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Analysis of the Application of Value Engineering in the Papua Police Headquarters Apartment Building Project

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ABSTRACT

This study discusses the application of Value Engineering in the construction project of the Papua Regional Police Flats (Papua Regional Police Flats) located in Koya Koso, Jayapura City. The main objectives are to identify high-cost work items, propose more economical material alternatives without compromising function and quality, and determine potential cost savings. The research follows the five stages of Value Engineering: information, creative, analysis, development, and recommendation. The analysis revealed that floor slabs, columns, and beams were the most cost-intensive components. Through material substitution and technical-economic evaluation, several feasible alternatives were proposed. The total cost savings achieved from implementing these alternatives amounted to IDR 1,054,481,004.59. These findings demonstrate that Value Engineering can significantly improve cost efficiency in construction projects without reducing work quality.

Keywords: *Value Engineering, Cost Efficiency, Construction Project, Material Alternatives, Apartment Building.*

1. INTRODUCTION

The Ministry of Public Works and Public Housing (PUPR) through the Directorate General of Housing has begun construction of flats (rusun) for the Papua Regional Police (Polda) in Jayapura City. This project aims to provide decent and affordable housing for Polri members, especially female police officers (Polwan). The Wisma Arunika type flats are designed to be three stories high with 44 residential units capable of accommodating up to 176 people, built on a 2,610 square meter plot of land. In addition to being a place to live, these flats are expected to be a means of fostering Polri members' families, supporting their welfare, and improving their performance on duty. With complete furniture facilities, this development also aims to strengthen relations between the police and the community and improve the quality of life of Polri members in Papua [1].

During the construction project, significant obstacles affected the mobilization process and workforce availability. A pile boring machine malfunctioned, with only one of the three planned units functioning properly. This hampered progress on the site. Furthermore, a lack of skilled labor in the local area forced the project team to bring in workers from outside the region. These delays potentially disrupted the project's schedule and efficiency. Therefore, a solution was needed to address these challenges to ensure smooth construction. Addendum 1 was implemented in the fifth week of March 22, 2024.

This project has a total budget of Rp. 21,430,400,000.00, of which the Standard Structure work absorbs the largest budget of Rp. 8,369,047,222.78 with a work weight of 42.149%. However, along with the delay, the second SCM was implemented which resulted in the second addendum which occurred in the 14th week on May 22, 2024. So the total cost for the Standard Structure work increased to Rp. 9,075,385,975.66.

However, the delays continued, so the 3rd SCM and 3rd addendum were held in the 25th week, August 9, 2024, which provided an additional time of a maximum of 50 calendar days with financial consequences borne by the contractor. The imposition of a fine of one per mil (1/1000) of the contract value is a risk that must be faced due to the provision of additional time after the end of the contract period. In accordance with Presidential Decree 16 of 2018 Article 79 paragraph (4), the imposition of a late fine sanction is determined by the PPK in the contract at one per mil (1/1000) of the contract value or the value of the contract portion for each day of delay.

Through the application of value engineering, it is hoped that the construction process of the Papua Regional Police flats can be carried out efficiently, resulting in more optimal costs, and increasing user satisfaction.

Based on the background above, this study will discuss "Analysis of the Application of Value Engineering in the Papua Police Flats Development Project".

2. LITERATURE REVIEW

2.1 Value Engineering

*Value Engineering*is a systematic approach to obtaining maximum results from every expense incurred. This approach requires creative efforts to analyze functions by eliminating or modifying unnecessary price additions in various processes such as construction financing, operations, implementation, maintenance, or equipment replacement, in order to find the best functional balance between cost, reliability, and project performance [2].

2.2 Purpose of Value Engineering

The purpose of Value Engineering analysis is to eliminate unnecessary costs and find alternatives that can meet needs at a lower cost, without sacrificing construction quality. Furthermore, this analysis aims to provide optimal results according to the funds spent, and helps distinguish between necessary and unnecessary elements. By applying the Value Engineering concept, it is hoped that savings will be achieved in terms of costs, time, and materials [3].

