takes 4 pieces of wooden planks. The size of the 2-door wardrobe for each unit made is 180 cm x 125 cm x 50 cm, while the ½ bureau table for each unit made is 120 cm x 60 cm x 75 cm. The following is a table showing the number of wooden planks used to make furniture:

Table 1. Use of Wooden Planks in Production

| Type of production | Wooden planks per unit | production every month | wooden planks every month |
|---|---|---|---|
| 2 door wardrobe | 10 sheet | 9 unit | 90 sheet |
| ½ bureau table | 4 sheet | 15 unit | 60 sheet |
| Total wooden planks used | | 150 sheet | |

The number of wooden planks provided each month is 150 pieces of wooden planks or $3m^3$. Producing these cabinets and tables also takes a long time. The time spent making a 2-door wardrobe for each unit was 13 hours, while the time spent making a ½ bureau table was 6 hours. The company works a maximum of 26 days per month with the length of time working each day is 8 hours/day, so the total time needed is 208 hours/month. The results of observations that have been obtained by researchers are that the wooden planks used to make furniture are agathis wood planks. After the researcher observed that the wooden planks used to produce the furniture were one of the strongest grade quality woods. The wooden planks are white to brown, smooth wood, and straight fiber. Data from interviews and observations using the graphical method are described as follows:

1. Determine the decision variables from the problems discussed above. The decision variables of the problem, namely
a. Two-door cabinets made at Zentha Meubel are given the symbol x
b. The desk ½ bureau made at Zentha Meubel is given the symbol y
2. Define the objective function and express it in a mathematical model In this stage the objective function is intended to be related to the net profit obtained by each of these products. The production profit that has been obtained at Zentha Furniture is IDR 1,250,000 / unit of two-door cupboard and IDR 350,000 / unit of ½ desk. The mathematical model of the objective function of the problems discussed is Z = 1,250,000x + 350,000y.
3. Identify constraints and express them in a mathematical model in the form of a two-variable linear inequality. After the data is identified from the various sources above, the constraints of these problems are the problem of the availability of wooden planks and the time needed to work on the furniture. The mathematical model of the problem, namely :
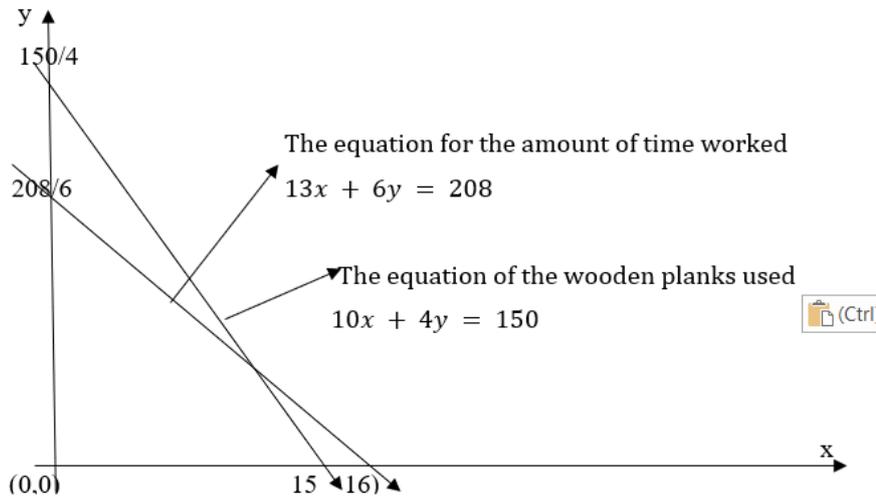
$$\text{Wooden board} = 10x + 4y \leq 150$$
$$\text{Time} = 13x + 6y \leq 208$$
$$x \geq 0$$

