JURNAL ILMIAH TEKNIK INDUSTRI
ISSN: 1412-6869 (Print), ISSN: 2460-4038 (Online)
Journal homepage: http://journals.ums.ac.id/index.php/jiti/index
doi: 10.23917/jiti.v23i1.3430

Taguchi Method for Optimizing Economic Product Selling Prices in MSMEs Concrete Industry

Rudi Tjahyono[1a#], Dewa Kusuma Wijaya[1b], Ardini Dwi Ningtyas[1c]

Abstract. *This article examines research related to determining the economic selling prices for concrete brick products at Karunia MSMEs, with the aim of optimization for production cost while still maintaining process quality. The method used in this research is Design of Experiment (DoE) based, namely Taguchi with regression, then continued with cost analysis to determine the optimal cost of production for efficiency. The technique in this method uses 3 variables, there are sand, cement and the length of time for mixing the concrete mixture with the quality parameters and production costs of the concrete bricks. Based on the experimental results, in achieving the goal of increasing cost efficiency, through sensitivity analysis it was obtained that the optimal composition of the cost of production was IDR 5,000 per piece of concrete brick, while maintaining SNI quality standards in optimal results of compressive strength is 117.37 kg/cm^2, water permeability is 7.77% and roughness is 52.42 μm. The cost of production is the same as the initial cost of production before composition optimization efforts are carried out, where the initial concrete brick product is indicated as not meeting SNI quality standards because it has a compressive strength value below standard. The results of this research are expected to be able to provide recommendations for economic selling price for concrete brick by production costs optimizing while maintain the SNI standard quality of concrete brick products.*

Keywords: *economic selling prices, Taguchi, optimization, production cost, quality.*

I. INTRODUCTION

Concrete bricks are a construction material in the form of forming bricks, an alternative substitute for clay bricks made from concrete with a composition of sand, cement and water. Karunia MSMEs is one of the MSMEs concrete brick industry in the city of Semarang which currently produces concrete bricks using Muntilan sand and Grobogan cement. The selling price of the concrete bricks produced is quite competitive for the local market in the city of Semarang, namely IDR 5,000. Through preliminary studies, the author carried out initial compressive strength tests on the concrete brick products, but it was discovered that the compressive strength results of the Karunia MSMEs concrete bricks did not meet SNI standards. Even when the compressive strength test was carried out using a hammer test instrument, the concrete brick product cracked and the compressive strength results did not come out. This strengthens several consumer complaints that have come in, related to selling prices that are not commensurate with quality, product quality that is lower than other competitors at the same price, and even some consumers demanding that the quality be increased or the selling price be lowered. This problem was then studied through this research by optimizing the quality and production costs of Karunia MSMEs concrete bricks in order to determine an economical selling price. The optimization carried out in this research uses the Taguchi method to find optimal values for several predetermined test parameters.

Related to research on concrete brick products in 2017 regarding the use of the Taguchi method to optimize the compressive strength of concrete bricks (Yuliana et al., 2017). In 2018 the Taguchi method was used to optimize the compressive strength and absorption capacity of concrete bricks (Sutoni, 2018) and analysis of the quality of concrete brick production in small industries (Hendriyani & Prakoso, 2018). In 2020,

[1] Industrial Engineering Department, Faculty of Engineering, Dian Nuswantoro University. Jl. Nakula I No. 5-11, Semarang 50131, Indonesia

[a] email: rudi.tjahyono@dsn.dinus.ac.id
[b] email: dewa.kuja@dsn.dinus.ac.id
[c] email: ardinidwi02@gmail.com
◆ corresponding author

Submited: 07-12-2023 Revised: 06-06-2024
Accepted: 15-06-2024

a quality analysis was carried out regarding the defect level of concrete brick products (Merjani, 2020) In 2021, research related to concrete brick product innovation began to be developed using a mixture of stone ash and styrofoam waste as raw materials, then compressive strength analysis was carried out (Widyananto et al., 2021), then development of environmentally friendly concrete bricks was also carried out using a mixture of plastic waste as raw material (Mustakim et al., 2021), optimizing physical and mechanical properties. concrete bricks use a mixture of rice husks as raw materials (Ardiansyah et al., 2021).