The application of value engineering to construction projects can convince stakeholders that investment in the project will generate assets with effective value. This application covers the stages of construction, use, and maintenance of the asset. This study identifies variables used to determine value savings through the application of value engineering in building construction. One approach used is to identify alternatives that have the potential to provide savings, both in terms of the materials used and the work methods applied. The steps include:

1. Determination of work items to which value engineering will be applied.
2. The advantages possessed by the selected alternative.
3. Savings obtained from the selected alternative compared to the initial design [4].

2.3 Value Engineering Stages

The stages of Value Engineering are divided into 5, namely:

1. Information Stage

The Information Phase is the initial step in Value Engineering that focuses on collecting comprehensive data related to the project being analyzed. The data collected includes technical and economic information such as the Cost Budget Plan (RAB), Bill of Quantities (BOQ), and the results of interviews with contractors and consultants. The goal is to understand the overall project conditions, including the type of work, implementation methods, unit prices, and implementation duration. In this phase, the main cost components are also identified using methods such as cost modeling and cost breakdown so that the focus of efficiency can be directed to the elements that contribute the most to costs. The Pareto Principle (80/20) is often used to focus attention on the most significant components of the total project cost [5].

2. **Creative Stage**

The Creative Stage aims to produce innovative alternatives in terms of materials, implementation methods and working time to fulfill the building's function effectively and efficiently [6].

3. **Analysis Stage**

The analysis phase is carried out to evaluate, test, and select alternatives that have the potential for cost savings without reducing quality or function. The analysis includes evaluating advantages and disadvantages, as well as calculating life cycle costs [7].

4. **Development Stage**

The Development phase focuses on developing the best alternative from the analysis phase into a complete proposal, including component, operational and maintenance cost calculations with the assistance of technical specialists [6].

5. **Recommendation Stage**

The Recommendation stage is the final stage in the Value Engineering process, which contains the best alternative proposals along with their technical and economic reasons and considerations. At this stage, the results of the analysis and decision-making are formulated clearly and convincingly to be presented to the authorities authorized to determine implementation. The goal is to ensure that the proposed alternatives have the best value with optimal savings, while also considering aspects of procurement, field implementation, and effective delivery methods so that the recommendations can be accepted and implemented properly [6].

3. METHODS

3.1 Research Location

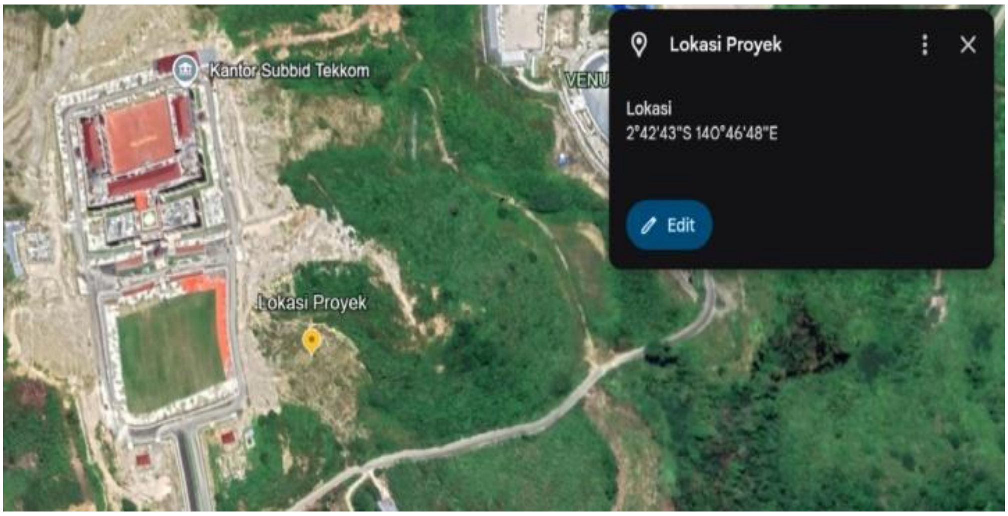

Figure 1. Research Location

On-site researchThe Papua Police flats are located in Koya Koso, Muara Tami District, Jayapura City.