$$y \geq 0$$

4. Draw all constraint functions that have been identified on one coordinate axis



The equation for the amount of time worked
$13x + 6y = 208$

The equation of the wooden planks used
$10x + 4y = 150$

5. Determine the area of the solution set that satisfies all linear inequalities and determine the coordinates of the area that is feasible for the set of solutions.
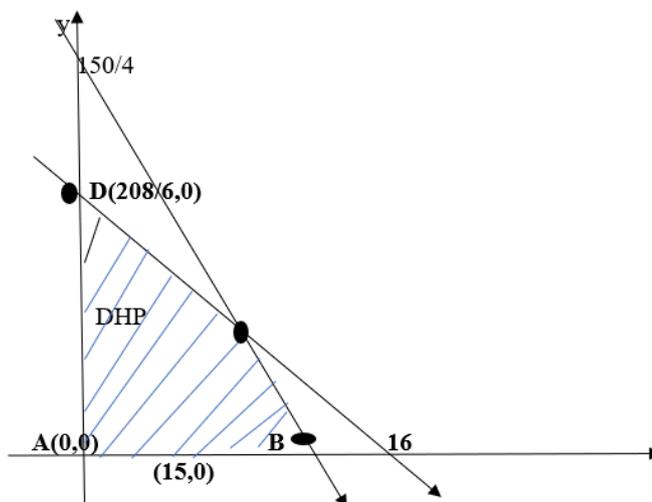


Based on the figure above, the corner points that have been obtained in the area of the settlement set are substituted into the objective function. The results of the substitution can be seen in the table below:

Table 2. Corner Point Test Results

| Angle Point | Purpose Function ( $Z = 1.250.000x + 350.000\,y$ ) |
|---|---|
| A (0,0) | $1.250.000\,(0) + 350.000\,(0) = 0$ |
| B (15 ,0) | $1.250.000\,(15) + 350.000\,(0) = 18.750.000$ |
| C (17/2, 65/4) | $1.250.000\,(17/2) + 350.000(\,65/4) = 16.312.500$ |
| D (0, 208/6) | $1.250.000\,(0) + 350.000(208/6) = 12.133.300$ |

The results of the calculation of profit optimization using the graph method, namely the corner point test above, the maximum value are obtained, namely the industrial company Zentha Furniture will produce 15 units of cabinets and 0 units of tables to get a profit of Rp. 18,750,000. The results of processing the optimization model on production at Zentha Meubel show that the production carried out at the industrial company is not yet optimal. We can see this in the total production that is different from the optimal conditions when tested using the graphical method based on existing constraints. Although the industrial company Zentha Meubel Mr. Andarias in factual conditions is different from its optimal conditions, profitably it is close to optimal profits. We can see these results in the table.

Table 3. Production Level

| Variable | Production rate | |
| --- | --- | --- |
| | Faktual | Optimal |
| X | 9 | 15 |
| Y | 15 | 0 |

Based on the table above, it shows that the number of production in fact at Zentha Meubel is 9 units of cabinets made per month and 15 units of tables that are made each month. But based on optimal processing results using the graph method shows that to achieve optimal results, the company will produce 15 units of cabinets to achieve the actual production profit optimization. If the company wants to produce furniture according to optimal conditions, then it should produce 15 units of cabinets to get a profit of IDR 18,750,000. The increase in profits was Rp. 2,250,000. The optimal solution size is found at an extreme point in the feasible region.

The feasible area in the research results is the shaded area that contains the points and meets the equation constraints. The results of optimizing the production profit of cabinets and tables at Zentha Furniture have obtained a feasible solution, namely at point (0.0), (15.0), (17/2, 65/4) so that the extreme point that produces the greatest objective function or the maximum is in B (15.0), which means that the company reaches the optimal point when producing 15 units of 2-door cabinets only. In the previous discussion of linear programs, we discussed the graph method. It is stated that the linear graphical method program can only be used to solve optimization problems involving two variables. So the linear graph method program is very helpful in producing optimization decisions in the problems that exist in Zentha Meubel.

## CONCLUSION

Based on the results of data analysis that have been described previously, it can be concluded that optimizing the production profits of cabinets and tables at Zentha

Meubel can be done by using the graph method. This can be seen from the results of the research where the calculation using the graphical method will obtain optimal results when the company produces 15 units of 2-door cabinets without having to make ½ desk bureau. The optimal profit that will be achieved by Mr. Andarias is IDR 18,750,000.

Recommendations from the results of the above research, namely the Zentha Furniture Company has not achieved the optimization of production profits, it is better if to achieve the optimization, the company uses the graph method to get more optimal results, to reduce the risk of loss, the owner of Zentha Furniture should pay attention to the supply of wooden planks in making furniture whether the goods are in stock according to the manufacture of the desired production quantity. For the owner of Zentha Furniture to get maximum results, employees should pay attention to their working hours.

**REFERENCES**

Abbas, B. S. (n.d.). Robert. T. H, Shinta. 2008. Analisa Produksi Menggunakan Model Optimasi Linear Programming Pada PT. MAST. *Jurnal Piranti Warta*, *11*(3), 469–482.

