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Engineering Value in Projects Building Construction: Case Research Sofifi 3-Story ASN Official House - North Maluku Province

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ABSTRACT
The sustainability of construction projects often hinges on managing costs effectively, as illustrated by the case study of an ASN housing building project in Sofifi, North Maluku. This research aims to achieve significant cost savings by optimizing the selection of construction materials and methods, utilizing the Value Engineering Method. This method systematically assesses the value of each component relative to its function, promoting an innovative approach to minimizing unnecessary expenditures. The research followed several structured stages: information gathering, creative ideation, analysis, evaluation, and development, each focusing on identifying feasible alternatives to reduce costs. The analysis identified two key solutions: replacing conventional flooring with precast materials for floor work and substituting lightweight brick walls with red brick walls. Implementing these changes reduced the total project cost from IDR 2,295,005,206 to IDR 1,698,939,324, achieving savings of IDR 596,115,883 (35%). The findings of this study provide practical implications for construction project management, offering a structured approach to material and method selection that can be adapted to broader-scale projects for enhanced cost-efficiency.

Keywords: Value Engineering, Floor Work, Wall Installation, ASN Official Housing Projects.

INTRODUCTION

Along with the times and the increase in population, human needs are increasingly diverse, including the need for housing (Lubis et al., 2022). This has spurred the construction service industry to meet this demand by providing the facilities and infrastructure needed by the community. One example is the construction of an ASN official house building in Sofifi City, the capital of North Maluku Province. In accordance with Law No. 2 of 2017 concerning Construction Services, construction activities must be carried out based on the principles of efficiency and effectiveness to ensure the achievement of optimal added value (Manurung, 2022).

This research focuses on cost analysis to avoid unnecessary expenditure on work items caused by less essential elements in the implementation of construction projects. The value engineering method is used as an appropriate approach to optimize costs in the construction of a three-story ASN official residence in Sofifi, North Maluku. The urgency of this research arises because the need for ASN official houses in Sofifi is increasing along with the increasing number of ASNs in the region. According to data from the Central Bureau of Statistics of North Maluku Province, in 2023 there were 46,255 ASNs, and this figure is projected to continue to grow in the coming years (BPS, 2024). Currently, the availability of official houses is still unable to meet these needs, so it is urgent to build additional official houses.

Value Engineering is a systematic approach to increasing the value of a product, project, or process by analyzing functions and finding ways to reduce costs without compromising quality or performance (Berawi et al., 2014), while in the (Jaya et al., 2019) Independent School building construction project Value engineering is a management technique that tries to use a systematic approach to find the best functional balance between cost, performance, and the appearance of a project. According to the building project of the Ibtidaiyah Negeri 3 madrasah building project, Gunungsitoli explained that the purpose of finding out the amount of construction cost savings, as well as getting the most appropriate material alternatives without changing the function of the building, is to apply value engineering analysis (VE) as the basic concept of cost savings (Irfanto et al., 2023). Meanwhile, the definition of Value Engineering is a technique to streamline the cost and time of construction work and maintain the quality of work results (Halik et al., 2018).

The novelty of this research lies in the application of value engineering methods in the construction project of ASN official houses in Sofifi, North Maluku, which is the main highlight. The project introduced the use of more cost-effective and efficient alternative materials as part of the innovations implemented. This article reinforces the justification that material selection, such as replacing conventional materials with precast materials and using red brick walls instead of light bricks, is a solution that has never been applied to similar projects in other areas. This research contributes by offering insights into how value engineering is applied in the Sofifi region which has specific project characteristics, both in terms of ASN's increasing housing needs and cost efficiency challenges in an area that may have logistical constraints and limited resources. Thus, this research enriches the literature on value engineering with a more local and relevant context.

RESEARCH METHOD

As seen in the description of the stages above, the research flow diagram below can explain the relationship between the stages, methods, and research outputs in the Building Construction Project: ASN Official House 3 Floors Sofifi North Maluku.