3.2 Data collection

The data used in this study is divided into two, namely:

1. Primary Data

The primary data needed in this research are the results of field observations, interviews, and material surveys.

2. Secondary Data

The primary data needed in this research include:

a. RAB Planner
b. Time Schedule
c. Shop drawing
d. Literature related to research

3.3 Research Flowchart

The research flowchart can be seen in Figure 2.

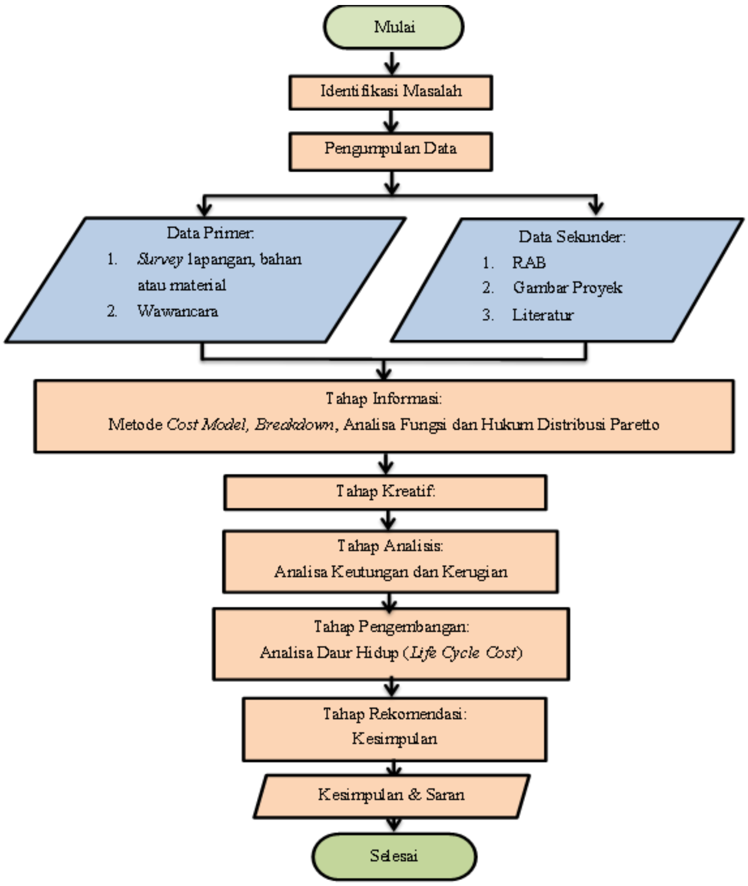

Figure 2. Research Flowchart

4. RESULTS AND DISCUSSION

4.1 Information Stage

*Breakdown*is an analytical method used to describe the cost distribution of each work item within a building element to identify potential waste. In the Standard Structural Work element, this process is performed by arranging cost components from highest to lowest to identify significant items. The results of the breakdown analysis are shown in Table 1.

Table 1. Standard Structure Job Breakdown

No	Uraian Pekerjaan	Nilai	%	Komp
1	Pekerjaan Lantai III	Rp 124.670.327,10	49,31	49,31
2	Pekerjaan Lantai II	Rp 56.092.557,93	22,18	71,49
3	Pekerjaan Lantai Dak	Rp 26.965.316,24	10,66	82,16
4	Pekerjaan Lantai I	Rp 24.503.863,96	9,69	91,85
5	Pekerjaan Lantai Atap	Rp 20.613.917,75	8,15	100,00
6	Pekerjaan Tanah	Rp -	0,00	100,00
7	Pekerjaan Sopi-Sopi	Rp -	0,00	100,00
8	Rangka Atap Baja	Rp -	0,00	100,00
Total		Rp 252.845.982,98	100,00	100,00

Based on the breakdown results in Table 1, an analysis was conducted using the Pareto Principle, which states that approximately 20% of work items contribute 80% of the total cost. In this study, this principle was used to identify the work with the highest costs, which was limited to the top 20% of components. Two work items were selected: the work on the second floor and the third floor. The results of the Pareto analysis are presented in Figure 3.

