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APPLICATION OF VALUE ENGINEERING IN ARCHITECTURAL WORK ON THE LAHAIROI LATERI CHURCH, AMBON CITY

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Abstract

Effective construction cost control such as saving construction costs will increase the chances of project success and user satisfaction. The biggest component in construction costs is material. High material costs necessitate a review of building functions. Construction savings are made by reviewing the largest cost components in architectural work. Review of material components is carried out using the value engineering method. Value engineering is a method for getting an alternative picture so that the costs incurred are more efficient than the initial planning costs. The application of value engineering to construction projects has a major impact on planning by generating reviews to obtain cost effectiveness. Research was conducted at the Lahairoi Lateri Church Building project located in Ambon City. The aim of this research is to find alternative material substitutes for architectural work and obtain total cost savings by using the concept of value engineering. The use of the value engineering concept is carried out by information phase, analyzing the function of using index function analysis techniques, identifying alternative materials, and evaluating the results of the alternative materials. Research using the value engineering concept on the Lahairoi Lateri Church Building Construction project, Ambon City achieved cost savings of 861,116,841.05 IDR. This amount saves 5.32% of the initial architectural work costs of 16,170,539,500 IDR. These results show that value engineering can eliminate unnecessary costs in church-type building without changing the building function.

Keywords: Program Evaluation, Stake's Countenance, Science Learning

Introduction

Construction cost is a key factor of project success and user satisfaction (Gulo et al., 2022; Kholiq et al., 2020). One of the causes of changes in costs is an increase in construction material costs (Pratiwi, 2014; Rani, 2022). This is reaffirmed because material costs in construction projects reach 60-80% of the total project costs (Ekeskär & Rudberg, 2022), so proper project cost planning is needed especially in choosing the materials (Adi Susanto et al., 2023; Soelaiman, 2017; Tanubrata & Trisyandi, 2019).

Large material components are needed for reviewing each project. One technique used to review construction costs is value engineering (Amelia & Sulistio, 2019; Ferdinand & Adianto, 2022; Steven & Tamtana, 2020). Value engineering is a technique used to identify the highest cost components and select ideal replacement material alternatives without changing the function (Halik, 2018; Pontoh et al., 2013; Sugianto, 2017). Value engineering in construction industry benefit the stakeholder to maximize the efficient of costs (Jadidoleslami & Azizi, 2022; Ozcan Deniz & Ramirez, 2021).

Value engineering is used to get an alternative solution, so that the costs incurred are more efficient than the initial planning costs without ignoring the function of the work (Diputera et al., 2018; Kartohardjono & Nuridin, 2017). The advantage of the value engineering method is that the approach is carried out neatly, systematically and structured from the main problem to analyzing value based on its function (Chandra et al., 2023; Rane, 2016). A value engineering study for church project was previously carried out on the GMIM Syaloom Karombasan Church Construction Project and obtained savings of 24.5% of the total project costs (Kembuan et al., 2016). It shows value engineering is effective to reduce the construction cost (Hendrianto et al., 2018; Ridwan et al., 2017). In reality the process of implementing value engineering often gives rise to internal conflicts between the parties involved in a project, even though value engineering has been recognized by engineering experts as one of the concepts that provides efficiency to construction projects (Zainuddin et al., 2023)

The value engineering process follows a methodology with systematic steps (Miladi Rad & Aminoroayaie Yamini, 2016). Value engineering is divided into 5 stages, information and data processing stage (Abdi et al., 2017), function analysis stage (Arumsari & Tanachi, 2018; Nandito et al., 2021; Tariq Al Amri, 2021), creative stage, evaluation stage (Abdel-Raheem et al., 2018), and presentation or recommendation stage (Senay Atabay & Niyazi Galipogullari, 2013). This process will result in a large difference in initial costs and costs with alternative materials (Ilayaraja & Zafar Eqyaabal, 2015; Irfanto et al., 2023; Triswandana, 2019).

In this research, the application of value engineering was carried out on the Lahairoi Lateri Church Building project located in Ambon City. The results of the initial Cost Budget Plan identification carried out on this project obtained 26.97% of the cost percentage for architectural components. Architectural components are the object of research because the application of value engineering to structural components requires complex structural analysis (Handayani et al., 2023; Salsabila et al., 2022; Sumarda et al., 2022). Apart from that, the architectural options are quite wide (Khaerul Bahri & Retno Indryani, 2018), so this research aims to obtain a percentage of savings from the initial Cost Budget Plan by applying value engineering techniques on architectural works.

Research Methodology

This research is qualitative research using the Laharoi Lateri Church project in Ambon City as the research object. The research began by conducting a literature study related to the theoretical concept of applying value engineering to construction projects. Next, the architectural work grouping stage was carried out, as well as searching and collecting various theories, data studies and research that had previously been carried out. The literature studies collected are in the form of concepts, work plans, application of value engineering, construction project planning theory in the form of material cost planning concepts for projects as well as previous research related to value engineering.

