DEVOTION
Journal of Research and Community Service
Volume 4, Number 2, February 2023
e-ISSN: 2797-6068 and p-ISSN: 2777-0915

ANALYST IS VALUE ENGINEERING ON THE CONSTRUCTION OF FLATS FOR EDUCATORS UGM SLEMAN

Kharisma Indah Purwanty, Wateno Oetomo, Laksono Djoko Nugroho
Universitas 17 Agustus 1945 Surabaya, Indonesia
Email: kharisma.ip83@gmail.com, wateno@untag-sby.ac.id, laksonodjoko@untag-sby.ac.id

KEYWORDS
value engineering, flats, educators

ABSTRACT

The construction of UGM Educator Flats in Sleman Regency has a total area of 7,035.5 m2 consisting of 6 floors in the form of rooms and management rooms for flats and 1 rooftop floor. The problem in implementing the construction of the UGM Educator Flats in Sleman Regency is that the available funds are limited, so value engineering needs to be carried out so that the construction can be completed as expected. Value Engineering aims to obtain the best value for a project or process by defining the functions required to achieve the value objectives and providing these functions at the lowest cost, consistent with the required quality and performance. The results of the study were (1) The work items for the UGM Sleman Educator House building that have the potential to be efficient are floor slab work t=12 cm, roof slab work t=15 cm, stair slab work t=15 cm and beam work. (2) The replacement design alternatives are: a. For beam work items, an alternative is to change formwork purchases to formwork leases, b. For floor slab work items, roof slab work items, stair slab work items, there are 2 alternatives chosen, namely replacing reinforcement with M10 wiremesh and changing formwork purchases to formwork rentals. (3) Cost savings achieved after Value Engineering was carried out by 11.47%, with details of work items as follows: a. Beam work, savings of 3.66%, b. Floor slab work t = 12 cm, savings of 5.55%, c. Roof slab work, t=15 cm, savings of 1.00 %, d. Ladder slab work, t=15 cm, savings of 1.26%. Compared to the Initial Design Budget Plan (RAB) of the project as a whole, the Alternative Design Budget Plan can save costs of 2.843%.

INTRODUCTION

Value Engineering is a creative and planned approach with the aim of identifying and streamlining unnecessary costs. Value Engineering is used to find an alternative that aims to produce costs that are better or lower than the pre-planned price with functional and quality constraints of work.

The construction of the UGM Educator Flats in Sleman Regency has a total area of 7,035.5 m^2 consisting of 6 floors in the form of room rooms and management rooms for flats and 1 rooftop floor. The construction of this flat includes foundation work, 1st to 6th floor structures, roof floor structures, light steel frames, stucco walls, ceilings, roof tops, frame work, window doors and their accessories, standard Mechanical and Electrical work, non-standard Mechanical and Electrical Work.

This research aims to make the use of resources more efficient so as to produce a final cost that is not too high but does not reduce the function of the Flats research entitled *Value Engineering* Analysis on the Construction of UGM Sleman Educator Flats. The construction of the UGM Educator Flats consists of 6 floors located in Sleman Regency

which is the area of Gajah Mada University, where the function of the building itself is as a residence or residence for UGM educators.

Based on the background that has been described, the problem can be formulated as follows:

1. What are the components of standard architectural work and standard structures of the UGM Sleman Educator Flats building that have the potential to be efficient using the *Value Engineering* method?
2. What are the alternatives to the initial design work components in *Value Engineering* analysis?
3. How much cost *saving* is obtained from the application of *Value Engineering*?

Based on the formulation of the problem above, the research guidelines are as follows:

1. To analyze the building components of the UGM Sleman Educators' House which have the potential to be efficient using the Value *Engineering* method.
2. To analyze alternative components of initial design work in Value *Engineering* analysis.
3. To analyze the cost *savings* achieved before and after Value *Engineering.*

This research is expected to provide benefits, especially for

1. For Academia
   Theoretically, academics can be used as a reference regarding
   Value Engineering of Components of Flats
2. For Practitioners
   Can be used as information about value engineering for the components of flat buildings that can be applied directly to future projects
3. For construction service providers
   Provide information or recommendations on alternatives that can streamline the cost of work on the project.
4. For the Government
   Provide an alternative or ideas that can streamline the budget expenditure of flats.