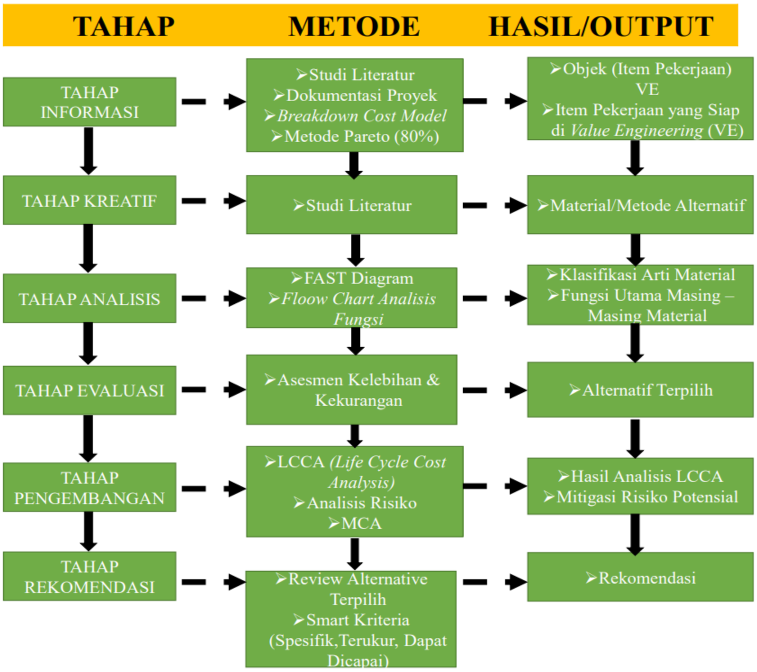

Figure 1. Research Flow Diagram

In the information stage, Pareto analysis is a method used to identify the project components that have the greatest impact on the total cost (Irfanto, 2022). The Pareto (80/20) principle states that approximately 80% of a project's cost often comes from only 20% of the work items (Irfanto & Charolin, 2024). By identifying the items that affect costs the most, this method can help project teams to focus value engineering on the most significant areas for savings. In this building project, Pareto analysis was used to sort out the work items that were considered to have the greatest potential for optimization, such as material selection and more efficient construction methods.

In addition, the creative stage serves to generate alternative solutions. The method used in this stage is a literature research to find alternative materials and methods that are more cost-effective without sacrificing quality. This creative stage plays an important role in developing various options that can be applied to improve project performance. In this project, the development of alternatives included cheaper material options or faster construction methods, while still considering long-term durability and performance. Although the creative stage generates a wide range of ideas, the process of selecting the most viable alternative is only carried out after an in-depth evaluation in the next stage.

The evaluation stage aims to examine the strengths and weaknesses of the alternatives generated in the creative stage. Through methods such as function analysis (FAST Diagram) and function analysis flowchart, the project evaluates how each alternative material fulfills the main function of the building (Rahwani et al., 2021). In addition, Life Cycle Cost Analysis (LCCA) and risk analysis were also conducted in this evaluation. LCCA was used to calculate the total cost throughout the life cycle of the building, including maintenance and material replacement costs (Wati et al., 2023). Risk analysis aims to identify potential risks that may arise from the application of alternative materials, such as the risk of material failure, problems in the construction process, or potential project delays (Masombe et al., 2021).

But while value engineering can provide significant cost savings, its application also brings a number of risks that need to be identified and managed. One of the main risks associated with the use of alternative materials is their quality, which may not be equivalent to conventional materials, thus affecting the service life of the building. In addition, new materials may require adjustments in construction methods or equipment used, potentially increasing the complexity and time of project implementation. There is also the risk of malfunction; if the selected materials do not meet the required standards, this may cause problems with the building structure in the future. To mitigate these risks, it is crucial to conduct material trials before implementation on larger projects, as well as conduct close monitoring during the construction phase. Conducting a more in-depth risk assessment can also help in selecting the most suitable materials and ensuring that risks that may arise are minimized.

RESULT AND DISCUSSION

Pareto Analysis

This analysis is carried out to find out how many and what work items have the potential to be analyzed by value engineering (VE). The Pareto principle applies an 80/20 ratio, which means that 80% of the result comes from 20% of the cause (Putra et al., 2021).