The next step is the data collection stage. Data collection consists of primary data in the form of Cost Budget Plan (CBP) data, Unit Price Analysis (UPA) and design drawings from planning consultants for the Lahairoi Lateri Church Building Project, Ambon City. Secondary data such as material data, equipment, literature studies related to value engineering and other data related to research. Next, an analysis is carried out using work breakdown structure and breakdown costs to determine architectural works that have the largest costs and have the potential to be applied to value engineering.

The next stage is function analysis using the Index Function Analysis method to determine work item that are worthy of applying value engineering. At this stage the material is divided into main function and supporting function or support function. Materials with the main function category are materials that are directly attached to the building, while materials with a supporting function are materials that connect or support the main material. The total material costs for the main functions in WUPA are materials which are calculated in the Worth (W) variable, while the total work costs are the Cost (C) variable. The C/W calculation will determine whether the work can be carried out by value engineering or not. In example in this, for example, 1:5 brick wall work consists of 3 materials, namely, red brick, cement and sand. Red brick is the main sticking material so it is categorized as a primary material, while cement and sand are secondary materials because they support the primary material. The total cost at UPA for a 1:5 brick wall is 227,640 IDR, while cement and sand are installed at 76,217 IDR, so the cost value is 303,857 IDR and the value is the total primary material, namely 227,640 IDR. The Cost/Worth result was 1.33, so it is worth carrying out value engineering.

Creative stage is initiated by searching for alternative substitutes for the materials used at a cheaper cost without changing their function. The alternative chosen was to replace the materials but still maintain the original building function. The new replacement materials used are materials approved by the planning consultant so that the function of the building does not change due to changes in these materials. The original material before modification is marked B0. The alternative search results are then collected and coded A1, A2, A3, etc. The purpose of coding is to facilitate the selection of alternatives that will be carried out in the next step. This study using the price list provided by the consultant and also the material price list provided by the Ambon city government in 2023.

Then, an evaluation stage is carried out to eliminate the selected alternatives by determining an analysis of the Unit Price Analysis each alternative material. The final stage is the presentation to show the selected alternative materials and the magnitude of the difference in Cost Budget Plan. An overview of the research flowchart can be seen in Figure 1.

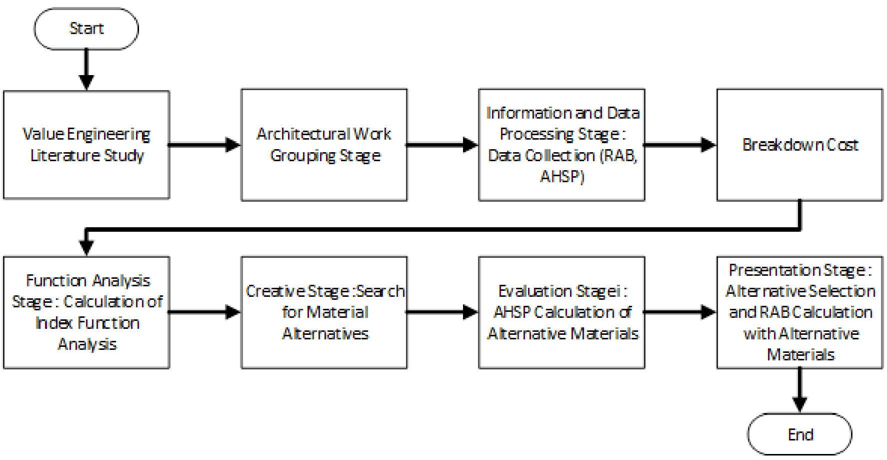

Figure 1. Research flow

Research Results and Discussion

Information and Data Processing Stage

Data collection and research information includes general project information, Cost Budget Plan (CBP) data, Unit Price Analysis (UPA) data and planning drawings. The name of the project in this research is the Construction of the Lahairoi Lateri Church Building which is located on Jl. Wolter Monginsidi, Lateri, Ambon City with a building area of 2587.5 m2 and a architectural works construction cost of 16,170,539,500.00 IDR.

This research data processing uses breakdown costs by sorting work item costs from largest to smallest and presenting them cumulatively to get the weight percentage for each work item. Percentages with a large work weight can be analyzed using the value engineering method. The following table 1 is a breakdown of the cost of architectural work for the Lahairoi Lateri Church Building.