In 2022, the development of concrete brick products was also researched using a mixture of kerosene slag waste as a raw material for compressive strength analysis (Ulfah et al., 2022), then environmentally friendly concrete brick products were developed again using a mixture of plastic bottles and the mixture was optimized using the Taguchi method (Tamalika et al., 2022), utilization The raw material for the corn cob mixture was also used in the development of concrete brick products and then an analysis was carried out related to physical properties, heat soaking and production costs (Fadhila & Winarno, 2022), and then the use of the Gray Relational Analysis and Principal Component Analysis methods was carried out to analyze the compressive strength and absorption capacity of the concrete brick products (Yuliana et al., 2022). In 2023, the Taguchi method will be used again to optimize the raw material mixture for concrete brick product mixtures in small industries (Umar et al., 2023).

Research related to machinery in the concrete brick production process has also been carried out several times, including an analysis of the development of a small industrial scale concrete brick production business using a single vibration machine (Willis et al., 2020). In relation to the concrete brick vibration machine, the development of a stepper motor as a vibration mechanism was also carried out and then an analysis of the increase in production was carried out (Matulessy et al., 2022). Furthermore, the machining technology for concrete brick production was also analyzed to determine the increase in production when using large-scale machines named conblock machines (Mahmuddin et al., 2023).

Research related to the economic study of concrete brick production has also been carried out several times, including the analysis of competition in selling prices for concrete brick products in the study of Islamic business perspectives (Susiyana et al., 2021). Controlling the supply of raw materials for concrete brick production uses the Economic Order Quantity method to reduce optimal production costs (Hidayat et al., 2022). Then research related to determining the optimal cost of production of concrete brick products uses the Full Costing method (Riningsih et al., 2022). Research related to analysis of decision making for accepting orders for concrete brick production uses the Differential Cost and Opportunity Cost methods (Taogan et al., 2022) Furthermore, research related to the Cost Plus Pricing method, which is one of the supporting references for this research, was carried out in determining the cost of production of a product (Fania Putri et al., 2022)

This research will focus on general types of concrete brick products made from concrete with reference to SNI quality standards for concrete concrete bricks. To obtain the optimal concrete brick composition, the concrete bricks must meet the quality requirements based on SNI 03-0349-1989 in Table 1.

Table 1. Concrete Brick Quality Requirements

Physical requirements	Unit	Quality level of hollow concrete bricks			
		I	II	III	IV
Minimum average gross compressive strength*	kg/cm^2	70	50	35	20
The minimum gross compressive strength of each test object	kg/cm^2	65	45	30	17
Maximum average water absorption	%	25	35	-	-

Furthermore, in the process of determining the economic selling price of the concrete brick products produced by Karunia MSMEs, optimization will be carried out based on experimental design using standard SNI parameter references in Table 1. Optimization is carried out using the compressive strength and water absorption parameters as well as additional parameters, namely surface roughness which is aesthetic value and production cost parameters related to efficiency. The technique of this research is that optimization based on experimental design is applied using the Taguchi method to find the optimal composition for concrete brick production by adjusting the cement raw materials, sand raw materials and the length of the concrete mixture mixing process for further testing with the four parameters above. After the optimization results are known, an analysis is then carried out regarding the economic aspects in order to determine the economic selling price of the concrete brick product while still taking into account the fulfillment of the SNI quality standards for concrete concrete bricks that have been determined.

II. Research Method

Figure 1 below shows the implementation flow of research activities carried out with the aim of determining the economical sales price Karunia MSMEs concrete brick products.

Table 2 explains the types of variables and multiple responses used in the research along with the notation used in the mathematical model.

III. Results and Discussions

The test results were carried out when the bricks were 21 days old show in Table 3. The tests carried out include surface roughness (Y_1), water absorption capacity (Y_2), compressive strength (Y_3) and production cost (Y_4). The factors are sand (X_1), cement (X_2) and mixing time (X_3).

The Signal to Noise Ratio in this cost analysis uses the smaller is better characteristic. The following is a response show in Table 4 for the signal to noise ratio obtained from the Taguchi

