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Cost Saving Analysis through Value Engineering Implementation in Hermina Aceh Hospital Building Project

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Abstract: *The construction project of the Hermina Aceh Hospital building is one of the construction projects that consists of structured and non-structured elements. The need for optimization of project funding effectiveness requires an organized approach, namely value engineering. The problem in this study is how to apply value engineering to the construction work of the Hermina Aceh Hospital building, what the best alternative is to replace the initial design with selected work items, and how much cost savings can be achieved after analysis with the value engineering method. This study aims to analyze the cost savings obtained from the application of value engineering and evaluate the difference in total planned costs before and after Value Engineering. The scope of the review in this study is limited only to architectural work, including wall and cladding work, door and window work, flooring work, and exterior work. The stages in this analysis include the information stage, creativity stage, analysis stage, development stage, and recommendation stage. The cost savings obtained from each work item in this study are wall and cladding work amounting to 367,040,188.62 IDR or 47.96%, door and window work amounting to 104,897,660.78 IDR or 57.98%, flooring work amounting to 444,590,643.60 IDR or 30.46%, and exterior work amounting to 15,306,348.30 IDR or 41.33%. The total cost of architectural work in the Hermina Aceh Hospital building project is 34,948,315,423.04 IDR; the cost savings obtained are 931,834,841.30 IDR; and there are costs after the implementation of Value Engineering amounting to. 34,016,480,581.75 IDR, or 2.67% of the initial architectural cost. The total cost of the entire Hermina Aceh Hospital building project is 95,960,840,000.00 IDR; the cost savings obtained are 931,834,841.30 IDR; and there are costs after the implementation of Value Engineering amounting to 95,029,005,158.71 IDR, or 0.97% of the total project cost.*

Keywords: Value Engineering, Cost Saving, Building Project, Hospital

1. Introduction

Value Engineering is a systematic and structured concept for performing function analysis to achieve the best value in construction projects. This concept focuses on value and function to balance time, cost, and quality. Value Engineering generates lower costs than planned prices initially, within functional limitations and work quality [1].

Research conducted by [2] stated that by applying Value Engineering to wall work, wall plastering, wall painting, and ceilings, cost savings of 220,825,479.42 IDR were achieved from the initial cost of 900,237,625.53 IDR, with a cost saving percentage of 24.5%.

One construction project currently underway in Aceh Besar District is the Hermina Hospital building project with a building area of 5,524.5 m2 and a development budget of 95,960,840,000.00 IDR (ninety-five billion nine hundred sixty million eight hundred forty thousand rupiah). The project is being built to support and improve health services for the community, especially in the Aceh Besar region. The significant financing aspect becomes the focus of attention for analysis and implementation of Value Engineering to find savings.

The problem in this study is how to apply Value Engineering to the construction work of Hermina Hospital in Aceh and what the best alternative is to replace the initial design of this work item, as well as how much cost savings are obtained after the implementation of Value Engineering. This study aims to determine cost savings and find the best alternatives to replace the initial design of work items, as well as cost savings after the implementation of Value Engineering at Hermina Hospital in Aceh. In the application of Value Engineering, the initial design used is the design made by planning consultants, and the works reviewed include external work, wall and cladding work, door and window work, and floor work.

2. Literature Review

Value Engineering is an organized and creative approach aimed at identifying unnecessary costs [1]. These unnecessary costs are expenses that do not provide quality, utility, or something that enhances appearance or desired characteristics by consumers [3].

A specific characteristic of the value engineering concept is systematic analysis, from the initial analysis to obtaining a final result that can be accounted for. This systematic process consists of interrelated stages known as the value engineering work plan [4].

The application of Value Engineering begins with the identification of work items from the entire project, finding work items with potential unnecessary costs, and creatively seeking new alternatives to achieve the same desired function as the previous design. This work plan also assists in determining parts that have higher costs compared to similar facilities [5].

Value Engineering, also known as value analysis, is a systematic and organized approach that focuses on improving the value of products, services, or processes by optimizing their functions while reducing costs [6]. It originated in the manufacturing industry but has since been widely adopted in various sectors, including construction, healthcare, and information technology.

