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Research Paper

Value Engineering in The Selection of Fire Proof Facade Materials for The Transjakarta Bus Stop Building at Roundabout Hi Jakarta

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ABSTRACT: *The façade system is a critical element of bus stop structures, serving not only as an aesthetic feature and weather barrier but also as a key component in ensuring fire safety. However, many façade materials used in public facilities still fail to meet fire resistance standards, with some even employing flammable components. In practice, material selection often prioritizes low initial costs over long-term safety and maintenance considerations, increasing the risk of fire hazards and future expenses. This study applies the Value Engineering (VE) approach to optimize the selection of fire-resistant façade materials, balancing cost efficiency, technical performance, and safety. A case study was conducted at the strategically located Bundaran HI TransJakarta Bus Stop, which experiences high passenger traffic and demands a high level of safety. The analysis compared the original façade material—Façade Seven® ACP PE—with two alternatives: Alucobond® A2 (Alternative 1) and Seven® ACP FR (Alternative 2). Life Cycle Cost Analysis (LCCA) results show total costs of Rp 5,839,108,944 for the original material, Rp 6,409,735,117 for Alternative 1, and Rp 5,563,289,858 for Alternative 2. The use of Seven® ACP FR yields a 5% cost saving for façade works compared to the original material and reduces total project costs by 0.70%, making it the most economical option. Risk analysis further confirms the superiority of Seven® ACP FR, with LCCA costs reduced from Rp 7,471,223,369.42 to Rp 5,897,558,846.65 after risk mitigation—reflecting a 21.06% saving. These findings highlight the potential of VE to deliver safer, more cost-effective, and sustainable material solutions for public transportation infrastructure.*

KEYWORDS: *Façade, fireproof, value engineering, alternatives*

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I. INTRODUCTION

TransJakarta serves as one of Jakarta's flagship public transportation modes, designed to reduce traffic congestion and promote sustainable urban mobility. As part of continuous service improvements, PT TransJakarta has undertaken the revitalization of several bus stations, including the strategically located Bundaran HI station. Revitalization in this context refers not only to physical refurbishment but also to enhancing functionality, safety, and overall user experience in line with modern transportation infrastructure standards.

A critical structural component in such facilities is the façade system, which functions beyond its aesthetic and weather-protective roles. The façade plays a pivotal role in fire safety, acting as a barrier that can help contain or slow the spread of fire. However, in practice, many façade systems in public buildings—including those in high-density urban areas—still rely on non-fire-resistant or even flammable materials. This creates significant safety risks, particularly in facilities like the Bundaran HI station, which experiences high passenger volumes and is located in a premium commercial and governmental district.

The core challenge lies in selecting a façade system that offers adequate fire resistance while remaining cost-effective and easy to maintain over its life cycle. In many cases, material selection processes overly prioritize initial procurement costs, neglecting long-term safety, operational reliability, and maintenance considerations. Such short-sighted decisions can increase the risk of fire hazards and lead to higher overall costs in the long run.

In this context, the application of Value Engineering (VE) becomes highly relevant. VE is a systematic and multidisciplinary problem-solving methodology that aims to optimize the balance between cost, function, and performance. Through structured stages—including information gathering, functional analysis, creativity, evaluation, development, presentation, and implementation—VE seeks to identify and eliminate unnecessary costs without compromising essential functions such as safety, durability, and user satisfaction.

Despite the recognized importance of VE in infrastructure projects, its comprehensive application in the selection of fireproof façade materials remains limited in Indonesia. Particularly in the design and implementation stages, the absence of a structured VE framework often results in suboptimal material choices. Therefore, this study applies the VE approach to evaluate and recommend optimal fireproof façade alternatives for the Bundaran HI TransJakarta Bus Stop. By incorporating cost analysis, technical performance assessment, and risk evaluation, this research aims to provide evidence-based recommendations that balance economic efficiency with safety and sustainability imperatives in public transportation infrastructure.

II. METHOD

This research was conducted at the Bundaran HI TransJakarta Bus Stop, located in Jakarta's central business district, precisely on M.H. Thamrin Street, Central Jakarta, DKI Jakarta Province. This bus stop was selected as the case study location due to its status as one of the most strategic and iconic stations within the TransJakarta network, particularly in the context of developing a modern and safe urban transportation infrastructure. As a station situated at the heart of governmental, business, hospitality, and commercial activities, Bundaran HI receives high public exposure and faces significant demands for safety and comfort, including the implementation of a fire-resistant façade system. These factors make Bundaran HI Bus Stop a relevant object for analysis in the selection of fire-proof façade materials and systems using the Value Engineering (VE) approach.