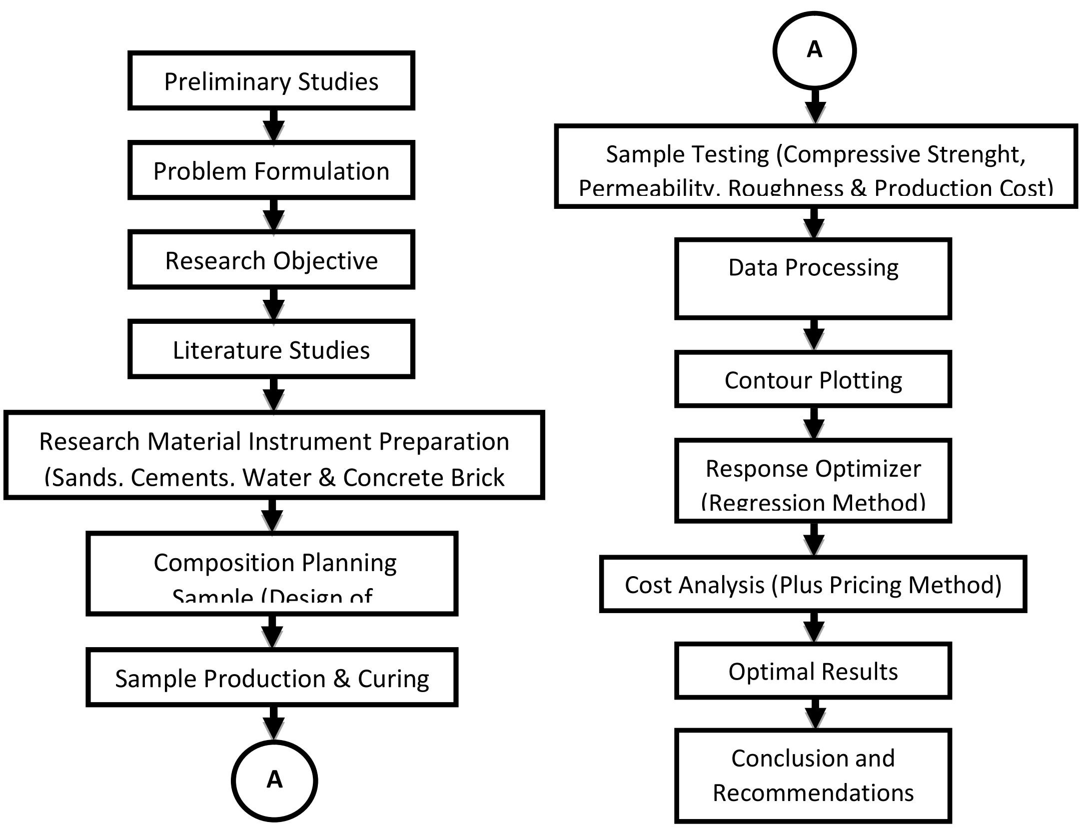

Figure 1. Research Flowchart Activites

Table 2. Variables and Responses

No	Notation	Category	Information
1	X_1	Decision variable 1	Sand Material
2	X_2	Decision variable 2	Cement Material
3	X_3	Decision variable 3	Concrete Mixing Time Process
4	Y_1	Response Parameter 1	Roughness
5	Y_2	Response Parameter 2	Permeability
6	Y_3	Response Parameter 3	Compressive Strenght
7	Y_4	Response Parameter 4	Production Cost

Table 3. Test Results

Sample Number	Variable Composition			Response			
	X_1	X_2	X_3	Y_1 (Ra)	Y_2 (%)	Y_3	Y_4
1	9	1	5	54.73	8.71	9.6	5,000
2	9	1.75	7	54.4	5.50	10.6	6,000
3	9	2.5	9	43.2	3.96	21.9	6,900
4	10	1	7	40.64	6.26	9.8	5,200
5	10	1.75	9	33.12	5.28	10.3	6,200
6	10	2.5	5	35.52	3.32	11.8	7,100
7	11	1	9	46.72	3.79	15.9	5,400
8	11	1.75	5	44.48	3.93	13	6,400
9	11	1	5	55.02	3.63	13	7,300

design analysis in Minitab software.

The results of software calculations with smaller is better results in the water absorption test were obtained at composition X_1 level 3 with the lowest value, namely -76.76. In factor X_1, level 3 was obtained with the lowest value, namely -77.73. The X_3 factor is obtained at level 3 with the highest value, namely -76.53. After obtaining the results of the calculations, they are depicted in the graph Figure 2.

Table 4. Signal to Noise Ratio

Level	X_1	X_2	X_3
1	-75.44	-74.32	-75.71
2	-75.73	-75.84	-75.72
3	-76.01	-77.02	-75.76
Delta	0.57	2.71	0.05
Rank	2	1	3

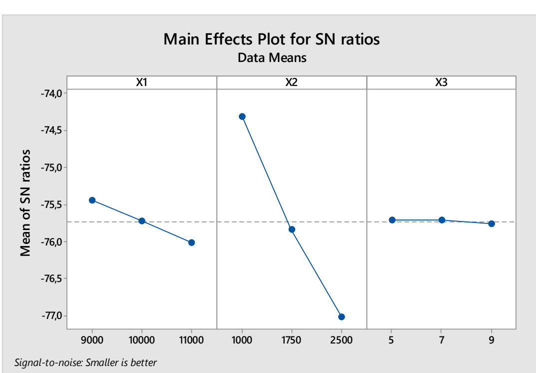

Figure 2. Cost Analysis Signal to Noise Ratio

Based on the results of data processing using software, the results are obtained in graphical form, the largest value is the best value. Based on the results of the graphic image from Figure 2, the best result obtained from the sand measurement was 11,000 gr, from the selected cement measurement results it was 2,500 gr, and from the selected mixing time results, it was 9 minutes.