RESEARCH METHOD

In the information will identify and determine the activities to be engineered the value of diman will first be grouped types of work based on their respective components of work and later a percentage value of the cost of each component of the work will be obtained. The steps at this information stage are to determine the *cost model*, *breakdown*, after that make a pareto chart chart and perform function analysis. The work item to be analyzed by value engineering is the structure work item.

1) *Breakdown*

   The analysis is carried out by identifying the work to be done by value engineering in the details of the cost of work on the construction of the UGM Sleman Educator Flats. To see the potential of a work item to be performed by Value Engineering, the cost of that work item is compared to the total cost of the entire project.

Table *1 Cost Breakdown*
Source: (Dell'Isola, 1974)

Item Pekerjaan	Biaya
Pekerjaan A	Rp.....
Pekerjaan B	Rp.....
Pekerjaan C	Rp.....
Pekerjaan D	Rp.....
Pekerjaan E	Rp.....
Pekerjaan F	Rp.....
Total	Rp. M
Biaya Total Keseluruhan	Rp. N
Presentase	= Rp. M / Rp. N = ...%

2) *CostModel*

Costmodel is done by creating a job chart grouped according to the elements of each job. The chart also includes a budget plan for the cost of each work item. *This cost model* is created to determine which jobs will be done value *engineering* by looking at the flow of the job chart. We can see the difference in the cost of each element of work that we use as a guide in value engineering analysis.

3) *Pareto* Chart Analysis

Pareto analysis is carried out to determine the highest costs on projects that have the potential to be carried out *value engineering* analysis. Pareto's Law applies: that is, 80 % of the total cost is contained by 20 % of its components.

Vilfredo Pareto (1848-1923) in (Gomes, 2016) in Pareto's distribution law states that 20% of the share of an item has a weight of 80% of the cost.

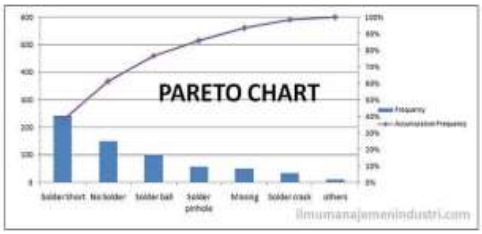


Figure 1 Pareto Distribution Law Graph
Source: Koh, 2017

To find out the building components of the UGM Sleman Educators' House that have the potential to be saved, a cost analysis is carried out by applying pareto analysis. The analysis is applied to the work of the superstructure in particular to the work of the roof, floor slab and working walls. The calculation steps are as follows:

1. Sort the total component costs from largest to smallest
2. Cumulatively sum up the total component costs
3. Calculate the percentage of the components of the work and add up cumulatively.

$$\%\,\text{Komponen Pekerjaan} = \frac{\text{Komponen Pekerjaan}}{\text{Jumlah Komponen Pekerjaan}} x100\%$$

4. Calculate the percentage of total component costs

$$\%\,\text{Biaya Komponen Total} = \frac{\text{Biaya Komponen Total}}{\text{Biaya Total Pekerjaan}} \text{x}\,100\%$$

5. Sum up the percentage of total component costs cumulatively.
6. Cumulative plot of percentage of job components (X-axis) with Cumulative percentage of total component costs (Y-axis)

A. Function Analysis Stage

Function analysis analyzes the main function and supporting function of each work item so that it can find out the comparison between the cost and the function produced to produce the function. In this study, work items with the highest cost / worth value will be taken. The higher the cost / worth value, the higher the possibility of savings that can be made.

Table 2 Form Analysis Function
Sumber: (Zimmerman & Hart, 1982)

Analisa Fungsi							
No	Deskripsi	Fungsi		Jenis	*Cost*	*Worth*	Keterangan
		Kata Kerja	Kata Benda				
Tindakan Kata Kerja		Jenis : B = Primer		(Fungsi Dasar)			
Kata Benda Terukur		S = Sekunder		*Cost/worth ratio* =.....			

B. Creative Stage

The creative stage is a stage where creative thinking is to come up with alternatives that will be used in conducting *value engineering* analysis on the construction components, namely structural and architectural components.

C. Analysis Stage

In this stage, an analysis of ideas or alternative inputs is held. Bad ideas are eliminated. Alternatives or ideas that arise are formulated and considered their advantages and disadvantages which are viewed from various angles.