Table 1. Breakdown cost recap results

	Work Item	Code	Percentage (%)
1	Brick Walls 1 : 5	X1	17.456
2	Homogeneous Ceramic Floor (Granite Tile) 60x60 cm	X6	15.991
3	Hollow Iron/Galvalum Frame and Hanger	X24	8.671
4	Type P1 Door Frame and Leaf	X13	7.002
5	Wall Plastering 1 : 4	X3	6.926
6	Type P2 Door Frame and Leaf	X14	6.080
7	PJ2 Door Frame and Leaf	X11	5.650
8	Tile roof ex. Onduvilla	X33	4.301
9	Wall Smoothing	X5	4.081
10	Wall Painting	X27	3.439
11	Stair Railing	X26	3.063
12	240x120x0.9 CM Gypsumboard Ceiling	X25	1.992
13	Type J1 Frames and Shutters	X16	1.900
14	30x30 Non Slip Ceramic	X7	1.756
15	Ceiling Painting	X28	1.706
16	Homogeneous Ceramic LT Stairs (Granite Tile) 30x60 cm	X9	1.218
17	Profile/Relief Work Floor 1 + Balcony 1	X40	0.908
18	Type J2 Frames and Window Shutters	X17	0.894
19	Brick Walls 1 : 3	X2	0.830
20	Gutter Floor Profile/Relief Work 1 + Balcony 2	X41	0.791
21	Ground Floor Profile/Relief Work	X39	0.718
22	Wall (Roof) Work	X31	0.654
23	Type 2 Dome Work	X30	0.529
24	Type 1 Dome Work	X29	0.492
25	Casement Window Hinges	X20	0.451
26	Wall Plastering 1 : 3	X4	0.324
27	the PJ3 Door Frame and Leaf	X12	0.289
28	Type J3 Frames and Window Shutters	X18	0.217
29	The PJ1 Door Frame and Leaf	X10	0.211
30	Roof Ridge ex. Onduvilla	X34	0.189
31	Gutter Floor Profile/Relief Work 2. Elv. +13.00	X42	0.177
32	Sitting Toilet	X35	0.165
33	Window Curtain Slot	X22	0.155
34	Type P3 Door Frame and Leaf	X15	0.146
35	Roof Plate Painter (Aquaproof)	X32	0.130
36	Gutter Floor Profile/Relief Work 4. Elv. +18.80	X44	0.119

	Work Item	Code	Percentage (%)
37	Class A 2 Slaag Door Locks	X23	0.097
38	Sink	X36	0.094
39	30x60 WC Wall Ceramics	X8	0.069
40	Casement Door Hinges	X19	0.060
41	Gutter Floor Profile/Relief Work 3. Elv. +15.50	X43	0.027
42	Door Rambunc Slot	X21	0.021
43	Water Faucet	X37	0.010
44	Floor Drain	X38	0.003

Based on Table 1, there are 44 architectural works. The work item with the highest total cost is the 1:5 Brick Wall Installation work item with a presentation value of 17.456% and the work item with the lowest total cost is the Floor Drain with a percentage value of 0.003%. At this stage there are 3 estimated work item, namely dome work, wall (roof) work and profile/relief work which cannot be included in subsequent calculations so there are 35 work item that can be carried out value engineering.

Function Analysis Stage

At the function analysis stage, the results are obtained in the form of cost and worth values according to the function of each material which illustrates the amount of efficiency savings from each work item. Cost value is the unit cost of the material and worth is the minimum cost to fulfill the function of a material. The cost/worth value requirement for savings to be made is that the results of the comparison of the values obtained are >1 (Iswati et al., 2017; Rahmawan & HS, 2021). If the cost/worth comparison results obtained are <1 or = 1, then savings cannot be made. Table 2 is a recap table calculation index function analysis that has C/W > 1:

Table 2. Index function analysis recap results

Code	Work Item	C/W
X1	Brick Wall 1:5	1.33
X2	Brick Wall 1:3	1.39
X3	Wall Plastering 1:4	1.95
X4	1:3 Sconing Wall Plastering	1.42
X6	Homogeneous Ceramic Floor Tile (Granite Tile) 60x60 cm	1.11
X7	Ceramic Floor 30x30 cm Anti Slip	1.27
X8	Ceramic WC Wall 30x60 cm	1.53
X9	Ceramic Stair Floor 30x60 cm	1.14
X24	Galvalume Hollow Iron Frames and Hangers	2.00
X25	Gypsum board ceiling 240x120x0.9 cm	1.12
X27	Wall Painting	1.46
X28	Ceiling Painting	1.46
X33	Tile Roof ex. Onduvilla	1.41
X34	Tiled Roof Ridge ex. Onduvilla	1.01

Based on Table 2, it shows that from the results of the recap of the function analysis stage, 14 work items were obtained that were suitable for value engineering. The application of the value engineering concept to 14 work items can be carried out because the function analysis value obtained is >1 so that the work above meets the requirements and can be continued to the next stage the creative stage.

Creative Stage

The creative stage is carried out by looking for alternative substitutes for materials whose function for each work item has been analyzed. The search for alternatives was carried out based on the 2022 Maluku Provincial Government Unit Price Standard Report and the 2023 Ambon City Unit Price Standard. The aim of the creative stage was to get a price that was cheaper than the original material price with the approval of the consultant (Irfanto et al., 2023). The following is the code B0 for the initial design material and the alternative replacement materials are coded A1, A2, A3 and so on with the aim of facilitating alternatives at the next stage.

The use of alternative variations is seen in terms of dimensions, brands and changes in material. Alternative selection is done by changing the brand/brand of material with a more affordable price with the same function and quality. At the creative stage, for every work that is worth carrying out value engineering, there are several alternative material variations.