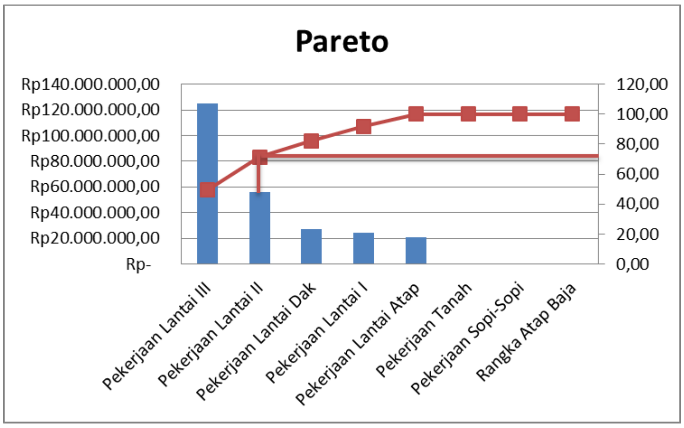

Figure 3. Pareto Chart

A Pareto analysis was also conducted on the Standard Structure work for Floors II and III. From each of these projects, several work items were identified that had the potential for value engineering analysis. The work items are as follows:

1. Second Floor Work
   a. Floor Slab Work: K300 Concrete and Reinforced Concrete Work.
   b. Column Work K1: Reinforced Concrete Work.
   c. Beam Work G1.1: Reinforced Concrete Work.
2. Third Floor Work
   a. Floor Slab Work: K300 Concrete and Reinforced Concrete Work.
   b. Beam Work G1.1: Reinforced Concrete Work.
   c. K3 Column Work: K300 Reinforced Concrete and Concrete Work.

4.2 Creative Stage

At this stage, alternative materials with lower prices but equivalent quality were developed, based on the Pareto principle. Price surveys were conducted at building supply stores in Jayapura Regency and then compared with the initial budget to assess cost efficiency without sacrificing quality.

4.3 Analysis Stage

This stage evaluates alternatives from the creative stage by calculating the cost budget for each item using unit price analysis to assess potential profits and losses. The following are the results of the cost budget calculations for each work item:

Table 2. Calculation of the Budget for K-300 Concrete Work on Floor Slab II Work

Uraian	Sat	Volume	Harga Satuan	Total Harga
Perencanaan Awal	M3	115,36	Rp 2.870.000,00	Rp 331.083.200,01
Alternatif 1	M3	115,36	Rp 2.621.943,84	Rp 302.467.440,96
Alternatif 2	M3	115,36	Rp 2.656.443,84	Rp 306.447.360,96
Alternatif 3	M3	115,36	Rp 2.679.443,84	Rp 309.100.640,96

Table 3. Calculation of the Budget Cost for 10-diameter Reinforced Concrete Work for Floor Plate II Work

Uraian	Sat	Volume	Harga Satuan	Total Harga
Perencanaan Awal	Kg	20.233,87	Rp 31.424,00	Rp 635.829.130,88
Alternatif 1	Kg	20.233,87	Rp 16.934,00	Rp 342.640.354,58
Alternatif 2	Kg	20.233,87	Rp 16.934,00	Rp 342.640.354,58
Alternatif 3	Kg	20.233,87	Rp 15.726,50	Rp 318.207.956,55

Table 4. Calculation of the Budget for the 16-diameter Reinforced Concrete Work for Column K1 on Floor II