Table 1. Pareto Analysis of Level 1 Job Items

No	Work Items	Total	Bobot	Pareto
1	Structure Work	3.021.450.257,51	40,54%	40,54%
2	Architectural Work	2.975.936.508,01	39,93%	
3	Mechanical & Electrical Work	1.100.775.925,82	14,77%	
4	Furniture	188.200.000,00	2,53%	
5	Preparatory Work	166.944.706,17	2,24%	
	Total	7.453.307.397,50	100,00%	80,47%

Source: Research Processing, 2024

Analysis of engineering value in level 1 work items: 2 work items have the highest weight, including structural work with a total cost of Rp. 3,021,450,257.51 (40.54%) and architectural work with a total cost of Rp. 2,975,936,508.01 (39.93%). The total of these two work items will be analyzed by value engineering (80.47%).

Table 2. Pareto results in 80% of the Level 2 Job Item of the Structure Job

No	Structural Work Items	Total	Weight (%)
1	Plate Installation	1.005.660.464,61	33%
2	Beam Installation	583.922.552,02	19%
3	Column Installation	557.258.488,83	18%
4	Foundation	537.230.051,64	18%
5	Roof Truss	219.905.132,21	7%
6	Land Clearing	112.303.972,00	4%

No	Structural Work Items	Total	Weight (%)
7	Sloof	5.169.596,19	0%
	Total	**3.021.450.257,51**	**100%**

Source: Pareto Analysis Results, 2024

Table 3. Pareto Yield 80% of Level 3 Architectural Work Items

Architectural Work			
It	**Work Item Name**	**Nominal Amount**	**Weight (%)**
1	Wall and Plastering Pair Work	IDR 1,289,394,742	44%
2	Floor Couple Jobs	IDR 410,326,085	14%
3	Door / Window Frame Work	IDR 336,053,104	12%
4	Ceiling Work	IDR 238,083,706	8%
5	Painting Jobs	IDR 196,127,884	7%
6	Roof Covering Work	IDR 162,068,843	6%
7	Ultility Work	IDR 140,504,386	5%
8	Display Area Jobs	IDR 128,096,401	4%
	Total	IDR 2,900,655,151	100%

Source: Pareto Analysis Results, 2024

Creative Stage

After conducting the previous analysis, 2 work items can be found that are suitable for value engineering (VE) analysis; the next stage is the creative stage, where an alternative analysis will be carried out – alternatives to replace the initial design.

Table 4. Creative Stage (Main Work Item with Alternative 1)

No	Main Work Items	Snack Price	Alternative Change 1	Snack Price
1	Installation of m3 Conventional Floor Plates	1.595.293,00	Installation of Precast Floor Plates	996.187,00
2	Pack. Installation of Light Brick Walls tbl. 10 cm with Ready to Use Mortar (MSP)	356.695,00	Installation of 1m2 red brick wall (5x11x22) cm thick 1/2 mixed stone 1SP :4PP	233.602,00

Source: Research Processed Results, 2024

The creative stage above explains that the 2 work items with the largest weight to be analyzed for value engineering have been carried out in the speculation/creative stage. For m2 precast floor plate work with a unit price of 996,187.00, and for wall installation, 233,602.00

Evaluation Stage

Table 5. Evaluate work items Alternative 1

Alternate Work Item 1			
It	**Work Items**	**Excess**	**Deficiency**
1	Precast Floor Plate 12 cm Thick	1. Fast working time	1. Work depends on the machine
		2. Cost-effective formwork	2. Accommodation only at night
		3. Neat work results	3. Requires expert handling
		4. Cost-effective formwork	4. Accommodation only at night

Alternate Work Item 1			
It	Work Items	Excess	Deficiency
		5. Neat work results	5. Requires expert handling
2	Installation of 1m2 red brick wall (5x11x22) cm thick 1/2 mixed stone 1SP :4PP	1. Environmentally Friendly	1. Old-fashioned effect
		2. Light Weight	2. Requires Expert Handling
		3. Strength & Durability	3. Long installation time