Evaluation Stage

In the evaluation stage, a new work unit price analysis is calculated based on material alternatives obtained from the 2022 Maluku Provincial Government Unit Price Standard Report and the 2022 Ambon City Unit Price Standard. The aim of the evaluation stage is to consider the alternatives that have been selected for material replacement. Next, the alternative material will be calculated by the latest Unit Price Analysis and the price difference will be calculated. The price obtained from this alternative material can be greater or smaller than the initial material. The material with the lowest UPA price will be selected as the alternative material. The following are the results of a recapitulation of material alternatives:

Table 3. Evaluation costs results of alternative brick wall 1:5 (X1)

Code	Alternative Materials	Cost	Cost Difference (%)
B0	Bricks (22 x 11 x 5 cm)	303,857.10	0
A1	Bricks (22 x 11 x 5 cm) Nusaniwe	336,617.10	+11%
A2	Bricks (22 x 11 x 5 cm) Baguala	287,757.10	-5%
A3	Bricks (22 x 11 x 5 cm) Ambon Bay	300,637.10	-1%
A4	Brick Wall Pair 1:6	305,852.50	+1%

In X1 can be seen that there are materials A1 and A4 which have a UPA that is 11% and 1% greater than the initial material so this material will be eliminated from X1 as an alternative choice. In alternative materials A1 to A3, the differences are obtained from areas of the material with the same specifications. Materials A2 and A3 have a smaller UPA but A2 is the material with the smallest value so the material chosen for work X1 is material A2.

Table 4. Evaluation costs results of alternative brick wall 1:3 (X2)

Code	Alternative Materials	Cost	Cost Difference (%)
B0	Bricks (22 x 11 x 5 cm)	316,773.35	0
A1	Bricks (22 x 11 x 5 cm) Nusaniwe	349,533.35	10%
A2	Bricks (22 x 11 x 5 cm) Baguala	300,673.35	-5%
A3	Bricks (22 x 11 x 5 cm) Ambon Bay	313,553.35	18%
A4	Brick Wall Pair 1:4	307,276.65	-3%
A5	Brick Wall Pair 1:5	303,857.10	-4%
A6	Brick Wall Pair 1:6	305,852.50	-3%

In X2 there are 2 materials that have values above the initial material (B0), namely A1 and A3, so this material is eliminated. The alternative material for A1 to A3 in work X2 is the same as X1 because the work is similar, namely brick wall work. The results obtained on X2 are the same as X1, namely by replacing with bricks from Baguala (A2) with a difference of 5% cheaper than the initial price.

Table 5. Evaluation costs results of alternative wall plestering 1:4 (X3)

Code	Alternative Materials	Cost	Cost Difference (%)
B0	Tonasa Cement (50 kg) Baguala	19,567.92	0
A1	Bosowa Cement (50 kg) Baguala	19,268.40	-1,5%
A2	Three Wheel Cement (50 kg) Baguala	18,894.00	-3,4%
A3	Conch Cement (50 kg) Baguala	18,394.80	-6,0%
A4	Gresik Cement (50 kg) Baguala	17,895.60	-8,5%
A5	Plastering 1:5 15 mm thick	18,664.37	-4,6%
A6	Plaster 1:6 Thickness 15 mm	17,826.68	-8,9%

In the X3 work there are several brands that are used as alternatives to Tonasa cement. From these results, it was found that changing plaster from 1:4 to 1:6 with Tonasa cement had the largest cost difference. This is another alternative provided by consultants to obtain more optimal results in X3 work. Changing to 1:6 plaster with a thickness of 15 mm using Tonasa cement reduced costs by 8.9% from the initial cost.

Table 6. Evaluation costs results of alternative 1:3 sconing wall plestering (X4)

Code	Alternative Materials	Cost	Cost Difference (%)
B0	Tonasa Cement (50 kg) Baguala	5,968.25	0
A1	Bosowa Cement (50 kg) Baguala	5,944.25	-0,4%
A2	Three Wheel Cement (50 kg) Baguala	5,914.25	-0,9%
A3	Conch Cement (50 kg) Baguala	5,874.25	-1,6%
A4	Gresik Cement (50 kg) Baguala	5,834.25	-2,2%

The evaluation of the work X4 is not much different from X3 because it is still in the Wall Plastering category. In this work, changes were only made to the brand of cement used because work X4 had a smaller volume than X3. The results of the cement replacement showed that Gresik Cement (A4) had the lowest UPA compared to other brands, so it was chosen as an alternative material.

Table 7. Evaluation cost results of alternative homogeneous ceramic granite tile 60×60 cm (X6)

Code	Alternative Materials	Cost	Cost Difference (%)
B0	Floor Ceramics 60x60	428,199.45	0
A1	Ceramic Floor 60x60 (Baguala)	222,399.45	-48,1%
A2	Ceramic Floor 60x60 (Teluk Ambon)	224,499.45	-47,6%
A3	Roman ceramic 60x60 cm Gol. A (Baguala)	291,699.45	-31,9%
A4	Roman ceramic 60x60 cm Gol. A (Ambon Bay)	296,949.45	-30,6%
A5	Granite 60x60 Eurogress White	275,949.45	-35,5%
A6	Granite 60x60 Grosetto Crystal White	356,274.45	-16,8%
A7	Granite 60x60 Happy House White	362,049.45	-15,4%
A8	Granite 60x60 Infinity Crystallo White Glossy	431,349.45	0,8%
A9	Granite 60x60 Roman Palacio Perla	440,274.45	2,8%

The X6 floor tile job has 9 alternatives because this job is one of the jobs that has many replacement alternatives without changing its function. Of the nine alternatives, most have a lower UPA value than the initial material. Differences in brand and location are also a consideration because there are many alternatives that can replace the initial material. The evaluation results showed that material originating from Baguala had a cheaper price compared to other locations with a difference of up to 48.1% from the price using the original material.