The data analysis in this research was carried out to evaluate and compare alternative fire-proof façade materials at the TransJakarta bus stop, employing a Value Engineering (VE) approach. The analysis process was conducted quantitatively and systematically based on the VE stages, supported by expert interviews and technical document studies.

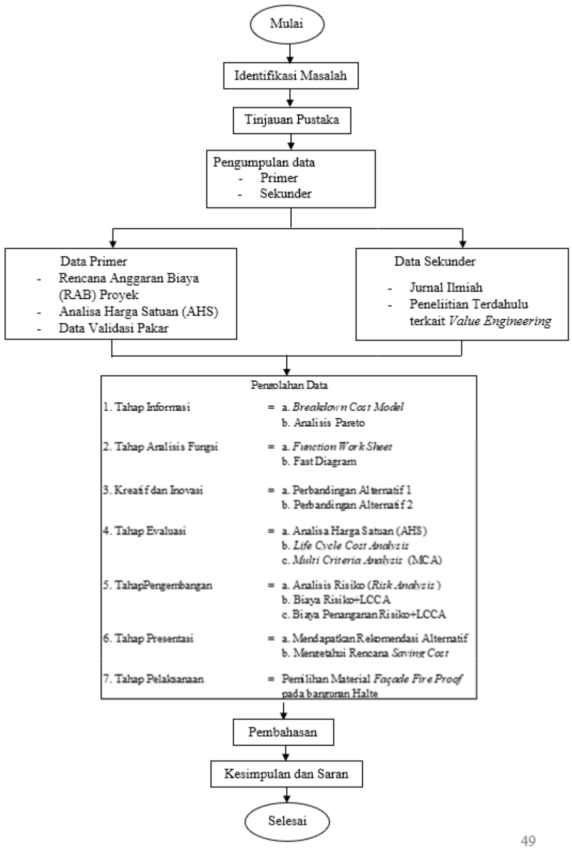
1. Data Collection Techniques
   a. Primary Data
   Primary data were obtained through direct interviews with experts and practitioners in the fields of construction and architecture, particularly those with experience or expertise in building façade planning and implementation, as well as fire safety aspects. The interviews were conducted in a structured manner using a question guide tailored to explore technical information, the implementation of Value Engineering (VE), and considerations in material selection related to safety and cost efficiency.
   b. Secondary Data
   Secondary data consisted of Technical project documents of the Bundaran HI TransJakarta bus stop obtained from relevant agencies such as TransJakarta, Technical specifications and technological data from fire-resistant façade material manufacturers, Scientific journals, textbooks, and academic publications discussing Value Engineering, fire-proof façade systems, and the technical and economic aspects of building material selection.
2. Engineering Value Engineering Stages
   a. Information Phase
   The information phase is the initial step in the Value Engineering (VE) process, aimed at thoroughly collecting and analyzing data related to the research object, particularly technical specifications, cost, function, and the existing condition of building elements. The main focus of this phase is to identify high-cost work items that have the potential to be further analyzed in an effort to improve project value without compromising functionality.
   During this stage, a Pareto Analysis is conducted based on the principle that a majority of project costs (approximately 80%) typically originate from a small portion of components (approximately 20%). This technique is used to identify work items that incur the highest costs and to determine priorities for further analysis in the value engineering process..
   b. Function Analysis Phase
   In this phase, the primary and secondary functions of the façade system are identified and classified, including aesthetic value, weather protection, and fire resistance. These functions serve as parameters for evaluating alternative solutions.
   c. Tahap Kreatif
   This phase involves generating a variety of alternative fire-proof façade materials based on literature review, technical references, and expert recommendations.
   d. Evaluation Phase

The evaluation phase is a continuation of the previous analysis process. After the creativity and innovation phase produces several alternatives, a more detailed assessment is conducted—particularly through Life Cycle Cost (LCC) analysis—to determine the most optimal option. To select the best alternative, the Analytic Hierarchy Process (AHP) method is applied. The selected alternative is the one with the highest economic value.

e. Development Phase
In the development phase, the selected alternative from the evaluation stage is refined and prepared as a technical recommendation ready for implementation. This includes the development of conceptual designs, cost estimates, technical specifications, and an analysis of impacts on project function, quality, and cost.

f. Presentation Phase
This phase involves reporting the recommended alternative through several activities, including preparing presentation documents and delivering a detailed explanation of the selected recommendation.

g. Recommendation/Implementation Phase
In this final stage, the selected and approved alternative solution is applied to the actual project planning or implementation. This includes preparing technical documents, revising the design, coordinating among project teams, adjusting the budget, and supervising field execution to ensure alignment with the value engineering recommendations.
The primary goal of the implementation phase is to ensure that the high-value ideas that have been analyzed and decided upon are realized effectively, efficiently, and in accordance with quality standards—ultimately resulting in overall value improvement for the project.