RESULT AND DISCUSSION

Value Engineering

The work plan (Job Plan) in *value engineering* for this research is divided into several work items, namely:

A. Information Stage

The data that was successfully collected was data from the work of the Construction of UGM Sleman Educators ' Flats with job owners from the Java III Housing Provision Implementation Center-Satker for Housing Provision in D.I. Yogyakarta Province. which is done by PT. Abadi Prima Inti Karya. The construction of the UGM Sleman Educator Flats has a building area of 7,035.5 m ^{2} and consists of 6 floors with a borepiled foundation depth of 12 m and uses a conventional structure.

The data that has been obtained are:

1. Planing Budget Costs
2. Standard Unit Price of District District. Sleman
3. Plan Drawings

The steps at this information stage are to determine the *cost model*, *breakdown*, after that create a pareto chart and perform function analysis. The work item to be analyzed by *value engineering* is the structure work item.

a. Cost Model - Breakdown

Cost model-Breakdown is created by classifying similar work items and then sorting them from highest cost to lowest cost. Such as immersing plate concrete work, slab fixing and slab formwork into the plate work. This is important to do to facilitate research

Table 3 *Cost Model* Table

No.	Work Items	Fee (Rp)	Percentage
A	B	C	D
1.	Preparatory Work	163.691.240	0,30
2.	RK3K Construction Work	29.790.000	0,05
3.	Standard Structure Work	13.640.206.569,90	24,78
4.	Standard Architecture Work	16.234.254.308,30	29,49
5.	ME Standart Jobs	5.237.623.170,03	9,51
6.	Non-Standard Structural Work	7.094.320.025,33	12,89
7.	Non Standart Architectural Work	2.646.313.696,18	4,81
8.	Non Standart Landscape Architecture Work	1.591.852.864,18	2,89
9.	Non Standard ME Jobs	8.412.483.840,91	15,28
Total		**55.050.537.715**	**100**

Source : Analysis Results

Table 3 shows the results of the cost consumption in each component of the work. From the results of the identification, it can be seen that the components of standard architectural work have the highest percentage of costs of Rp. 16,234,254,308.30 or equal to 29.49% of the total total value, then continued with standard structural work of Rp. 13,640,206,569.90 or equal to 24.78%, of the total total value. So that at this stage it can be identified which components of the works are selected for value engineering.

Furthermore, the work items contained in the standard structure work component, are selected to *be broken down* or sorted from the one with the highest percentage of cost to the percentage of the lowest costh.

Table 4 *Breakdown of* Standard Structure Jobs

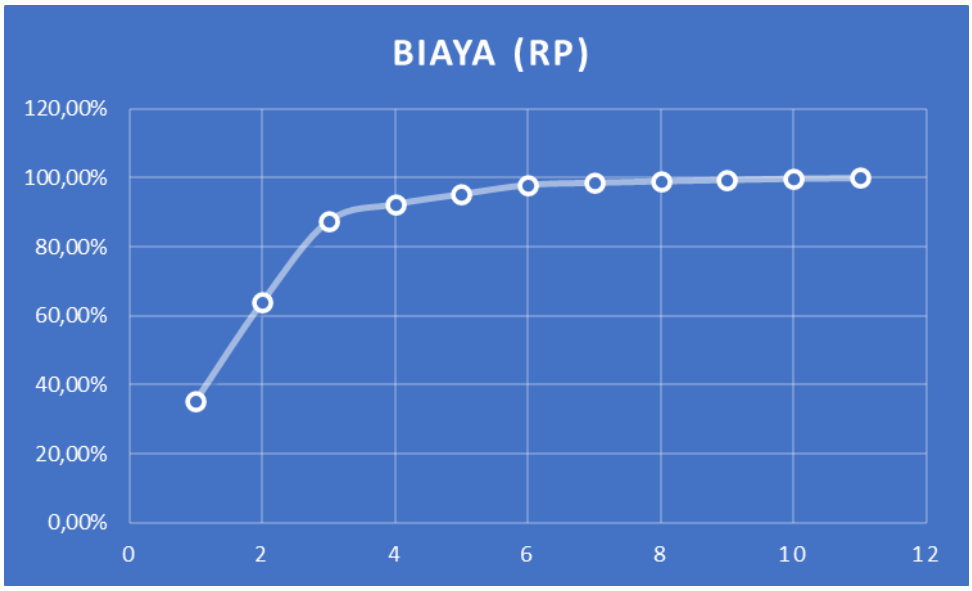
No.	Work Items	Fee (Rp)	Percentage	Cumulative percentage
Floor-wide work				
A	**B**	**C**	**D**	**And**
1	Beam	4.830.771.851,77	35,42%	35,42%
2	Column	3.896.612.064,30	28,57%	63,98%
3	Floor slab, t=12 cm	3.211.994.641,73	23,55%	87,53%
4	Roof plate, t=15 cm	660.109.762,46	4,84%	92,37%
5	Ladder plate, t=15 cm	398.489.545,38	2,92%	95,29%
6	Ground floor slab, t=10 cm	368.999.883,59	2,71%	98,00%
7	Rafter beam work	84.388.468,36	0,62%	98,62%
8	Stair roof plate, t=12 cm	62.910.394,75	0,46%	99,08%
9	Steel column work SC 1	50.032.794,23	0,37%	99,44%
10	Staircase bordes beams	48.862.471,15	0,36%	99,80%
11	Gording work	27.034.692,17	0,20%	100,00%