1. Regression Equation

Roughness Regression Equation: (1)

$$Y_1 = 65{,}6 - 0{,}00102\ X_1 - 0{,}00186\ X_2 - 0{,}97\ X_3$$

Permeability Regression Equation: (2)

$$Y_2 = 21{,}06 - 0{,}001137\ X_1 - 0{,}001744\ X_2 - 0{,}9244\ X_3$$

Compressive Strenght Regression Equation: (3)

$$Y_3 = 0{,}8 - 0{,}00003\ X_1 - 0{,}00253\ X_2 - 1.142\ X_3$$

Production Cost Regression Equation: (4)

$$Y_4 = 1950 - 0{,}2000\ X_1 - 1{,}2667\ X_2 - 0{,}00\ X_3$$

From the equation in Figure 2, it shows the regression equation of the factors sand, cement and mixing time on the response, namely cost analysis. In this equation, it can be interpreted that the cost value will be greater if there is a lot of sand, a lot of cement and the length of mixing time has no effect.

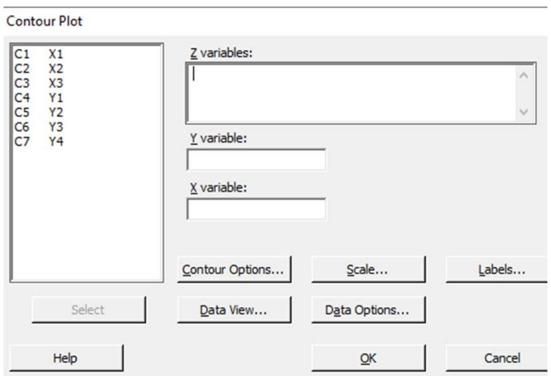

Figure 3. Contour Plot Display Interface

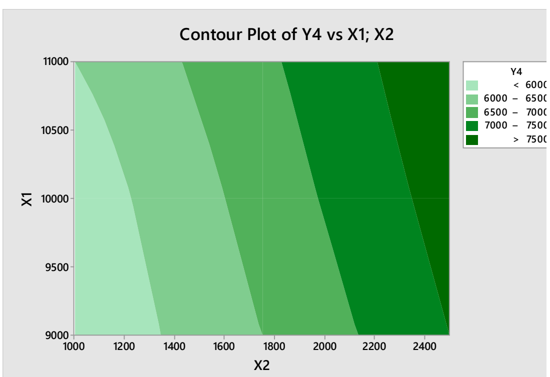

Figure 4. Contour Plot X_1 and X_2 Againts Y_4

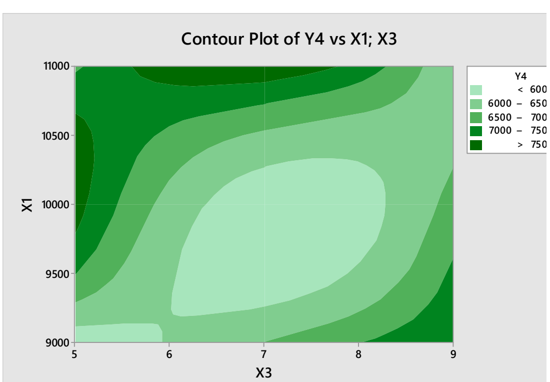

Figure 5. Contour Plot X_1 and X_3 Againts Y_4

2. Contour Plot

A contour plot is a graph that connects two independent variables and a dependent variable. The graph on the contour plot shows the value of the Z variable for the combination of variables X and Y. The X and Y values are displayed along the X and Y axes, while the contour lines and bands represent the Z value. Here Figure 3 show software display interface for contour plot input.

In this study, the contour plot shows the role of factors on the response. The factors themselves are indicated by the variable X, Meanwhile, the response is indicated by the variable Y. For this contour plot, there are a combination of 2 factors for the response, so there are 3 combinations of factors for the response. In the first combination, it is a combination of X_1 and X_2 with respect to Y. For X_1 it is sand and X_2 is cement, while Y itself is a response consisting of Y_1 roughness, Y_2 permeability, Y_3 Compressive Strenght, and Y_4 cost analysis. The following is a control plot of X_1 and X_2 against Y_4 shown in Figure 4.