One of the key principles of Value Engineering is the emphasis on function. Practitioners of Value Engineering seek to understand the primary function or purpose of a product, service, or process and identify opportunities to enhance that function while minimizing costs [7]. This often involves questioning traditional methods and exploring alternative approaches to achieve the same or better outcomes.

Value Engineering typically involves a multidisciplinary team consisting of engineers, designers, cost estimators, and other relevant stakeholders. These teams collaborate to analyze existing designs or processes, identify areas for improvement, and develop creative solutions that offer better value without sacrificing performance or quality [8].

Research has shown that value engineering can lead to significant cost savings and improvements in project outcomes. For example, a study by [9] found that the application of Value Engineering techniques in construction projects resulted in cost savings ranging from 5% to 25%, depending on the project complexity and scope. Similarly, research by [10] demonstrated that value engineering contributed to enhanced project performance, increased stakeholder satisfaction, and reduced project duration in the construction industry [11]. Overall, Value Engineering is a powerful tool for enhancing value and optimizing resources in various domains.

3. Methodology

The application of Value Engineering research was conducted on the construction project of Hermina Aceh Hospital located on Jalan Soekarno Hatta, Kp. Ajee Pagar Air, Kec. Ingin Jaya, Aceh Besar. The stages in the Value Engineering research on the construction of Hermina Aceh Hospital are as follows:

3.1 Preparation Stage

Before conducting the research process, the researcher must prepare by collecting or obtaining project data. Data collection can be carried out by both consultants and contractors. After obtaining the project data, the researcher then conducts observations at the project site to gain a general overview of the field conditions. The data used in the research is categorized into two groups: a. primary data; b. secondary data. From the collected data, Value Engineering analysis is performed to achieve cost savings. Value Engineering analysis is carried out in five stages: information stage, creativity stage, analysis stage, development stage, and recommendation stage.

3.2 Information Stage

In this stage, gathering project information and necessary data involves:

i. Project description
ii. Primary data is obtained directly from the source (without intermediaries).
iii. Secondary data comprises supporting data that can be used as input and a reference for value engineering analysis.
iv. Breakdown: In this model, the system is broken down from the highest to the lowest elements, listing costs to illustrate expenditure distribution. In addition to actual costs, i.e., costs from non-existent design results, benefit values are also included, which are estimates from the value engineering team of the lowest cost to meet basic functions.
v. Functional analysis aims to: a. Classify main functions (basic functions) and supporting functions (secondary functions). b. Obtain a comparison between costs and the benefit value needed to produce these functions.

3.3 Creativity Stage

The creativity stage in value engineering involves exploring alternative ideas and concepts. The basic principle of this stage is that the quantity of ideas is prioritized. b. Combination and improvisation of ideas are encouraged. c. All ideas are collected without criticism or evaluation of existing ideas. After gathering data and information such as the cost budget plan for the Hermina Aceh Hospital building, the potential work for applying value engineering is identified, namely: wall and cladding work, door and window work, floor work, and exterior work.

3.4 Analysis Stage

This stage aims to analyze the predetermined alternatives from the creative stage and then choose the best alternative as the proposed design in the recommendation stage. The steps taken in the analysis stage include analyzing the advantages and disadvantages.

3.5 Development Stage

The development stage involves preparing final recommendations in writing for the selected alternatives. The steps in the evaluation stage are as follows:

i. Prepare alternatives for the selected ideas to be further developed.
ii. Conduct a project life cycle cost analysis.

3.6 Recommendation Stage

This stage presents the overall decision-making analysis results, which are then handed over to the authorities responsible for decision-making regarding the Value Engineering alternatives.

4. Results

The research findings are presented after data processing is conducted according to the research problem and objectives. These findings result from the application of Value Engineering to the Hermina Aceh Hospital building and determine the cost-saving outcomes obtained after implementing Value Engineering in the Hermina Aceh Hospital building.

4.1 Information Stage

The information stage is the initial stage in Value Engineering planning. In this stage, general information about the work items to be analyzed is collected. This includes data on the initial work, such as planning drawings and budget plans. General information for each selected work item can be seen in Table 1 below.