Total		**13.640.206.569,90**	**100,00%**	

Source: Analysis Results

b. Diagram Pareto

Based on the *breakdown*, an analysis was carried out to determine the limits of high-cost work items using the legal basis of pareto distribution to determine 80% of the total cost derived from 20% of high-cost work items. Pareto distribution graphs are created by determining the cumulative amount of costs and the amount of work in percentage form which is then plotted in a graph consisting of an x-axis for the cumulative percentage of work and a y-axis for a cumulative percentage of costs.



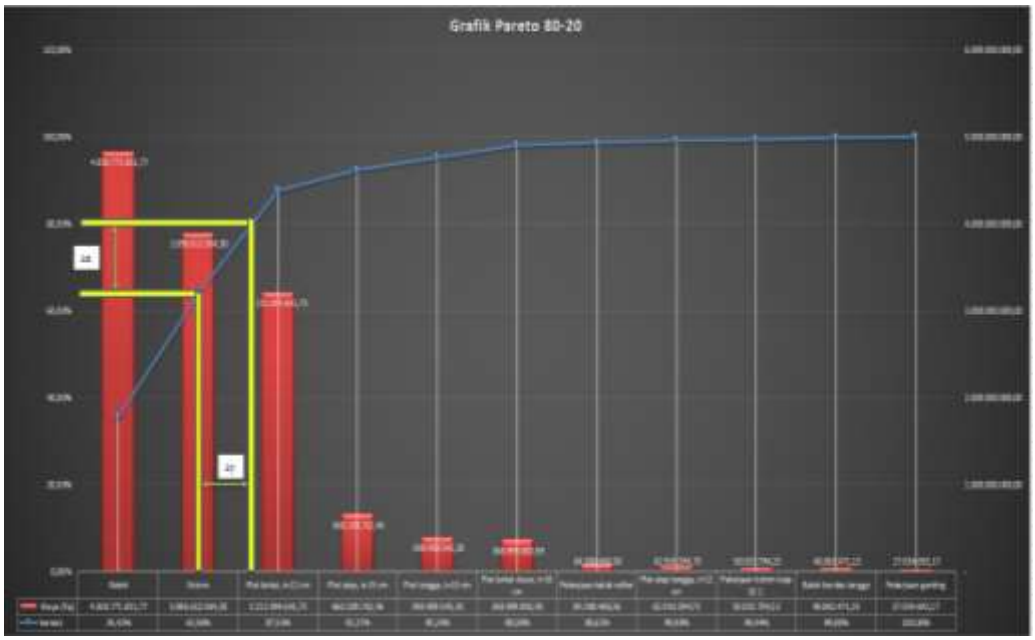


Figure 3 Pareto Analysis Chart Structural Work

Source : Research Results

Based on the calculation results of pareto analysis, 6 work items were obtained that had a high cost value. These work items include:

1. beam work with a percentage of costs of 35.42%,
2. column work with a percentage of costs of 28.57%,
3. floor slab work (t=12 cm) with a percentage of 23.55%,
4. roofing plate work (t=15 cm) with a percentage of 4.84%,
5. ladder plate work (t=15) with a percentage of 2.92%,
6. ground floor slab work (t=10 cm) with a percentage of 2.71%

From the results of the description above, the author is quite concentrated on the 6 jobs with the highest percentage. From the results of collecting information data, then analyzing the functions of each work item included in the pareto calculation results

c. Function Analysis

Function analysis analyzes the main function and supporting function of each work item so that it can find out the comparison between the cost and the function produced to produce the function. In this study, work items with the highest cost / worth value will be taken. The higher the cost / worth value, the higher the possibility of savings that can be made.