Based on the image above, it can be concluded that the minimum response value, namely less than IDR 6,000, results from X_1 being 9,000 gr and X_2 being 1,000 gr. In the second combination, namely the combination of X_1 and X_3 against Y. Figure 5 below is a control plot of X_1 and X_3 against Y_4.

Based on the Figure 5, it can be concluded that the minimum response value is less than IDR 6,000. In the Figure 5, it is known that there are 2 minimum response values, the first is produced at X_1 at 9,000 gr and at X_3 at 5 minutes. The second response value was produced at X_1 at 10,000 gr and at X_3 at 7 minutes. In the second combination, namely the combination of X_2 and X_3 against Y. Figure 6 below is a control plot of X_2 and X_3 against Y_4.

Based on the Figure 6, it can be concluded that the minimum response value is less than IDR 6,000. In the Figure 6, it is known that there are 2 minimum response values, the first is produced at X_2 at 1,000 gr and at X_3 at 5 minutes. The second response value was produced at X_2 at 1,000 gr and at X_3 at 7 minutes.

3. Response Optimizer

This response optimizer aims to determine the multi-response of the four existing responses,

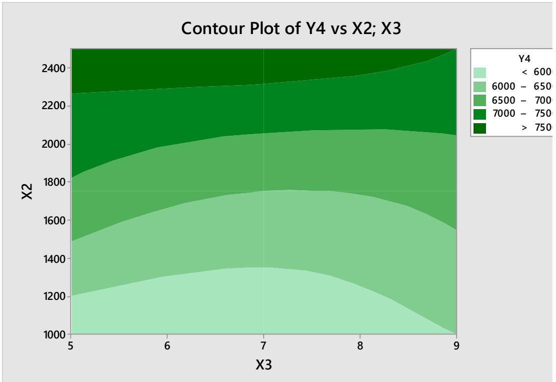

Figure 6. Contour Plot X_2 and X_3 Againts Y_4

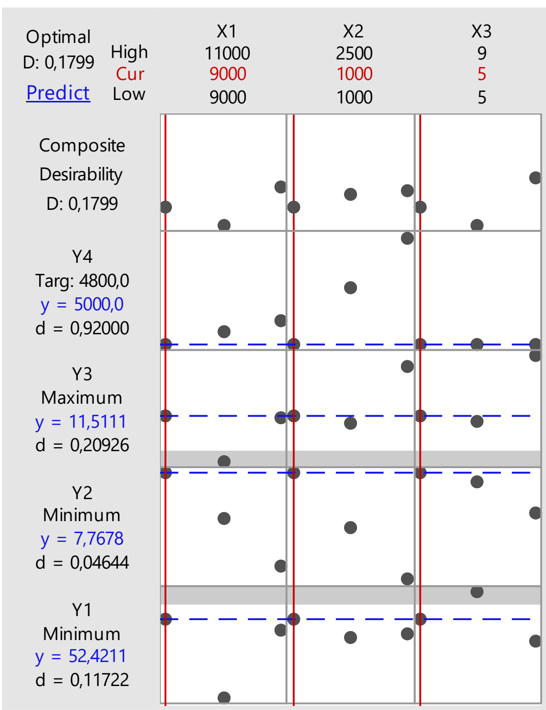

Figure 7. Response Optimizer

```
Multiple Response Prediction

Variable   Setting
X1         9000
X2         1000
X3         5


Response    Fit  SE Fit       95% CI            95% PI
Y4         5000       0  ( 5000;  5000)  ( 5000;  500
Y3        11,51    3,01  (-1,43; 24,45)  (-8,05; 31,0
Y2         7,77    1,31  ( 2,15; 13,39)  (-0,73; 16,2
Y1        52,42    3,72  (36,43; 68,41)  (28,24; 76,6
```

Figure 8. Multiple Response Prediction

namely roughness, permeability, Compressive Strenght and cost. From the results of this response optimizer, the main objective is to find out the optimal composition for 4 responses at once. Figure 7 show the results of the response optimizer anf Figure 8 show the results of multiple response prediction for the optimization of composition.

From Figure 8 it is known that the optimal composition for these three factors is X_1 of 9,000 gr, X_2 of 1,000 gr and X_3 of 5 minutes. The results of the optimal composition are in accordance with the composition of sample number 1. From this composition you will get a surface roughness of 52.42 µm, a water absorption capacity of 7.77%, a compressive strength of 11.51 Mpa and a selling price of IDR 5,000.