Table 8. Evaluation costs results of alternative ceramic floor 30×30 cm anti slip (X7)

Code	Alternative Materials	Cost	Cost Difference (%)
B0	Non Slip 30x30 Ceramic Floor	195,202.66	0
A1	Ceramic Asia Tile 30x30 Nirwana Gray (Anti Slip)	130,058.56	-33,4%
A2	Ceramic Asia Tile 30x30 Oscar Gray (Anti Slip)	137,933.56	-29,3%
A3	IKAD Ceramic 30x30 GE 1220 P2 (Anti Slip)	148,958.56	-23,7%
A4	IKAD Ceramic 30x30 GE 24052 DO (Anti Slip)	151,058.56	-22,6%

Evaluation in X7 work is replacing the 30x30 ceramic floor material which has anti-slip properties. There are several alternative brands and types for anti-slip floor ceramic materials as shown in A1 to A4. The evaluation results showed that Ceramic Asia Tile 30x30 with Nirwana Gray color, which has anti-slip properties, has a UPA that is 33.4% lower than the original material.

Table 9. Evaluation costs results of alternative ceramic WC wall 30×60 cm (X8)

Code	Alternative Materials	Cost	Cost Difference (%)
B0	Gray Tiles 30x60	97,282.68	0
A1	Gray Tiles 30x60 (Sirimau)	94,976.57	-2,4%
A2	Platinum Wall Ceramic 30x60 D. Grey	98,291.57	1,0%
A3	Platinum Wall Ceramic 30x60 D. Cream	138,071.57	41,9%

Material changes in work X8 have the same nature as X7, namely replacing them with alternative materials that are available or permitted. In this work there was no significant change in costs, even the alternative materials A2 and A3 had a higher UPA than the initial material. Gray Tiles 30x60 which comes from Sirimau is an alternative material choice because it has a lower UPA of 2.4%.

Table 10. Evaluation costs results of alternatives ceramic stair floor 30×60 cm (X9)

Code	Alternative Materials	Cost	Cost Difference (%)
B0	Ceramic Stairs 30x60	347,900.70	0
A1	Floor Ceramics 30x60 (Baguala)	204,575.70	-41,2%
A2	Ceramic Floor 30x60 (Teluk Ambon)	206,675.70	-40,6%
A3	Granite 30x60 D Palat Bruno	344,225.70	-1,1%
A4	Granite 30x60 D Tube Cream	355,775.70	2,3%
A5	Granite 30x60 Roman Rivoli Ornare	369,425.70	6,2%
A6	Roman Granite 30x60 Cumbria Ash	383,075.70	10,1%

Work X9 is a stair floor using tile 30x60 cm. Similar to the X6 work, in this work changes by changing brands and locations are an alternative to replacing the initial material. The use of 30x60 cm ceramic material has a slight difference between A2 and A3. The price difference is obtained from the location where the material is taken. Although 30x60 floor tiles originating from Teluk Ambon have a difference of 40.6%, 30x60 floor tiles originating from Baguala have the highest difference, namely 41.2% cheaper than the original material, so this material alternative was chosen for value engineering.

Table 11. Evaluation costs results of alternative galvalume hollow iron frames and hangers (X24)

Code	Alternative Materials	Cost	Cost Difference (%)
B0	Hollow metal frame 40.40.2 mm/4 m	104,146.67	0

Code	Alternative Materials	Cost	Cost Difference (%)
A1	Hollow Iron 40 mm x 40 mm x 4 m, thickness 1 mm (Black) Baguala	78,420.00	-24,7%
A2	Hollow Iron 40 mm x 40 mm x 4 m, thickness 1.2 mm (Black) Baguala	106,920.00	2,7%
A3	Hollow Iron 40 mm x 40 mm x 6 m, thickness 2 mm (Black) Baguala	106,946.67	2,7%
A4	Hollow Iron 40 mm x 40 mm x 4 m, thickness 1 mm (Black) Ambon Bay	89,420.00	-14,1%
A5	Hollow Iron 40 mm x 40 mm x 4 m, thickness 1.2 mm (Black) Ambon Bay	106,920.00	2,7%
A6	Hollow Iron 40 mm x 40 mm x 6 m, thickness 2 mm (Black) Ambon Bay	108,946.67	4,6%
A7	Hollow Iron 40 mm x 40 mm x 4 m, thickness 1 mm (Black) Sirimau	79,920.00	-23,3%
A8	Besi Hollow 40 mm x 40 mm x 4 m, tebal 1,2 mm (Hitam) Sirimau	103,920.00	-0,2%
A9	Besi Hollow 40 mm x 40 mm x 6 m, tebal 2 mm (Hitam) Sirimau	100,613.33	-3,4%

In the X24 evaluation, material changes focus on differences in thickness and also the location of alternative materials. The difference in thickness does not affect the function or strength of the building because it is only used on the ceiling of the building which is not subject to additional load. Several alternatives show that using thinner materials can reduce UPA. The evaluation results showed that there were almost similar differences, namely Hollow Iron 40 mm x 40 mm x 4 m, thickness 1 mm (Black) Sirimau had a lower UPA of 23.3% and Hollow Iron 40 mm x 40 mm x 4 m, thickness 1 mm (Black) Baguala has a lower UPA of 24.7%. Because Hollow Iron 40 mm x 40 mm x 4 m, thickness 1 mm (Black) originating from Baguala has a greater difference, this material is an alternative material for X24 work.