Table 5 Analysis of Column Work Functions

Column Work **Function:** **1. Load bearing** **2. Thorough successor of the load to the base of the building**				
No	Description	Function	Cost (Rp)	Worth (Rp)
1	Concrete f'c 30 mpa	Load bearing	675.835.582,26	675.835.582,26
2	Fixing	Load Bearing	2.995.472.284,91	2.995.472.284,91
3	Formwork	Molding Concrete	225.304.197,13	-
Total			**3.896.612.064,30**	**3,671.307.867,17**
C/W			**1,061**	

Source: Analysis Results

Table 6 Analysis of Beam Work Functions

Beam Work **Function:** **1. Load bearing** **2. Funneling the load to a column**				
No	Description	Function	Cost (Rp)	Worth (Rp)
1	Concrete f'c 30 mpa	Load bearing	893.106.251,47	893.106.251,47
2	Fixing	Load Bearing	2.657.126.638,71	2.657.126.638,71
3	Formwork	Molding Concrete	1.280.538.961,59	-
Total			**4.830.771.851,77**	**3.550.232.890,18**
C/W			**1,361**	

Source: Analysis Results

Table 7 Analysis of Floor Slab Work Function t=12 cm

Floor Slab Work t=12 cm
Function:
1. **Load bearing**
2. **As a barrier to the lower and upper floors**
3. **As a place to stand on the upper floors**
4. **As a construction stiffener in the horizontal plane**

No	Description	Function	Cost (Rp)	Worth (Rp)
1	Concrete f'c 30 mpa	Load bearing	640.786.162,96	640.786.162,96
2	Fixing	Load Bearing	1.167.938.502,11	1.167.938.502,11
3	Formwork	Molding Concrete	1.403.269.976,66	-
Total			**3.211.994.641,73**	**1.808.724.665,07**
C/W			**1,776**	

Source: Analysis Results

Table 8 Analysis of Roof Plate Work Function t=15 cm

Roof Plate Work t=15 cm
Function:
As a construction stiffener in the horizontal plane

No	Description	Function	Cost (Rp)	Worth (Rp)
1	Concrete f'c 30 mpa	Load bearing	155.755.751,75	155.755.751,75
2	Fixing	Load Bearing	231.479.990,94	231.479.990,94
3	Formwork	Molding Concrete	272.874.019,77	-
Total			**660.109.762,46**	**387.235.742,69**
C/W			**1,705**	

Source: Analysis Results

Table 9 Analysis of Ladder Plate Work Function t=15 cm

Stair Plate Work t=15 cm
Function:
1. **As a construction stiffener in the horizontal plane**
2. **Footing tools when climbing stairs**

No	Description	Function	Cost (Rp)	Worth (Rp)
1	Concrete f'c 30 Mpa	Load bearing	101,303,365,93	101,303,365,93
2	Fixing	Load Bearing	188.151.639,45	188.151.639,45
3	Formwork	Molding Concrete	109.034.540,00	-
Total			**398.489.545,38**	**289.455.005,38**
C/W			**1,377**	

Source: Analysis Results

Table 10 Analysis of Ground Floor Slab Work Function t=10 cm

Ground Floor Slab Work t=10 cm **Function:** **1. Load bearing** **2. As a barrier to the lower and upper floors** **3. As a place to stand on the upper floors**				
No	Description	Function	Cost (Rp)	Worth (Rp)
1	Urugan sirtu floor elevation t = 35 cm (ex-excavation)	Stabilizes the original ground surface and spreads the load	85.390.978,94	85.390.978,94
2	Soil compaction CBR > 6%	1. Improves soil shear strength 2. Reduced soil compressibility 3. Reduced soil permeability 4. Reducing volume changes as a result of changes in moisture content	46.560.369,74	46.560.369,74
3	Urug sand on urug soil t=10 cm (in buildings)	Stabilizes the original ground surface and spreads the load	25.791.472,41	25.791.472,41
4	Cast concrete working floor t=5 cm (in buildings)	Load Bearing	40.301.288,63	40.301.288,63
5	Concrete f'c 30 MPa	Load Bearing	137.008.184,44	137.008.184,44
6	Iron *Wiremesh* M-8	Load Bearing	33.947.589,42	33.947.589,42
Total			**368.999.883,59**	**368.999.883,59**
C/W			**1**	