Table 1: Information Stage

Information Stage		
Project: Hermina Aceh Hospital Construction Project Reviewed Item: Architecture Work		
No	Information Source	Project Data
1	PT. Gelora Intan Reksa, on the Hermina Aceh Hospital Construction Project	a. Planning drawings b. Budget plan (RAB)

Breakdown analysis is used to depict the distribution of costs for the elements of a building. The cost of each work item is then compared to the total project cost to obtain the percentage weight of the work. If a work item has a significant weight, it has the potential to undergo Value Engineering analysis. After identification, several work items with potential for value engineering implementation are selected. Besides having significant costs, the selection of work items can be based on material and design considerations that can generate various replacement alternatives. After identification, the activities with potential for Value Engineering can be seen in Table 2 below.

Table 2: Cost Breakdown

No	Work Item	Cost		Cumulative	
		IDR	%	IDR	%
1	Preparation, Infrastructure, and Supporting Work	2,055,033,421.00	5.88	2,055,033,421.00	5.88
2	Wall and Cladding Work	7,211,542,238.42	20.63	9,266,575,659.42	26.52
3	Door and Window Work	3,365,997,032.53	9.63	12,632,572,691.95	36.15
4	Floor Work	3,377,099,296.00	9.66	16,009,671,987.95	45.81
5	Ceiling Work	1,451,497,670.00	4.15	17,461,169,657.95	49.96
6	Sanitary Work	1,880,285,427.82	5.38	19,341,455,085.77	55.34
7	Other Work	154,627,000.00	0.44	19,496,082,085.77	55.79
8	Facade Work	2,083,521,363.00	5.96	21,579,603,448.77	61.75
9	Exterior Work	11,906,156,012.12	34.07	33,485,759,460.89	95.82
10	Provisional Sum Work	222,153,846.15	0.64	33,707,913,307.04	96.45
11	Other Works	1,240,402,116.00	3.55	34,948,315,423.04	100.00
Total		34,948,315,423.04	100.00		

Functional analysis aims to clarify main (basic) and supporting functions, as well as to compare costs and values to determine potential unnecessary costs. If the cost-to-value ratio is greater than >1, the work item can undergo Value Engineering. The results of the functional analysis for each activity can be seen in Table 3 below.

Table 3: Functional Analysis

No	Work Item	Cost (IDR)	Worth (IDR)
1	Preparation, Infrastructure, and Supporting Work	2,055,033,421.00	-
2	Wall and Cladding Work	7,211,542,238.42	7,211,542,238.42
3	Door and Window Work	3,365,997,032.53	3,365,997,032.53
4	Floor Work	3,377,099,296.00	3,377,099,296.00
5	Ceiling Work	1,451,497,670.00	-
6	Sanitary Work	1,880,285,427.82	-
7	Other Work	154,627,000.00	-
8	Facade Work	2,083,521,363.00	-
9	Exterior Work	11,906,156,012.12	11,906,156,012.12
10	Provisional Sum Work	222,153,846.15	-
11	Other Works	1,240,402,116.00	-
Total		34,948,315,423.04	25,860,794,579.07
Cost / Worth > 1			1.35

4.2 Creativity Stage

In this stage, innovation and creativity are utilized to manage cost elements that potentially lead to cost loss while adhering to the principle of not compromising the performance, quality, benefits, functions, and aesthetics of selected work elements in the Value Engineering concept. This creativity stage is applied to the four work items that have a cost-to-worth ratio exceeding 1.

i. Wall and cladding work, the initial plan specifies the following:
   a. Interior paint (Chrysan White ex. Dulux/Sunstone White ex. Primashield);
   b. Interior paint (Green Satin ex.Duluxe)

c. Exterior paint (Wall Paint Exterior Kuta ex. Primashield/Jplast White ex. Jotun)
d. After analysis and study, it is proposed to consider alternative materials that are more cost-effective and efficient. Alternative I for wall and cladding work is as follows:
e. Interior paint: Nippon Paint Super Vinilex;
f. Exterior paint: Nippon Paint Elastex
g. Alternative II for wall and cladding work is as follows:
h. Interior paint: Propan Eco Shield
i. Exterior paint: Propan Ultraproof
j. Alternative III for wall and cladding work is as follows:
k. Interior paint: Nippon Paint Super Vinilex;
l. Interior paint: Nippon Paint Vinilex
m. Exterior paint: Propan Ultraproof