4. Current Cost Analysis

Collecting production costs by calculating the amount of production costs, where these costs will be charged to each unit of product produced. Karunia MSMEs produces bricks, paving, kansteen, roster, etc. In calculating the cost of production, the author groups production costs into three parts, namely raw material costs, direct labor costs and factory overhead costs. The cost of production is very influential in calculating the company's profit and loss. If the company is not careful or makes a mistake in determining the cost of production, it will result in errors in determining the profit and loss that the company will obtain. The following is a breakdown of costs for brick products at Karunia MSMEs.

Raw Material Costs

The following is the raw materials costs for brick production for one month at Karunia MSMEs. Table 5 shows raw material costs for concrete bricks.

Table 5. Raw Material Costs for Concrete Bricks at Karunia MSMEs

Raw Material Types	Prices
Sands	IDR 7,800,000
Cements	IDR 3,217,500
Total Raw Material Costs	IDR 11,017,500

Direct Labor Costs

The following is the calculation of direct labor costs per day at Karunia MSMEs. Table 6 shows direct labor costs for concrete bricks.

Table 6. Direct Labor Costs for Concrete Bricks at Karunia MSMEs

Workers	Number of Product Units	Wages (IDR)	Total Wages
Concrete Brick Labors	150	IDR 1,000	IDR 150,000
Total Direct Labor Costs			IDR 150,000

In a month, workers leave for 6 days, therefore the total direct labor costs for a month are calculated as follows.

Direct labor costs = 26 days x IDR 150,000 (5)
= IDR 3,900,000

In one month Karunia MSMEs incurs costs of IDR 3,900,000 for wages for brick workers.

Overhead Costs

The following are factory overhead costs for Karunia MSMEs in one month. Table 7 shows overhead costs for concrete bricks.

Table 7. Overhead Costs for Concrete Bricks at Karunia MSMEs

Item	Total Costs
Depreciation Expenses	IDR 1,000,000
Electricity	IDR 250,000
Water	IDR 100,000
Vehicle Fuel	IDR 400,000
Holiday Allowance	IDR 1,000,000
Total Overhead Costs	IDR 2,750,000

The results of the cost analysis related to concerete brick production costs are summarized in Table 8, which then becomes a reference for Karunia MSMEs in the process of determining product selling prices.

Table 8. Summary of Concerete Brick Production Costs at Karunia MSMEs

No.	Item	Total Costs
1.	Raw Material Costs	IDR 11,017,500
2.	Direct Labor Costs	IDR 3,900,000
3.	Overhead Costs	IDR 2,750,000
	Total Production Costs	IDR 17,667,500
	Total Concrete Brick Production	3,900 pcs

In determining the selling price Karunia MSMEs uses Cost Plus Pricing method, where by calculating the total cost per unit plus a certain amount to cover the desired profit.

Total Selling Price
= Production Costs + (% mark up × Production Costs) (6)
= IDR 17,667,500 + (5% × Rp 17,667,500)
= IDR 18,550,875

Selling Prices per Product
= Total Selling Prices / Total Production (7)
= IDR 18,550,875 / 3,900
= IDR 4,756

So, the selling price is rounded to IDR 5,000

5. Optimal Cost Analysis

This optimal composition has a composition with 9,000 gr of sands and 1,000 gr of cements. The following are the details in one month (26 days) with daily production of 150 concrete bricks.

Raw Material Costs

The following is the optimal raw materials costs for brick production for one month at Karunia MSMEs. Table 9 shows raw material costs for concrete bricks.

Table 9. Optimal Raw Material Costs

Raw Material Types	Prices
Sands	IDR 7,020,000
Cements	IDR 4,826,250
Total Raw Material Costs	IDR 11,846,250

Direct Labor Costs

The following is the calculation of optimal direct labor costs per day at Karunia MSMEs. Table 10 shows direct labor costs for concrete bricks.

Table 10. Optimal Direct Labor Costs

Workers	Number of Product Units	Wages (IDR)	Total Wages (IDR)
Concrete Brick Labors	150	IDR 1,000	IDR 150,000
Total Direct Labor Costs			IDR 150,000

In a month, workers leave for 6 days, therefore the total direct labor costs for a month are calculated as follows:

Direct Labor Costs = 26 days x IDR 150,000 (8)
= IDR 3,900,000

So, in one month Karunia MSMEs incurs costs of IDR 3,900,000 for wages for concrete brick workers.

Overhead Costs

The following are factory optimal overhead costs for Karunia MSMEs in one month. Table 11 shows overhead costs for concrete bricks.