After function analysis, the work items with the highest *cost / worth* values are floor plate work items t=12 cm, roof plate work t=15 cm, ladder plate work t=15 cm and beam work. It is these four work items that proceed to the next stage to find alternatives to their replacements and the amount of savings that can be obtained.

B. Creative Stage

At this creative stage, it comes up with alternative ideas for high-cost work items that will then be selected to determine the best alternative replacement at the analysis stage. Some alternative designs that the author gets:

Table 11 Job Replacement Alternatives

No	Work Items	Alternative 1	Alternative 2

1	Beam Work	Replacing conventional formwork with formwork rental	Replacing conventional formwork with formwork rental
2	Floor Slab Work t=12 cm	Replacing conventional formwork with formwork rental	• Replacing conventional formwork with formwork rental • Replacing reinforcing iron with *wiremesh*
3	Roof Plate Work t=15 cm	Replacing conventional formwork with formwork rental	• Replacing conventional formwork with formwork rental • Replacing reinforcing iron with *wiremesh*
4	Stair Plate Work t=15 cm	Replacing conventional formwork with formwork rental	• Replacing conventional formwork with formwork rental • Replacing reinforcing iron with *wiremesh*

Source: Data processing results

C. Analysis Stage

In the calculation of unit price analysis, the coefficient value figure used refers to the annex to the Pupr Regulation No. 1 / PRT / M / 2022 and for the unit price, the rental price of the formwork follows the unit price of the Sleman Regency area.

a. Alternative Design Analysis 1

Table 12 Comparison of Initial Design Budget Plans (RAB) And Alternative Design 1

No.	Work Items	Initial Design	Alternative Design 1	Percentage Against The Value Of Standard Structure Work
A	**B**	**C**	**D**	**And**
1	**Beam**	**4.830.771.851,77**	**4.331.021.633,86**	**3.66 %**
2	Column	3.896.612.064,30	3.896.612.064,30	0,00 %
3	**Floor slab, t=12 cm**	**3.211.994.641,73**	**2.515.939.728,57**	**5,10 %**
4	**Roof plate, t=15 cm**	**660.109.762,46**	**524.757.830,22**	**0,99 %**
5	**Ladder plate, t=15 cm**	**398.489.545,38**	**356.545.015,125**	**0,31 %**
6	Ground floor slab, t=10 cm	368.999.883,59	368.999.883,59	0,00 %
7	Rafter beam work	84.388.468,36	84.388.468,36	0,00 %
8	Stair roof plate, t=12 cm	62.910.394,75	62.910.394,75	0,00 %
9	Steel column work SC 1	50.032.794,23	50.032.794,23	0,00 %

10	Staircase bordes beams	48.862.471,15	48.862.471,15	0,00 %
11	Gording work	27.034.692,17	27.034.692,17	0,00 %
Total		**13.640.206.569,90**	**12.267.104.976,325**	**10,07 %**

b. Alternative Design Analysis 2

Table 13 Comparison of Initial Design Budget Plans (RAB) And Alternative Design 2

No.	**Work Items**	**Initial Design**	**Alternative Design 2**	**Percentage Against The Value Of Standard Structure Work**
A	**B**	**C**	**And**	
1	Beam	**4.830.771.851,77**	**4.331.021.633,86**	**3,66 %**
2	Column	3.896.612.064,30	3.896.612.064,30	0,00 %
3	Floor slab, t=12 cm	**3.211.994.641,73**	**2.455.440.426,46**	**5,55 %**
4	Roof plate, t=15 cm	**660.109.762,46**	**523.362.239,75**	**1,00 %**
5	Ladder plate, t=15 cm	**398.489.545,38**	**226.546.392,78**	**1,26 %**
6	Ground floor slab, t=10 cm	368.999.883,59	368.999.883,59	0,00 %
7	Rafter beam work	84.388.468,36	84.388.468,36	0,00 %
8	Stair roof plate, t=12 cm	62.910.394,75	62.910.394,75	0,00 %
9	Steel column work SC 1	50.032.794,23	50.032.794,23	0,00 %
10	Staircase bordes beams	48.862.471,15	48.862.471,15	0,00 %
11	Gording work	27.034.692,17	27.034.692,17	0,00 %
Total		**13.640.206.569,90**	**12.075.211.461,40**	**11,47 %**