The total initial design cost for wall and cladding work is 765,276,160.00 IDR. The cost-saving difference after replacing materials with alternative I is 359,002,546.38 IDR, or 46.91%. The cost-saving difference after replacing materials with alternative II is 365,083,356.78 IDR, or 47.71%. The cost-saving difference after replacing materials with alternative III is 367,040,188.62 IDR, or 47.96%.

ii. Door and window work, the initial plan specifies the following:
Wooden door size 1000x2200mm, Solid Wood, Fin. Taco Sheet, Archritave Engineered, Fin. Taco Sheet, Engineered Wood Door Leaf, Fin. HPL main Gold Teak 5356M, Ex. Perform, PVC Edging Taco, Handle Handle LHTR 0016 22mm SSS, MTS IL DL 8485 Lock, CYL DC DL 60MM SN, Hinge Accessories ESS EL 4X3X2MM BB SSS ex. Dekkson. After analysis and study, it is proposed to consider alternative materials that are more cost-effective and efficient.

The alternative I for door and window work is as follows: PVC door + installed glass size 1000x2200mm, con type, Soligen handle, and Soligen hinge. As for alternative II for door and window work: Installed Class II wooden door size 1000x2200mm, Alessa recessed handle and lock type DH-03002-100, Gta Gerber hinge. The total initial design cost for door and window work in the Hermina Aceh Hospital building is 180,933,333.18 IDR. The cost-saving difference after replacing materials with alternative I is 79,733,333.18 IDR, or 44.07%. The cost-saving difference after replacing materials with alternative II is 104,987,660.78 IDR or 57.98%.

iii. Floor work, the initial plan specifies the following:
a. Installation of homogeneous tiles size 600x600mm in New Crystal Grey, ex. Valentino Gress, including the formation of adhesive mortar patterns, tools, and other necessary equipment as per the drawings and specifications.
b. Installation of HT-size 600x600mm type Rover Beige, ex. Valentino Gress, including the formation of screed adhesive mortar patterns, tools, and other necessary equipment as per the drawings and specifications.
c. Installation of HT size 600x600mm type Tirso Bianco, ex. Valentino Gress, including the formation of screed adhesive mortar patterns, tools, and other necessary equipment as per the drawings and specifications.
d. Installation of HT size 600x600mm type Graton Ivory, ex. Valentino Gress, including the formation of screed adhesive mortar patterns, tools, and other necessary equipment as per the drawings and specifications.

After analysis and study, it is proposed to consider replacing materials with others that are more cost-effective and efficient. Alternative I for the floor is as follows:

a. Installation of granite size 600x600 mm, Montello Type Lw 6011
b. Installation of granite size 600x600 mm, Ikad Type Imola
c. Alternative II for the floor is as follows:
d. Installation of granite measuring 600x600 mm, Ikad Type Laguna.
e. Installation of granite measuring 600 x 600 mm, Montello Type 6627.

The total initial design cost for floor work in the Hermina Aceh Hospital building is 1,459,775,505.00 IDR. The cost-saving difference after replacing materials with alternative I is 444,590,643.60 IDR, or 30.46%. The cost-saving difference after replacing materials with alternative II is 431,736,449.10 IDR or 29.58%.

iv. Exterior work, the initial plan specifies the following:
a. Exterior paint.
b. Interior paint.
c. Floor drain type HN51P, ex. Sanei.
d. The replacement of alternative materials for exterior work is as follows:
e. Alternative I:
f. Exterior paint, Nippon Elastex type.
g. Interior paint, Nippon Super Vinilex type.
h. Floor drain, Wasser Hsa-6442 type.
i. Alternative II:
j. Exterior paint, Propan Ultraproof type.
k. Interior paint, Propan Eco Shield type.
l. Floor drain, Wasser Hsa-6442 type.

The total initial design cost for exterior work in the Hermina Aceh Hospital building is 37,038,840.00 IDR. The cost-saving difference after replacing materials with alternative I is 14,782,764.30 IDR, or 39.91%. The cost-saving difference after replacing materials with alternative II is 15,306,348.30 IDR, or 41.33%.