Uraian	Sat	Volume	Harga Satuan	Total Harga
Perencanaan Awal	Kg	9.287,44	Rp 31.424,00	Rp 291.848.514,56
Alternatif 1	Kg	9.287,44	Rp 21.764,00	Rp 202.131.844,16
Alternatif 2	Kg	9.287,44	Rp 21.764,00	Rp 202.131.844,16
Alternatif 3	Kg	9.287,44	Rp 20.556,50	Rp 190.917.260,36

Table 5. Calculation of the Budget for the 16-diameter Reinforced Concrete Work on the G1.1 Beam Work on Floor II

Uraian	Sat	Volume	Harga Satuan	Total Harga
Perencanaan Awal	Kg	8.732,50	Rp 31.424,00	Rp 274.410.080,00
Alternatif 1	Kg	8.732,50	Rp 21.764,00	Rp 190.054.130,00
Alternatif 2	Kg	8.732,50	Rp 21.764,00	Rp 190.054.130,00
Alternatif 3	Kg	8.732,50	Rp 20.556,50	Rp 179.509.636,25

Table 6. Calculation of the Budget Cost of K-300 Concrete Work on Floor Slab III Work

Uraian	Sat	Volume	Harga Satuan	Total Harga
Perencanaan Awal	M3	115,36	Rp 2.870.000,00	Rp 331.083.200,01
Alternatif 1	M3	115,36	Rp 2.621.943,84	Rp 302.467.440,96
Alternatif 2	M3	115,36	Rp 2.656.443,84	Rp 306.447.360,96
Alternatif 3	M3	115,36	Rp 2.679.443,84	Rp 309.100.640,96

Table 7. Calculation of the Budget for the 10-diameter Reinforced Concrete Work for the Floor Plate III Work

Uraian	Sat	Volume	Harga Satuan	Total Harga
Perencanaan Awal	Kg	20.119,87	Rp 31.424,00	Rp 632.246.794,88
Alternatif 1	Kg	20.119,87	Rp 16.934,00	Rp 340.709.878,58
Alternatif 2	Kg	20.119,87	Rp 16.934,00	Rp 340.709.878,58
Alternatif 3	Kg	20.119,87	Rp 15.726,50	Rp 316.415.135,55

Table 8. Calculation of the Budget for the 16-diameter Reinforced Concrete Work on the G1.1 Beam Work on Floor III

Uraian	Sat	Volume	Harga Satuan	Total Harga
Perencanaan Awal	Kg	8.099,73	Rp 31.424,00	Rp 254.525.915,52
Alternatif 1	Kg	8.099,73	Rp 21.764,00	Rp 176.282.523,72
Alternatif 2	Kg	8.099,73	Rp 21.764,00	Rp 176.282.523,72
Alternatif 3	Kg	8.099,73	Rp 20.556,50	Rp 166.502.099,74

Table 9. Calculation of the Budget for the Cost of Reinforced Concrete Work on the K3 Column Work on Floor III

Uraian	Sat	Volume	Harga Satuan	Total Harga
Perencanaan Awal	Kg	6.634,24	Rp 31.424,00	Rp 208.474.357,76
Alternatif 1	Kg	6.634,24	Rp 21.764,00	Rp 144.387.599,36
Alternatif 2	Kg	6.634,24	Rp 21.764,00	Rp 144.387.599,36
Alternatif 3	Kg	6.634,24	Rp 20.556,50	Rp 136.376.754,56

Table 10. Calculation of the Budget for K-300 Concrete Work on the K3 Column Work on Floor III

Uraian	Sat	Volume	Harga Satuan	Total Harga
Perencanaan Awal	M3	31,62	Rp 2.870.000,00	Rp 90.749.400,00
Alternatif 1	M3	31,62	Rp 2.621.943,84	Rp 82.905.864,10
Alternatif 2	M3	31,62	Rp 2.656.443,84	Rp 83.996.754,10
Alternatif 3	M3	31,62	Rp 2.679.443,84	Rp 84.724.014,10

4.4 Development Stage

At this stage, the initial costs are compared with the engineered costs to determine the savings value, namely the difference between the initial budget and the alternative costs.