Source: Research Processed Results, 2024

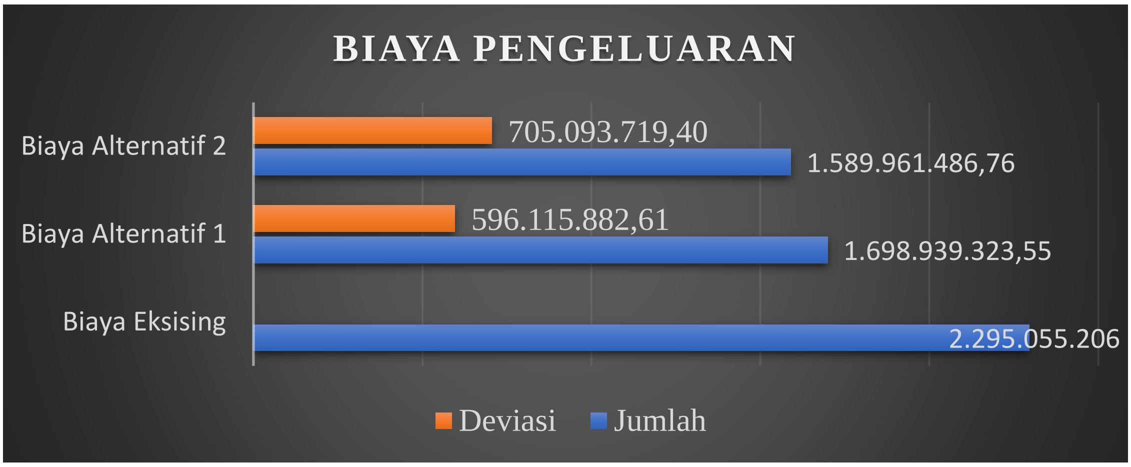

Figure 2. Graph Comparison of Existing Costs, Alternative 1, and Alternative 2

After looking at the advantages and disadvantages and comparing the cost of each work item, it can be concluded that "Alternative 1" is the right choice as a reference in the selection of alternatives in the value engineering (VE) analysis to be applied.

Function Analysis

The purpose of functional analysis is to identify and understand the main needs of a material, thus creating a more effective and efficient solution. A worksheet that aims to describe the functions of the "Alternative 1" construction material (Selected Alternative) in value engineering analysis can include an analysis of the benefits of each work item.

Table 6. Function Analysis of Selected Work Items

It	Work Items	Function Phase		
	Job Item Name (Level 4)	Research		
		Why	Function	How
1	Precast Floor Plates	Load distribution	Where to stand	Supporting the load
2	Red brick wall (5x11x22) cm thick 1/2 mixed stone 1SP :4PP	Security guard	Room Dividers	Divide the room

Development Stage

The Life Cycle Cost Analysis (LCCA) of the selected alternative work items (Alternative 1) contains the total cost of each work item, as shown in the table below.

Table 7. Life Cycle Cost Analysis (LCCA) Cost Recap Work Items

Life Cycle Cost Analysis (LCCA) Cost Recap Work Items			
	Existence Fee	**Alternative Fee 1**	**Alternative Fee 2**
Sum	IDR 2,295,055,206.16	IDR 827,427,618.37	IDR 724,784,363.98
Deviation		IDR 1,467,627,587.79	IDR 1,570,270,842.18
Saving		64%	68%

Source: Research Processing, 2024.

Presentation of the total existing cost of Rp.2,295,055,206.16 alternative work 1 with a total of Rp. 827,427,618.37 and total alternative work 2 Rp.724,784,363.98. Meanwhile, the deviation of alternative work 1 is IDR 1,467,627,587.79 (64%), alternative 2 is IDR 1,570,270,842.18 (68%).