4.3 Analysis Stage

In this stage, an analysis is conducted on the alternatives determined in the creativity stage to select the best alternative as the proposed design in the recommendation stage. The method used in selecting these alternatives involves analyzing their advantages and disadvantages.

4.4 Development Stage

A Life Cycle Cost (LCC) analysis is conducted to determine the most economical alternative among a series of alternatives. In the calculation of LCC, each alternative consists of initial costs and replacement costs. The recapitulation of LCC for each task is presented in the figure below.

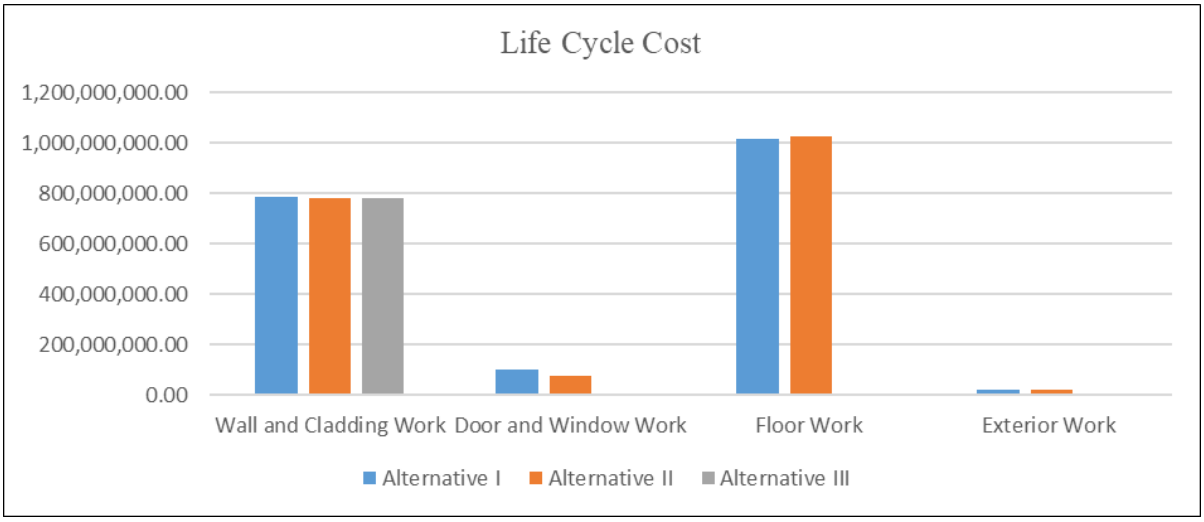

Figure 1: Life Cycle Cost for Alternative Work

Based on Figure 1, it can be observed that the most economically viable alternative design for wall and cladding work is alternative III, with a weight of 39.99%. For door and window work, alternative II with a weight of 57.98% is the most economical. Furthermore, for floor work, alternative I, with a weight of 30.46%, is the most cost-effective. As for exterior work, alternative I, with a weight of 39.91%, is the most economical.

4.5 Recommendation Stage

Based on the results obtained in the previous stages, alternative designs selected for recommendation are known. The alternatives are chosen based on cost savings and considerations from various analyses and methods used.

Table 4: Recommendation Results for Wall and Cladding Work

Project Work Item	Hermina Aceh Hospital Construction Project Wall and Cladding Work
Initial Plan	- Interior Paint, (Chrysan White ex. Dulux/Sunstone White ex. Primashield)
	- Interior Paint, (Green Satin ex. Dulux)
	- Exterior Paint, (Wall Paint Exterior Kuta ex. Primashield/Jplast White ex. Jotun)
Proposal	- Interior Paint, Nippon Super Vinilex Type - Exterior Paint, Nippon Elastex Type
Savings	367,040,188.62 IDR from initial design work cost
Basis for Consideration	Based on the results of life cycle cost calculations

From Table 4, it can be explained that the cost savings obtained for wall and cladding work are 367,040,188.62 IDR, or 47.96%.