Table 11. Optimal Overhead Costs

Item	Total Costs
Depreciation Expenses	IDR 1,000,000
Electricity	IDR 250,000
Water	IDR 100,000
Vehicle Fuel	IDR 400,000
Holiday Allowance	IDR 1,000,000
Total Overhead Costs	IDR 2,750,000

The results of the cost analysis related to concerete brick optimal production costs are summarized in Table 12, which then becomes a new reference for Karunia MSMEs in determining the best selling price for products by considering quality aspects (SNI standard for concrete bricks).

Table 12. Summary of Optimal Concerete Brick Production Costs

No.	Item	Total Costs
1.	Raw Material Costs	IDR 11,846,250
2.	Direct Labor Costs	IDR 3,900,000
3.	Overhead Costs	IDR 2,750,000
	Total Production Costs	IDR 18,496,250
	Total Concrete Brick Production	3,900

Regarding the determination of the optimal selling price for Karunia MSMEs concrete brick production from the results of implementing the optimization method in this research, the best economic selling price for the concrete brick product is produced as follows:

Total Selling Price
= Production Costs + (% mark up × Production Costs) (9)
= IDR 18,496,250+ (5% × IDR 18,496,250)
= IDR 19,421,062.5

Selling Prices per Product
=Total Selling Prices / Total Production (10)
= IDR 19,421,062.5 / 3,900
= IDR 4,979

So, the optimal economic selling price is rounded to IDR 5,000

6. Optimal Results Summary of Multiple Paramater

Table 13 shows a summary of the conditions before and after optimization efforts regarding the quality and production costs of Karunia MSMEs concrete bricks, which shows the results of the final condition with the same selling price which is able to provide much better quality values and is in accordance with SNI standards regarding concrete bricks.

Table 13. Optimal Results Summary

Parameter	Before	After
Roughness	48.72 μm	52.42μm
Permeability	8.75%	7.77%
Compressive Strenght	-	11.51 Mpa or 117.37 kg/cm^2
Production Costs	IDR 5,000	IDR 5,000

IV. CONCLUSION

The results of the research that has been carried out show that there has been a significant change in results due to efforts to optimize the concrete brick production process at Karunia MSMEs, where in Table 13 shows significant changes in all response parameters used in this research. Using the same production cost reference, namely IDR 5,000, product quality can be produced that meets SNI standards regarding compressive strength of 117.37 kg/cm2, where this result is above the specified standards. Meanwhile, the quality of water absorption is also able to meet standards and aesthetic aspects, namely roughness can produce smoother brick products. Further research can carry out a sensitivity analysis to reduce production costs by less than IDR 5,000 while maintaining SNI standard quality, so that Karunia MSMEs can obtain recommendations for more efficient production cost proposals for determining more economical selling prices. The results of this research can also be generalized and applied to other brick SMEs in Indonesia using the same types of materials.

REFERENCES

Ardiansyah, D., Amran, Y., & Dewi, S. U. (2021). Optimasi Sifat Fisik dan Mekanis Batako Menggunakan Sekam Padi. Jurnal TAPAK, 11(1), 67–73. http://u.lipi.go.id/1320332466

Fadhila, A. N., & Winarno, S. (2022). Investigasi Sifat-Sifat Fisik, Redaman Panas dan Biaya Produksi pada Batako dengan Bonggol Jagung sebagai Agregat. Jurnal AGREGAT, 7(2), 702–708.

Fania Putri, R., Soebijono, T., Erstiawan, M. S., & Arifin, M. (2022). Relevansi Metode Cost Plus Pricing untuk Menentukan Harga Pokok Produksi pada Konveksi. Jurnal JAE (Jurnal Akutansi Dan Ekonomi), 7(3), 30–41. https://doi.org/10.29407/jae.v7i3.18683

Hendriyani, I., & Prakoso, D. (2018). Analisis Kualitas Batako Produksi Industri Kecil Kota Balikpapan. SNITT- Politeknik Negeri Balikpapan, 234–239.

Hidayat, D. F., Hardono, J., & Ardiansyah, I. (2022). Penerapan Pengendalian Persedian Produksi Batako Menggunakan Metode Economic Order Quantity (EOQ) di CV. Indah Kiat. Jurnal JT, 11(2), 40–52. http://jurnal.umt.ac.id/index.php/jt/index

Mahmuddin, Rizalihadi, M., Bermansyah, S., & Affifuddin, M. (2023). Peningkatan Produksi Batako Secara Home Industry dengan Menggunakan Conblock Moveable Press Machine (CMPM) di Aceh Besar. Jurnal RESONANSI, 1(1), 16–23.