Table 8.Risk Mitigation Costs on Selected Work Items

It	Work Items	Total Alternative Costs 1	Risk Mitigation Costs
1	Installation of Precast Floor Plates	544.865.455,98	6.300.000,00
2	Installation of Red Brick Walls	1.154.073.867,57	3.322.800,00
	Total	**1.698.939.323,55**	**9.622.800,00**
	Existing	**2.295.055.206,16**	
	Remnant	**596.115.882,61**	**586.493.082,61**

Source: Research Processed Results, 2024

Risk mitigation costs are costs incurred from savings from the 1 Rp alternative 596,115,882.61 to overcome the risks that occur in the selected alternative work items at a cost of Rp. 9,622,00.00, and the rest obtained is Rp. 586,493,082.61.

Recommendation Stage

After seeing the results of the analysis of each of the stages above, we can recommend one selected alternative (Alternative 1) with the use of selected materials in the creative stage, among others.

Table 9. Selected Work Item Endorsement

It	Work Items	Desc.	Alternative 1
1	Installation of Conventional Floor Plates	Replaced	Installation of Precast Floor Plates
2	Light Brick Wall	Replaced	Red Brick Wall

Source: Research Processed Results, 2024

The use of precast floor slabs offers some significant advantages in terms of quality and durability. Precast slabs are produced under strict quality control at the factory, thus ensuring consistency and higher strength compared to conventional methods (Rahmadia & Tarigan, 2024). They also have better resistance to weather changes and structural stresses, which in turn reduces the frequency of future repairs and maintenance (Hia et al., 2024). The use of such high-quality materials has the potential to significantly reduce maintenance costs due to less risk of damage and the need for long-term repairs.

Meanwhile, red brick walls, while traditionally stronger and sturdier, require more attention in terms of maintenance than lightweight bricks (Winata et al., 2024). Red bricks tend to be more prone to cracks due to changes in temperature and humidity, which can add to maintenance costs if not anticipated. However, if installed correctly and supported by proper construction methods, red bricks have a long service life and provide solid structural stability.

Besides the quality and durability aspects, there is also the impact on project completion time. The use of precast floor slabs can significantly speed up the construction process, as these elements come ready to install without the need for site casting (Indra & Priskasari, 2021). This reduces site labor time and allows the project to be completed faster. In contrast, the installation of red brick walls takes more time compared to lightweight bricks as the installation process is more manual and time-consuming (Suryapratama et al., 2024). This can slow down some stages of construction, although the quality of the resulting building is superior.

From a labor use point of view, precast floor slabs reduce the need for labor in the field, given their simpler and faster installation process. However, the installation of red bricks still requires skilled labor to ensure that the walls are built correctly and safely (Fatoni et al., 2024). While there is a greater labor requirement for red brick walls, the overall efficiency of using precast slabs can help balance the labor burden required (Abdul Hamid Mahdy, 2021). In conclusion, although there are some challenges in terms of time and labor, the use of high-quality materials with good durability will result in a stronger and more stable building, while reducing future maintenance costs.

CONCLUSION

The conclusion of this research successfully highlighted the significant cost savings achieved through the application of value engineering on the 3-Storey ASN Office House project in Sofifi, North Maluku Province. The application of Value Engineering (VE) resulted in a project cost reduction of Rp. 596,115,882.61, with a final savings of Rp. 586,493,082.61 after accounting for risk mitigation costs. These findings demonstrate the effectiveness of the VE approach in optimizing project resources while minimizing costs. There are some specific recommendations proposed for future implementation of the Value Engineering method. First, it is important to expand the scope of VE beyond just cost control, but also include optimization of time and manpower management. Efficient project execution requires careful planning and a dedicated VE team that monitors the financial and operational aspects of the project. In addition, time efficiency for critical tasks-such as the installation of red brick walls and precast floor slabs-should be thoroughly evaluated to improve overall productivity. Furthermore, incorporating a comprehensive risk analysis during the decision-making process is essential to ensure that potential risks can be identified and mitigated early on. Future research should focus on validating the long-term effectiveness of the preferred alternative (alternative 1), by assessing its impact on project costs and operational efficiency over time.

These steps will ensure that the VE methodology can be refined and applied to similar construction projects with greater success.

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