Table 5: Recommendation Results for Door and Window Work

Project Work Item	Hermina Aceh Hospital Construction Project Door and Window Work
Initial Plan	- Wooden door size 1000x2200mm, Solid Wood, Fin. Taco Sheet, Archritave Engineered, Fin. Taco Sheet, Engineered Wood Door Leaf, Fin. HPL main Gold Teak 5356M, Ex. Perform, PVC Edging Taco, Handle Handle LHTR 0016 22mm SSS, Lock MTS IL DL 8485, CYL DC DL 60MM SN, Hinge Accessories ESS EL 4X3X2MM BB SSS ex. DEKKSON
Proposal	- Class II Wooden Door installed size 1000x2200mm, Alessa type Flush Handle and Lock DH-03002-100
Savings	104,897,660.78 IDR from initial design work cost
Basis for Consideration	Based on the results of life cycle cost calculations

From Table 5, it can be explained that the cost savings obtained for door and window work are 104,897,660.78 IDR, or 57.98%.

Table 6: Recommendation Results for Floor Work

Project Work Item	Hermina Aceh Hospital Construction Project Floor Work
Initial Plan	- Pair of Homogeneous Tiles size 600x600mm New Crystal Grey ex. Valentino Gress including the formation of adhesive mixture pattern, tools, and other accessories according to the drawing and specifications.
	- Pair of HT size 600x600mm type Rover Beige ex. Valentino Gress including the formation of screed adhesive mixture pattern, tools, and other accessories according to the drawing and specifications.
	- Pair of HT size 600x600mm type Tirso Bianco ex. Valentino Gress including the formation of screed adhesive mixture pattern, tools, and other accessories according to the drawing and specifications.
	- Pair of HT size 600x600mm type Graton Ivory ex. Valentino Gress including the formation of screed adhesive mixture pattern, tools, and other accessories according to the drawing and specifications.
Proposal	- Pair of Granite size 600 x 600 mm Montelo Type Lw 6011 - Pair of Granite size 600 x 600 mm Ikad Type Imola
Savings	444,590,643.60 IDR from initial design work cost
Basis for Consideration	Based on the results of life cycle cost calculations

From Table 6, it can be explained that the cost savings obtained for floor work are 444,590,643.60 IDR, or 30.46%.

Table 7: Recommendation Results for Exterior Work

Project Work Item	Hermina Aceh Hospital Construction Project Exterior Work
Initial Plan	- Exterior Paint - Interior Paint - Floor Drain Type HN51P ex. San ei
Proposal	- Exterior Paint, Nippon Type Elastex - Interior Paint, Nippon Type Super Vinilex - Floor Drain Type Wasser HSA-6442
Savings	15,306,348.30 IDR from initial design work cost
Basis for Consideration	Based on the results of life cycle cost calculations

From Table 7, it can be explained that the cost savings obtained for exterior work are 15,306,348.30 IDR, or 41.33%.