Matulessy, J., Richard Kermite, R., & Lesnussa, M. (2022). Peningkatan Kapasitas Produksi Batako Press dengan Menggunakan Motor Stepper Sebagai Vibrator pada UD. Chierda Kota Ambon. Jurnal Pengabdian Masyarakat IRON, 5(1), 437–443.

Merjani, A. (2020). Analisa Tingkat Kecacatan untuk Mengurangi Defect di Produksi Batako dengan Metode Seven Tools dan PDCA. Jurnal Profisiensi, 8(2), 188–196.

Mustakim, Handayani, D. I., & Suhandini, Y. (2021). Pemanfaatan Limbah Plastik Sebagai Bahan Campuran Batako dalam Implementasi Green Manufacturing. Jurnal Flywheel, 12(2), 43–55.

Riningsih, D., Rukmini, M., Yunanto, F., Gabriella Denakrisnada, S., & Wahyu Prihardini, O. (2022). Pelatihan Dan Pendampingan Penentuan Harga Pokok Produksi Usaha Batako “Bangun Berkah” Dengan Metode Full Costing Di Desa Duwet Kecamatan Wates Kabupaten Kediri. Jurnal Pengabdian Untuk Mu NegeRI, 6(1), 117–123. https://doi.org/10.37859/jpumri.v6i1.3531

Susiyana, Adrianto, F., Saputra, E., & Sofyan, A. S. (2021). Fenomena Persaingan Harga Perspektif Etika Bisnis Islam: Sektor Industri Usaha Batako di Kabupaten Buton Tengah. Jurnal AT TAWAZUN, 1(2), 51–68. http://journal.uin-alauddin.ac.id/index.php/attawazun/index

Sutoni, A. (2018). Uji Kuat Tekan dan Daya Serap pada Batako dengan Menggunakan Metode Taguchi. Jurnal Sistem Dan Manajemen Industri, 2(2), 93. https://doi.org/10.30656/jsmi.v2i2.711

Tamalika, T., Mz, H., Asnawi, B., Aprilyanti, S., & Suryani, F. (2022). Pemanfaatan Botol Plastik Sebagai Bahan Campuran Batako Menggunakan Desain Eksperimen Taguchi. JIME (Journal of Industrial and Manufacture Engineering), 6(1), 75–83. https://doi.org/10.31289/jime.v6i1.7088

Taogan, G. S., Ilat, V., & Pusung, R. J. (2022). Analisis Differential Cost dan Opportunity Cost dalam Pengambilan Keputusan Menerima atau Menolak Pesanan Khusus pada UD Mandiri. Jurnal LPPM Bidang EkoSosBudKum, 5(2), 1300–1305.

Ulfah, U., Widya, L. K., & Stiyanta, N. C. (2022). Perbandingan Studi Uji Kuat Tekan Batako Manual dengan Bahan Tambahan Limbah Kerak Pengolahan Minyak Tanah. Rang Teknik Journal, 5(2), 312–320. https://doi.org/10.31869/rtj.v5i2.3314

Umar, A., Uslianti, S., & Prawatya, Y. E. (2023). Desain Ekperimen Batako Mengunakan Metode Taguchi pada Usaha Batako Karya Sepakat. Jurnal INTEGRATE (Industrial Engineering and Management System), 7(2), 154–159. https://jurnal.untan.ac.id/index.php/jtinUNTAN/issue/view/2162

Widyananto, E., Alami, N., & Suladi, H. (2021). Analisis Kuat Tekan Batako Dengan Agregat Halus Abu Batu dan Limbah Styrofoam. Jurnal Surya Beton, 5(2), 53–60. http://jurnal.umpwr.ac.id/index.php/suryabeton

Willis, D., Priyasmanu, T., Panji, W., Hari, D., Setyawan, E. Y., Teknologi, I., & Malang, N. (2020). Pengembangan Usaha Masyarakat dalam Pembuatan Batako dengan Sistem Vibration Tunggal di Kec. Pare Kab. Kediri. Jurnal JASTEN (Aplikasi Sains Teknologi Nasional), 1(1), 19–23.

Yuliana, S., Asdi, Y., & Yanuar, F. (2017). Penerapan Metode Taguchi untuk Analisis Kekuatan Tekan Batako. Jurnal Matematika UNAND, 6(3), 76–83.

Yuliana, S., Yanuar, F., & Devianto, D. (2022). Analisis Daya Tekan dan Daya Serap Pada Batako Menggunakan Pendekatan Grey Relational Analysis dan Principal Component Analysis. Jurnal Elementer, 8(2), 81–90.