Table 11. Summary of Alternative Cost Savings for Floor II Work

	Pekerjaan Pelat Lantai			
	Uraian	Rekayasa 1	Rekayasa 2	Rekayasa 3
	Beton K-300	Rp 28.615.759,06	Rp 24.635.839,06	Rp 21.982.559,06
Lantai 2	Besi Beton	Rp 293.188.776,30	Rp293.188.776,30	Rp 317.621.174,33
	Kolom K1			
	Besi Beton	Rp 89.716.670,40	Rp 89.716.670,40	Rp 100.931.254,20
	Balok G1.1			
	Besi Beton	Rp 84.355.950,00	Rp 84.355.950,00	Rp 94.900.443,75

The following are the alternative results selected for each job on the second floor:

1. Floor Slab Work for K300 Concrete Work is Alternative 1
2. Floor Plate Work for Reinforced Concrete Work is an alternative 3
3. Column K1 work for reinforced concrete work is Alternative 3.
4. G1.1 Beam Work for Reinforced Concrete work is Alternative 3.

Table 12. Summary of Alternative Cost Savings for Floor II Work

	Pekerjaan Pelat Lantai			
	Uraian	Rekayasa 1	Rekayasa 2	Rekayasa 3
	Beton K-300	Rp 28.615.759,06	Rp 24.635.839,06	Rp 21.982.559,06
	Besi Beton	Rp 291.536.916,30	Rp291.536.916,30	Rp 315.831.659,33
Lantai 3	Balok G1.1			
	Besi Beton	Rp 78.243.391,80	Rp 78.243.391,80	Rp 88.023.815,78
	Kolom K3			
	Besi Beton	Rp 64.086.758,40	Rp 64.086.758,40	Rp 72.097.603,20
	Beton K-300	Rp 7.843.535,90	Rp 6.752.645,90	Rp 6.025.385,90

The following are the alternative results selected for each job on the third floor:

1. Floor Slab Work for K300 Concrete work is Alternative 1.
2. Floor Plate Work for Reinforced Concrete Work is an alternative 3
3. G1.1 Beam Work for Reinforced Concrete work is Alternative 3.
4. K3 Column Work for Reinforced Concrete work is Alternative 3.
5. K3 Column Work for K300 Concrete work is Alternative 1.

4.5 Recommendation Stage

The final stage in the value engineering analysis serves to summarize the results of the previous stages. The following are recommendations for the second and third floor work.

Table 13. Recommendations for Floor Plate Work II

Tabel Rekomendasi Pekerjaan Pelat Lantai II					
Item Pekerjaan	:	Pelat Lantai, t=130 mm			
Biaya Awal	:	Rp			966.912.330,89
Biaya Rekayasa	:	Rp			620.675.397,51
Rencana Awal	:	Beton K-300	=	Rp	1.565.701,01
	:	Besi Beton	=	Rp	23.000,00
Usulan	:	Beton K-300	=	Rp	1.350.000,00
	:	Besi Beton	=	Rp	10.000,00
Penghematan	:	Rp			346.236.933,38
Dasar Pertimbangan	:	Harga lebih murah dengan mutu yang tetap			

Table 14. Recommendations for Column K1 Work on Floor II

Tabel Rekomendasi Pekerjaan Kolom K1					
Item Pekerjaan	:	Kolom K1			
Biaya Awal	:	Rp			291.848.514,56
Biaya Rekayasa	:	Rp			190.917.260,36
Rencana Awal	:	Besi beton	=	Rp	23.000,00
Usulan	:	Besi beton	=	Rp	14.000,00
Penghematan	:	Rp			100.931.254,20
Dasar Pertimbangan	:	Harga lebih murah dengan mutu yang tetap			