From the results of the RAB comparison in table 4.17 and table 4.18, a percentage value of standard structure work was obtained, namely in alternative design 1 of 10.07% and in alternative design 2 of 11.47%.

D. Recommendations

Of the 2 alternative designs that have been analyzed, the author recommends alternative designs 2, namely:

a. The purchase of conventional formwork was replaced by a good formwork rental for beams, a 12 cm floor slab, a 15 cm roof floor plate and a 15 cm ladder plate
b. Replacement of reinforcing iron to wiremesh on beams, 12 cm floor slabs, 15 cm roof floor slabs and 15 cm stair plates

Table 14 Cost Budget Plan (RAB) Alternative Design 2

NO	TYPES OF WORK	TOTAL PRICE (Rp)
I	**PREPARATORY WORK AND CONSTRUCTION RK3K WORK**	**193.481.240,00**
	Preparatory Work	163.691.240,00
	Construction R3K Work	29.790.000,00
II	**STRUCTURE, ARCHITECTURE AND ME WORK**	**53.292.059.366,48**
II.a	**STANDARD WORK**	**33.547.088.939,73**
	Standard Structure Work	12.075.211.461,40
	Standard Architecture Work	16.234.254.308,30
	Standard Mechanical and Electrical Work	5.237.623.170,03
II.b	**NON STANDARD WORK**	**19.744.970.426,75**
	Non-Standard Structural Work	7.094.320.025,33
	Non Standart Architectural Work	2.646.313.696,33
	Non-Standard Landscape Architecture Work	1.591.852.864,18
	Mechanical and Electrical Work	8.412.483.840,91
	Total I+II	**53.485.540.606,48**
	Rounded corners right	**53.485.540.000,00**
	PPN 11 %	**5.883.409.400,00**
	Total	**59.368.949.400,00**
	Rounded corners right	**59.368.949.000,00**

Table 15 Percentage of Initial Design Values Against Alternative Design 1 and Alternative 2

NO	RAB Design	Job Value (Rp)	Difference (Rp)	Percentage (%)
1	Rab Initial Design	61.106.093.850,00	-	-
2	Alternative Design RAB 1	59.581.951.000,00	1.524.142.850,00	2,494 %
3	Alternative Design RAB 2	59.368.949.000,00	1.737.144.850	2,843 %

CONCLUSION

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

There are 4 work done by Value Engineering, namely beam work, floor slab work t=12 cm, roof floor plate work t=15 cm, stair work t=15 cm.

Alternative replacement designs for these work items, namely:

For block work items, an alternative replacement is to convert the purchase of formwork into a formwork rental;

For floor slab work items, there are 2 alternative substitutes chosen, namely replacing reinforcement fixing with M10 wiremesh and converting the purchase of formwork into formwork rental;

For roof floor plate work items, there are 2 alternative replacements chosen, namely replacing reinforcement fixing with M10 wiremesh and converting the purchase of formwork into formwork rental;

For stair plate work items, there are 2 alternative substitutes chosen, namely replacing reinforcement fixing with M10 wiremesh and converting formwork purchases into formwork rentals;

The amount of savings obtained from the analysis carried out, amounted to 2.843% for alternative design 2.

REFERENCES

Abrar, Husen. 2011. *Project Management*. Andi, Yogyakarta

Agrama, Fatma A., Maher T. Al-Nemr and Mohamad A. Abdo. 2014. Value Engineering For Low-Cost Housing Construction In Egyptian Expansion Urban. *Advanced Research in Engineering Sciences. Vol. 2(2) April 2014.*

Ahuja, H.N., 1994. *Project Management Techniques in Planning and Controlling Construction Projects.* John Wiley & Sons. Inc New York.