Table 12. Evaluation costs results of alternative gypsum board ceiling 240×120×0.9 cm (X25)

Code	Alternative Materials	Cost	Cost Difference (%)
B0	Gypsum board 240 x 120 x 0.9 cm	26,896.20	0
A1	9 mm Gypsum Board (Sirimau)	19,980.20	-25,7%
A2	9 mm Gypsum Board (Teluk Ambon)	20,708.20	-23,0%
A3	9 mm Gypsum Board (Baguala)	20,708.20	-23,0%
A4	Gypsum Jayaboard (1.20 m x 2.40 m), thickness = 9 mm	42,184.20	56,8%
A5	Kalsi board	37,816.20	40,6%

The results of the evaluation of alternative materials for work X24 showed that differences in location prices were the main factor determining the selection of alternative materials. Of the three locations Sirimau, Ambon Bay and Baguala, there are quite small differences in UPA between the three. Gypsum Board from Sirimau has the lowest UPA, namely a difference of 25.7% from the initial material.

Table 13. Evaluation costs results of wall painting (X27)

Code	Alternative Materials	Cost	Cost Difference (%)
B0	Cover Paint (Oil Paint)	27,048.00	0
A1	Vinilex Wall Paint	16,597.00	-38,6%
A2	Anti-Moss Wall Paint	24,709.00	-8,6%
A3	Metrolite Wall Paint	19,041.00	-29,6%

Code	Alternative Materials	Cost	Cost Difference (%)
A4	Avitex Wall Paint	20,289.00	-25,0%
A5	Catylax Wall Paint	19,145.00	-29,2%
A6	No drop leak proof paint	24,917.00	-7,9%
A7	Waterproof Paint	30,429.00	12,5%

Painting work is the work most often carried out by value engineering because it has quite a wide alternative types and brands. The brand used in the X27 job evaluation is the brand in the material catalog and approved by the planning consultant. From 7 alternative materials, it was found that Vinilex Wall Paint (A1) was the alternative material with the lowest UPA, having a difference of 38.6% compared to the initial material.

Table 14. Evaluation costs results of ceiling painting (X28)

Code	Alternative Materials	Cost	Cost Difference (%)
B0	Cover Paint (Oil Paint)	27,048.00	0
A1	Vinilex Wall Paint	16,597.00	-38,6%
A2	Anti-Moss Wall Paint	24,709.00	-8,6%
A3	Metrolite Wall Paint	19,041.00	-29,6%
A4	Avitex Wall Paint	20,289.00	-25,0%
A5	Catylax Wall Paint	19,145.00	-29,2%
A6	No drop leak proof paint	24,917.00	-7,9%
A7	Waterproof Paint	30,429.00	12,5%

The same with X27, in X28 which is ceiling painting, an alternative material similar to X27 is used. The results obtained were the same, namely Vinilex Wall Paint (A1) was the alternative material with the lowest UPA, having a difference of 38.6% compared to the initial material.

Table 15. Evaluation costs results of alternative tile roof ex. Onduvilla (X33)

Code	Alternative Materials	Cost	Cost Difference (%)
B0	Onduvilla Tile Roof	290,080.00	0
A1	Prima Roof Tile (0.30 mm)	142,240.00	-51,0%
A2	Rainbow roof tiles	148,640.00	-48,8%
A3	Pri roof tiles. Roof 87 x 83 cm x 0.25 mm	139,040.00	-52,1%
A4	Sakura Roof tiles	183,840.00	-36,6%

Evaluation of X33 work using several Tile Roof alternatives other than Onduvilla (B0). Based on the search, 4 other alternatives were found with various brands. Prima Roof Tile is an alternative because it has a fairly low UPA. Prima Roof Tile has 2 types, such as A1 and A3, namely a thickness difference of 0.3 mm and 0.25 mm. Of the two alternative materials with the Prima Roof Tile brand, the lowest UPA was obtained, namely Pri roof tiles with a thickness of 0.25 mm with a UPA difference of 52.1% compared to the initial material.

Table 16. Evaluation costs results of alternative tiled roof ridge ex. Onduvilla (X34)

Code	Alternative Materials	Cost	Cost Difference (%)
B0	Onduvilla Tile Rooftop	116,400.00	0
A1	Prima Roof Tile Roof Ridge	70,350.00	-39,6%
A2	Rainbow Tile Roof Ridge	72,550.00	-37,7%
A3	Sakura Roof Tile Ridge	79,150.00	-32,0%

Evaluation of the X34 is the same as the X33 by focusing on changing the type of Tile Roof Ridge. There are only 3 alternative materials available, namely Prima, Rainbow and Sakura. Of the three alternative materials, Prima Roof Tile Roof Ridge material has the lowest UPA, although the difference with Rainbow and Sakura just a little.