Table 15. Recommendations for G1.1 Beam Work on Floor II

Tabel Rekomendasi Pekerjaan Balok G1.1					
Item Pekerjaan	:	Balok G1.1			
Biaya Awal	:	Rp			274.410.080,00
Biaya Rekayasa	:	Rp			179.509.636,25
Rencana Awal	:	Beton K-300	=	Rp	23.000,00
Usulan	:	Beton K-300	=	Rp	14.000,00
Penghematan	:	Rp			94.900.443,75
Dasar Pertimbangan	:	Harga lebih murah dengan mutu yang tetap			

Table 16. Recommendations for Floor Plate Work III

Tabel Rekomendasi Pekerjaan Pelat Lantai III					
Item Pekerjaan	:	Pelat Lantai, t=130 mm			
Biaya Awal	:	Rp			963.329.994,89
Biaya Rekayasa	:	Rp			618.882.576,51
Rencana Awal	:	Beton K-300	=	Rp	1.565.701,01
	:	Besi Beton	=	Rp	23.000,00
Usulan	:	Beton K-300	=	Rp	1.350.000,00
	:	Besi Beton	=	Rp	10.000,00
Penghematan	:	Rp			344.447.418,38
Dasar Pertimbangan	:	Harga lebih murah dengan mutu yang tetap			

Table 17. Recommendations for G1.1 Beam Work on Floor III

Tabel Rekomendasi Pekerjaan Balok G1.1					
Item Pekerjaan	:	Balok G1.1			
Biaya Awal	:	Rp			254.525.915,52
Biaya Rekayasa	:	Rp			166.502.099,74
Rencana Awal	:	Besi Beton	=	Rp	23.000,00
Usulan	:	Besi Beton	=	Rp	14.000,00
Penghematan	:	Rp			88.023.815,78
Dasar Pertimbangan	:	Harga lebih murah dengan mutu yang tetap			

Table 18. Recommendations for K3 Column Work on Floor III

Tabel Rekomendasi Pekerjaan Kolom K3					
Item Pekerjaan	:	Kolom K3			
Biaya Awal	:	Rp			299.223.757,76
Biaya Rekayasa	:	Rp			219.282.618,66
Rencana Awal	:	Beton K-300	=	Rp	1.565.701,01
	:	Besi Beton	=	Rp	23.000,00
Usulan	:	Beton K-300	=	Rp	1.350.000,00
	:	Besi Beton	=	Rp	14.000,00
Penghematan	:	Rp			79.941.139,10
Dasar Pertimbangan	:	Harga lebih murah dengan mutu yang tetap			

CONCLUSION

Based on the results of the analysis carried out through five stages of the Value Engineering method on the Papua Police Flats Development project in Koya Koso, several main conclusions were obtained which directly refer to the research objectives as follows:

1. High-cost work items in the planning design that have the potential to be analyzed using the value engineering method are Floor Plates, Columns, and Beams, especially on the second and third floors of the building.
2. An alternative that can be used to reduce costs without reducing the function or performance of the structure is to use lower-priced reinforced concrete and select an efficient concrete mix.
3. The amount of cost savings that can be achieved after implementing value engineering analysis is Rp. 1,054,481,004.59.

Overall, these results show that the systematic application of Value Engineering can provide a significant contribution to cost efficiency without reducing the quality or function of the planned building structure.

SUGGESTION

From the results of the analysis that has been carried out, several suggestions can be taken for further development, including the following:

1. In this thesis, the author only analyzes one alternative: selecting more efficient materials for cost savings. However, many other factors, such as construction methods, implementation techniques, labor, and time planning, can also contribute to cost optimization.
2. The authors recommend that subsequent analyses be more comprehensive, considering a variety of alternatives and creative ideas, including the latest construction technologies and design optimizations. This broader approach is expected to yield greater savings in costs, time, and resources, as well as long-term benefits for the project.

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