Anwar, S., & Afrizalmi, L. (2015). Optimization of Production Planning Using Goal Programming Method (A Case Study in a Cement Industry). *Int. J. Appl. Math. Electron. Comput*, *3*(5), 90–95.

Arief, U. W. (2014). *Analisis Kemampuan Siswa dalam Menyelesaikan Soal Pokok Bahasan Program Linear dalam Mata Pelajaran Matematika Kelas IV MI DDI Kalukuang Kec. Tallo Kota Makassar Sulawesi Selatan*. Universitas Islam Negeri Alauddin Makassar.

Ba'ru, Y., & Remme, B. V. (2019). Penerapan Metode Grafik Dalam Merencanakan Produksi Kue Ibu Patrisia di Rantelemo. *Jurnal Keguruan Dan Ilmu Pendidikan*, *8*(1), 21–25.

Chiang, A. C., & Wainwright, K. (2005). *Dasar-dasar matematika ekonomi*. Sudigno S, Nartanto, penerjemah.

Christian, S. (2013). Penerapan linear programming untuk mengoptimalkan jumlah produksi dalam memperoleh keuntungan maksimal pada cv cipta unggul pratama. *The Winners*, *14*(1), 55–60.

Hartama, D., Andani, S. R., Pradana, T. A. Y., Ayu, E. M., & Solikhun, S. (2020). *Riset Operasi: Optimalisasi Produksi Menggunakan Metode Simpleks & Metode Grafik*. Yayasan Kita Menulis.

Hasmi, R. A. (2018). Optimasi perencanaan produksi dengan menggunakan metode linear programming pada CV. Aceh Bakery. *Jurnal Optimalisasi*, *1*(1).

Hilman, M. (2019). *OPTIMASI JUMAH PRODUKSI PRODUK FURNITURE PADA PD. SURYA MEBEL DI KECAMATAN CIPAKU DENGAN METODE LINIER PROGRAMMING*.

Indah, D. R., & Sari, P. (2020). Penerapan Model Linear Programming Untuk Mengoptimalkan Jumlah Produksi Dalam Memperoleh Keuntungan Maksimal (Studi Kasus pada Usaha Angga Perabot). *Jurnal Manajemen Inovasi*, *10*(2).

Kelvin, S., & Jobiliong, E. (2015). Optimasi Keuntungan Produk Helm PT Mega Karya Mandiri dengan Menggunakan Metode Linear Programming. *Seminar*

*Nasional Teknik Industri*, 44–54.

Marzukoh, A. (2017). *Optimasi Keuntungan Dalam Produksi Dengan Menggunakan Linear Programming Metode Simpleks (Studi Kasus UKM Fahmi Mandiri Lampung Selatan)*. UIN Raden Intan Lampung.

Merlyana, M., & Bahtiar, S. A. (2008). Sistem Informasi Untuk Optimalisasi Produksi dan Maksimasi Keuntungan Menggunakan Metode Linear Programming. *Jurnal Piranti Warta*, *11*(03), Hal-370.

Nur'safara, U. M. (2015). *Optimasi produksi dengan menggunakan metode grafis untuk menentukan jumlah produk yang optimal (kasus pada house of leather bandung)*. Fakultas Ekonomi Dan Bisnis (UNISBA).

Prawirosentono, S. (2007). *Manajemen Operasis dan Studi Kasus*. Jakarta: Penerbit Bumi Aksara.

Purba, R. (2012). Penerapan Logika Fuzzy Pada Program Linear. *Fakultas Keguruan Dan Ilmu Pendidikan Universitas Musamus Merauke*.

Sinaga, P. (2016). PERANCANGAN OPTIMASI PRODUKSI SARUNG TANGAN MENGGUNAKAN LINEAR PROGRAMING PADA PT. SMART GLOVE INDONESIA. *Informasi Dan Teknologi Ilmiah (INTI)*, *4*(1), 44–50.

Supriyadi, S., Muslimat, A., Pratama, R., & Ramayanti, G. (2017). Implementasi Linear Programming Untuk Memaksimalkan Keuntungan. *Prosiding Seminar Nasional Riset Terapan| SENASSET*, 183–189.

Taha, H. A. (2003). *Operation Research: An Introduction, 7th*.

Tannady, H. (2017). Optimasi Produksi Meubel Menggunakan Model Pemrograman Linear. *Business Management Journal*, *10*(1).