Based on Tables 3 to Table 16, data obtained from the evaluation recap results in the form of costs for each material replacement alternative for each work item that is feasible to carry out value engineering. The results of the evaluation stage recap are used to create the presentation stage to obtain the total costs that must be incurred for purchasing alternative materials. At the evaluation stage there is an analysis of the calculation of the unit price of material for each work item from all alternatives available at the creative stage with different values from the initial material price.

Presentation Stage

The presentation stage is the final stage in value engineering research by presenting the best alternative in terms of cost. The best alternative choice is made after going through the evaluation stage and then presented in the latest Cost Budget Plan calculation. The aim of the presentation stage is to obtain the best alternative material costs resulting from value engineering. At the presentation stage, each alternative material selected will replace the initial design material. The following is a volume table of 14 works carried out by value engineering,

Table 17. Calculation of valume for value engineering

Work Item	**Code**	**Volume**	**Unit**
Brick Wall 1:5	X1	1,773.90	m^3
Brick Wall 1:3	X2	81.80	m^3
Wall Plastering 1:4	X3	3,587.97	m^3
1:3 Sconing Wall Plastering	X4	163.60	m^3
Homogeneous Ceramic Floor Tile (Granite Tile) 60x60 cm	X6	1,169.52	m^3
Ceramic Floor 30x30 cm Anti Slip	X7	217.12	m^3
Ceramic WC Wall 30x60 cm	X8	19.28	m^3
Ceramic Stair Floor 30x60 cm	X9	103.70	m^3
Galvalume Hollow Iron Frames and Hangers	X24	1,759.91	m^3
Gypsum board ceiling 240x120x0.9 cm	X25	1,759.91	m^3
Wall Painting	X27	3,547.80	m^3
Ceiling Painting	X28	1,759.91	m^3
Tile Roof ex. Onduvilla	X33	516.88	m^2
Tiled Roof Ridge ex. Onduvilla	X34	49.04	m^2

Based on Table 17, it shows that each work item that can be carried out by value engineering has a different volume. Volume at the presentation stage influences the calculation of unit prices and total prices for alternative variations. The purpose of using volume is to obtain a new CBP by multiplying the volume by the unit price analysis of work resulting from the selected evaluation stage. The following is a table of recapitulation results from the presentation stage on material changes after value engineering was carried out:

Table 18. Value engineering recapitulation results presentation stage

Code	**Initial Materials**	**Value Engineering Materials**	**Initial UPA (IDR)**	**VE UPA (IDR)**
X1	Bricks (22 x 11 x 5 cm)	Bricks (22 x 11 x 5 cm) Baguala (A2)	472,140.66	453,625.67
X2	Bricks (22 x 11 x 5 cm)	Bricks (22 x 11 x 5 cm) Baguala (A2)	486,994.35	468,479.35
X3	Tonasa Cement @ 50 Kg	1:6 Plastering Using Tonasa Cement @ 50 Kg	92,624.36	90,621.93

Code	Initial Materials	Value Engineering Materials	Initial UPA (IDR)	VE UPA (IDR)
X4	Tonasa Cement @ 50 Kg	Gresik Cement @ 50 Kg (A4)	94,907.49	94,753.39
X6	Granite Tile 60x60 cm	Ceramic 60x60 cm (Baguala) (A1)	656,045.61	419,375.62
X7	Ceramic 30x30 cm Non Slip	Ceramic Asia Tile 30x30 Nirwana Gray (Anti Slip) (A1)	388,099.31	313,183.60
X8	Wall Ceramics 30x60 cm	Gray Tiles 30x60 (Sirimau) (A1)	171,243.83	168,591.80
X9	Floor Ceramics 30x60 cm	Floor Ceramics 30x60 cm (Baguala) (A1)	563,702.05	398,878.30
X24	Hollow metal frame 40.40.2 mm / 6 m	Hollow Iron 40 mm x 40 mm x 4 m, 1 mm thick (Black) Baguala (A1)	236,407.42	206,821.75
X25	Gypsum board 240 x 120 x 0.9 cm	9 mm Gypsum Board (Sirimau) (A1)	54,300.93	46,638.48
X27	Cover Paint (Nippe Auto 2000)	Vinilex Wall Paint (A1)	46,506.57	34,487.92
X28	Cover Paint (Nippe Auto 2000)	Vinilex Wall Paint (A1)	46,506.57	34,487.92
X33	Onduvilla roof	Pri roof tiles. Roof 87 x 83 cm x 0.25 mm (A3)	399,252.40	205,148.50
X34	Nok Onduvilla	Prima Roof Tile Ridge (A1)	185,000.50	126,155.00

Based on the recapitulation results table, it shows that for each work item there is a change in alternative material at a more affordable price, resulting in a change in the costs incurred. After selecting alternative materials, the new CBP will be calculated and compared with the initial CBP for the 14 work items. Value engineering Unit Price Analysis will be calculated with volume to make new Cost Budget Plan. The results of the Cost Budget Plan calculation after value engineering have a smaller value compared to the initial Cost Budget Plan because the unit prices used have been selected through the evaluation stage. The following is a table of recapitulation results of the initial Cost Budget Plan and the Cost Budget Plan after value engineering is carried out:

Table 19. Results of value engineering budget plan calculation

Kode	Work Item	Initial CBP (IDR)	VE CBP (IDR)
X1	Brick Wall Work 1:5	837,530,325.31	804,686,567.14
X2	Brick Wall Work 1:3	39,836,138.02	38,321,611.03
X3	Wall Plastering Work 1:4	332,333,788.11	325,149,127.59
X4	1:3 Sconing Wall Plastering Work	15,526,864.95	15,501,654.19
X6	Homogeneous Tile Floor Ceramic Work (Granite Tile) 60x60 cm	767,258,467.09	490,468,172.18
X7	Floor Ceramic Work 30x30 cm Anti Slip	84,264,122.95	67,998,423.18
X8	Toilet Wall Ceramic Work 30x60 cm	3,301,267.67	3,250,141.40
X9	Stair Floor Ceramic Work 30x60 cm	58,455,902.86	41,363,680.23
X24	Galvalume Hollow Iron Frame and Hanger Work	416,055,775.29	363,987,666.04
X25	Gypsumboard Ceiling Work 240x120x0.9 cm	95,564,749.36	82,079,527.34
X27	Wall Painting Work	164,996,026.07	122,356,260.31
X28	Ceiling Painting Work	81,847,386.05	60,695,644.09
X33	Tile Roof Work ex. Onduvilla	206,365,580.53	106,037,156.68
X34	Tile Roof Ridge Work ex. Onduvilla	9,072,424.48	6,186,641.20
	Total	**3.879.667.285,84**	**3,018,550,444.79**

Based on the table of recapitulation results of the Cost Budget Plan calculation, it shows that the value of the Cost Budget Plan for the initial work is greater than the Cost Budget Plan after value engineering has been carried out. The application of value engineering on this church project resulted in significant savings on the X33 work, where the CBP value reduction was up to 48.62%. This shows a change in material from Onduvilla to Prima roof tiles. Roof 87 x 83 cm x 0.25 mm which does not change the function of the roof itself can reduce project costs quite significantly so that the application of value engineering becomes necessary in every construction project. Apart from the X33 work, the X6 work has the biggest difference in value, namely up to IDR 276,790,295 just by replacing the type of ceramic from the initial plan with ceramic from Baguala. In the Budget Plan for the initial 14 works, a value of 3,879,667,285.84 IDR was obtained then after value engineering was carried out, the Cost Budget Plan for the 14 work items was 3,018,550,444.79 idr. The savings obtained from calculating the initial Cost Budget Plan and after carrying out value engineering are 861,116,841.05 IDR. These results show that the application of value engineering can save 5.32% or a change in CBP of 16,170,539,500 IDR to 15,309,422,658 IDR.

There is still very little research on church buildings, especially in island areas. When compared with other buildings such as GMIM Syaloom (Kembuan et al., 2016), the savings of 5.32% are still less than GMIM Syaloom which is in Manado City, which is 24.5%. This difference is caused by the replacement material at the Laharoi Lateri church being less and also at a different price than GMIM Syaloom which is located in the city. In other types of buildings such as school building projects in the Nias Islands a total savings of 3.76% was obtained (Irfanto et al., 2023), government building construction work in North Aceh district had savings of 2.5% (Zainuddin et al., 2023), and construction of community health centers in NTT where savings of only 3.4% were obtained from initial costs (Nandito et al., 2021). This shows that the project location is one of the factors in the savings. Access to alternative material archipelagic locations will be more difficult than in city. This shows that value engineering is very dependent on the type of work, work load, and material alternatives. Material alternatives depend on the availability of alternatives in the area, which means engineering value also depends on the project location. This shows that value engineering results vary greatly depending on access to available replacement materials and also the location of the project.

Conclusion

The application of value engineering to the architectural work of the Lahairoi Church Building project includes several key areas: brick wall masonry, plastering, ceramic tiling, ceiling installation, painting, and roofing. The selected alternatives for each type of work are as follows: (1) Wall Masonry: Red Brick (22x11x5cm) from Baguala, with 1:6 plastering using Tonasa Cement and 1:3 sconing plastering with Gresik Cement. Painting is done with Vinylex paint.; (2) Ceramic Work: For floors and walls, use 60x60 cm Baguala Ceramic Tiles, 30x30 cm Asia Tile Nirwana Gray Ceramic (anti-slip), 30x60 cm Sirimau Gray Tiles for walls, and 30x60 cm Baguala Ceramic Floor Tiles for stairs.; (3) Ceiling Work: Install Hollow Iron (40x40 mm x 4 m, 1 mm thick, Black) from Baguala, with 9 mm Gypsum Board from Sirimau, painted with Vinylex Paint.; and (4) Roofing Work: Utilize Pri Roof Tiles (87x83 cm x 0.25 mm) and Prima Roof Tiles. The value engineering process led to significant cost savings for the Lahairoi Church Building project. Initially, the budget for architectural work was IDR 16,170,539,500. After applying value engineering, the revised budget is 15,309,422,658 IDR, resulting in cost savings of 861,116,841.05 IDR, or 5.32%.

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