Anugerahini, Ajeng Tantri, Lila Ayu Ratna Winanda and Munasih. 2021. Value Engineering Analysis on Building Projects (Case Study on a 5-Storey Inpatient Building at Dr. Iskak Tulungagung). Sondir Journal. vol.5 No.2 of 2021, pp. 64-71. https://ejournal.itn.ac.id /index.php/sondir. February 23, 2022

Armando, T. 2015. Application of Value Engineering in the *Andalas University Teaching* Hospital Building Construction Project. Civil Engineering, *Andalas University Padang.*

Central Statistics Agency (BPS). 2019. Statistics Indonesia 2019.

Central Statistics Agency (BPS). 2020. Regulation of the Central Statistics Agency Number 2 of 2020 concerning the Standard Classification of Indonesian Business Fields.

Barrie and Poulson. 1984. Definition of Value Engineering According to Experts. http://pengertian-pengertianinfo. blogspot.co.id /2015/11/understanding-value-engineering according to.html. accessed 3 August 2022

Blaang, Djemaboet, 1986. *Housing and Settlements as Basic Necessities.* Indonesian Torch Foundation, Jakarta.

Dimyati & Nurjaman. 2014. *Project Management. Faithful Library. Bandung*

Dell'Isola, A. J. 1974. Value Engineering in the Construction Industry. *Construction Publishing Corp., Inc., New York*

Dell'Isola, A. J. 1997. Value engineering : practical applications for design, construction, maintenance & amp; operations. Mass. : R. S. Means Company, Kingston

Donomartono. 1999. Application of Value Engineering to Optimize Costs at the Planning Stage of Building Construction with Prestressed Concrete Block Structures. *Faculty of Engineering, Sepuluh Nopember Institute of Technology, Surabaya*

Dipohusodo, Istimawan. 1996. Project & Construction Management. *Kanisius, Jogjakarta.*

Ervianto, Wulfram I. 2005. *Construction Project Management.* Andi Yogyakarta, Yogyakarta.

Ervianto, Wulfram I. 2006. Exploration of technology in construction: Precast concrete

O'Brien, James J. 1978. Value Analysis in Design and Construction. McGraw-Hill, New York.

Pranata, Y. A. & Yunizar. 2011. Modeling of Field Shear Walls as Equivalent Column Elements in Low-Rise Reinforced Concrete Buildings. Journal of Civil

Engineering, VII(1), pp. 85-97.
Priyanto, Herry. 2010. Optimization of the application of value engineering at the building design stage in Indonesia. Thesis of the Faculty of Engineering, University of Indonesia.
Ramadan, Fitra Al and Dwi Dinariana. 2018. Application of Value Engineering in Rusunawa Development Project in Sidoarjo. Journal of IKRA-ITH Technology Vol 2 No 3, November 2018, ISSN 2580-4308.
Rondinelli, A. Dennis. 1990. Development Projects as Integrated Management: An Adoptive Approach to Public services. Bumi Aksara, Jakarta.
Sepira, Bella. 2020. Application of Value Engineering in Ubud Batu Malang Hotel Development Project. Malang National Institute of Technology.
Soehendradjati, R. J. B., 1987. Construction Management. Gadja Mada University Press, Yogyakarta.
Subagya. 2000. Project Management Analysis. Graha Pena, Bekasi.
Thoengsal, James. 2014. Efficiency of Using Construction Materials in Reducing the Emergence of Waste Materials. http://jamest hoeng sal.blogspot.co.id/p/blog-page_20.html, accessed June 25, 2022.
Ustoyo, Dwi Ari. 2007. Application of Value Engineering to Elements and Foundations of the Rectorate Building Project of the University of Muhammadiyah Semarang. Semarang State University.
Wahyudi, Wachid Hashim and Dhian D. Prayuda. 2020. Value Engineering Studies as One of the Approaches to Selecting Building Floor Plates Using the AHP (Analytical Hierarcy Process) Method. Journal of Infrastructure Engineering. Volume 4 Number 1, June 2020: 1-8
Wardana, Mohammad Roy, Rudi Waluyo and Yenywaty Simamora. 2019. Engineering Analysis of the Value of Gedueng Building Beam and Column Structure Work (Case Study of the Investment Agency and One-Stop Integrated Service of Palangka Raya City). Journal of Engineering. Volume 2, No. 2, April 2019: 101 – 111
Zainudin. 2011. Project Management. Andi Offset, Yogyakarta