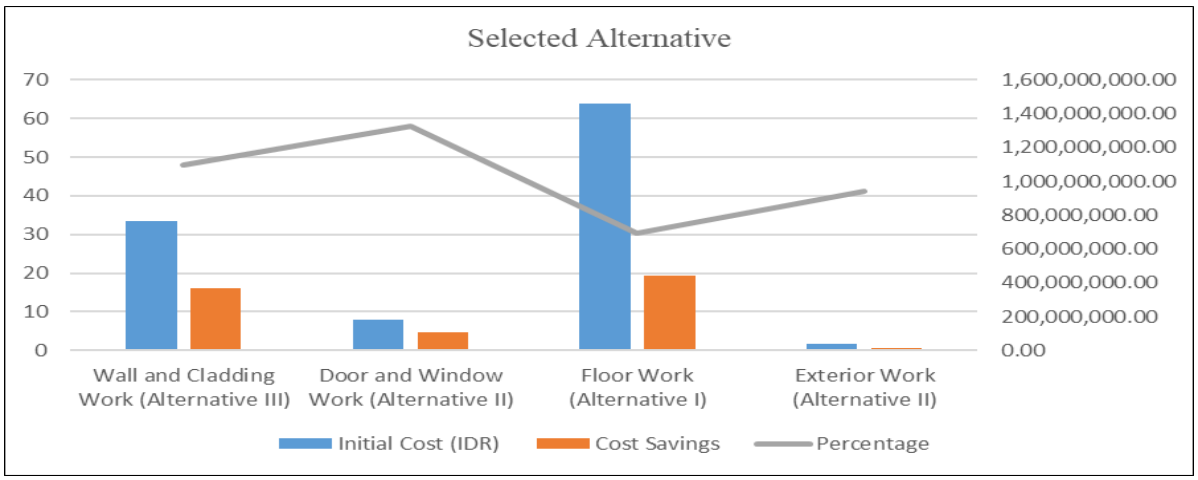

Figure 2: Selected Alternative

In Figure 2, a recapitulation of the results from Value Engineering is provided. After the application of Value Engineering, savings were obtained in four selected tasks: wall and cladding work, door and window work, floor work, and exterior work. The savings percentages are 47.96%, 57.98%, 30.46%, and 41.33% respectively. The total cost savings obtained are 1,084,068,321.30 IDR, representing 36.42% of the total initial architecture costs.

5. Discussion

In this study, the application of Value Engineering was conducted through five stages: the information stage, the creativity stage, the analysis stage, the development stage, and the recommendation stage. In the information stage, four work items were identified as having the potential for Value Engineering applications because they had a higher total cost percentage compared to other work items. Therefore, value engineering was necessary to achieve cost savings. The 4 work items include wall and cladding work, door and window work, floor work, and exterior work.

Based on the creativity stage, several alternative designs were developed to achieve cost savings without compromising the performance, quality, benefits, function, or aesthetics of the work elements. For wall and cladding work, there were 3 alternatives with weightings of 49.91% for alternative I, 47.71% for alternative II, and 47.96% for alternative III. For door and window work, there were 2 alternatives, with weightings of 44.07% for alternative I and 57.98% for alternative II. For floor work, there were 2 alternatives, with weightings of 30.46% for alternative I and 29.58% for alternative II. For exterior work, there were 2 alternatives, with weights of 39.91% for alternative I and 41.33% for alternative II.

In the analysis stage, the advantages and disadvantages of each work item from each alternative proposed in the creativity stage were identified. In the development stage, alternatives with the most economical costs were determined. The alternative designs with the most economical costs were alternative III for wall and cladding work, alternative II for door and window work, alternative I for floor work, and alternative II for exterior work compared to other alternatives. In the recommendation stage, it is recommended to use alternative III for wall and cladding work with a weight of 47.96%, alternative II for door and window work with a weight of 57.98%, alternative I for floor work with a weight of 30.46%, and alternative II for exterior work with a weight of 41.33%. The total cost savings obtained amounted to 1,084,068,321.30 IDR, representing 36.42% of the total initial architecture costs. The total weightings obtained represent 0.97% of the total project cost. Therefore, it can be concluded that the application of Value Engineering in the construction project of Hermina Aceh Hospital can provide cost savings.

6. Conclusion

The application of Value Engineering yielded several significant findings. Firstly, four distinct work items were identified as suitable candidates for value engineering: wall and cladding work, door and window work, floor work, and exterior work. Secondly, the implementation of value engineering led to substantial cost savings across various areas: for wall and cladding work, savings amounted to 367,040,188.62 IDR, constituting 47.96% of the total initial cost; for door and window work, savings reached 104,897,660.78 IDR, representing 57.98% of the total initial cost; for floor work, savings were 444,590,643.60 IDR, equivalent to 30.46% of the total initial cost; and for exterior work, savings totaled 15,306,348.30 IDR, accounting for 41.33% of the total initial cost. Thirdly, the total architecture cost following the application of

Value Engineering was 34,016,480,581.75 IDR, amounting to just 2.67% of the total initial architecture cost. Finally, the overall project cost for Hermina Aceh Hospital post Value Engineering stood at 95,029,005,158.71 IDR, representing a mere 0.97% of the total project cost.

Based on the outcomes of the Value Engineering application, the following recommendations are put forward: Firstly, it is advised to initiate Value Engineering at the outset of the project to attain the most favorable outcomes. Early implementation enables comprehensive evaluation and strategic adjustments that maximize efficiency and cost-effectiveness throughout the project lifecycle. Secondly, to optimize cost savings and enhance the effectiveness of Value Engineering initiatives, the establishment of a dedicated Value Engineering team is strongly recommended. Such a specialized team can bring together expertise from various domains, ensuring thorough analysis, innovative solutions, and seamless implementation of cost-saving measures.

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