Gambar 3. 1 Diagram Alur

III. RESULTS

1. Information Phase

a. Breakdown Cost Model
In identifying work items using the Breakdown Cost Model method (Level 1), the percentage (%) of each work item—ranging from the largest to the smallest—within the project of Construction and Revitalization of the BRT TransJakarta Bus Stop (Bundaran HI Station) is obtained. This step is then followed by the application of Pareto Analysis.

Table 4.1 Project Cost of the Construction and Revitalization of the BRT TransJakarta Bus Stop (Bundaran HI Station)

NO	DESCRIPTION	SUB-TOTAL (IDR)	TOTAL COST (IDR)
1	PRELIMINARY WORK		RP 1,888,053,090
1.1	SITE PREPARATION WORK	RP 1,687,249,575	
1.2	DEMOLITION WORK	RP 200,803,515	
2	GENERAL CONDITIONS	INCLUDED	INCLUDED
3	FOUNDATION WORK		NOT APPLICABLE
3.1	BORED PILE FOUNDATION	NOT APPLICABLE	
4	STRUCTURAL WORK		RP 13,671,861,674
4.1	SUBSTRUCTURE WORK	RP 3,164,067,655	
4.2	SUPERSTRUCTURE WORK	RP 1,346,024,353	
4.3	STEEL STRUCTURE WORK	RP 9,161,769,667	
5	ARCHITECTURAL WORK		RP 16,897,507,460
5.1	FAÇADE AND ROOF CLADDING	RP 8,204,167,889	
5.2	STAIR AND RAILING FINISHING	RP 723,702,958	
5.3	WALL MASONRY WORK	RP 287,045,656	
5.4	DOORS AND WINDOWS	RP 1,617,965,844	
5.5	WALL FINISHING	RP 881,827,147	
5.6	FLOOR FINISHING	RP 1,741,993,671	
5.7	CEILING FINISHING	RP 3,056,495,261	
5.8	ACCESSORIES	RP 90,916,367	
5.9	SANITARY WORK	RP 147,813,000	
5.10	SIGNAGE	RP 136,020,000	
5.11	INTERIOR BUILT-IN AND FURNITURE	RP 9,559,667	
6	MECHANICAL, ELECTRICAL & PLUMBING (MEP) WORK		RP 6,583,302,923
6.1	PLUMBING WORK	RP 803,648,200	
6.2	FIRE PROTECTION SYSTEM	RP 640,144,600	
6.3	HVAC SYSTEM	RP 250,259,140	
6.4	ELECTRICAL WORK	RP 1,971,643,600	
6.5	ELECTRONICS	RP 798,046,683	
6.6	GENERATOR SET	RP 406,413,200	
6.7	ELEVATOR AND ESCALATOR	RP 1,239,047,500	
6.8	DEMOLITION WORK	RP 204,100,000	
6.9	SUPPORTING WORK	RP 270,000,000	
7	CONSTRUCTION SAFETY SUPPORT		RP 239,000,000
7.1	CONSTRUCTION SAFETY & COVID-19 PROTOCOLS	RP 239,000,000	
TOTAL PROJECT COST		RP 39,279,725,147	

b. Pareto Analysis of Roof Cladding Work

Based on the analysis, the total cost for Level 3 work items under Façade and Roof Cladding is Rp 8,204,167,889. The Pareto analysis shows that the Aluminium Composite Panel (ACP) work holds the largest percentage among all items. The ACP Seven Polyethylene (AC-03) installation on the curved ceiling at the exterior of the 1st floor accounts for a cost of Rp 2,496,028,357, representing 30.42% of the total. The ACP Seven Polyethylene (AC-03) on the interior wall of the 1st floor costs Rp 1,088,332,746, or 13.27%, while the ACP Seven Polyethylene (AC-03) on the exterior wall of the 1st floor contributes 9.73%. In total, the Aluminium Composite Panel (ACP) work amounts to Rp 4,140,973,376, which represents 53.42% of the façade and roof cladding cost.

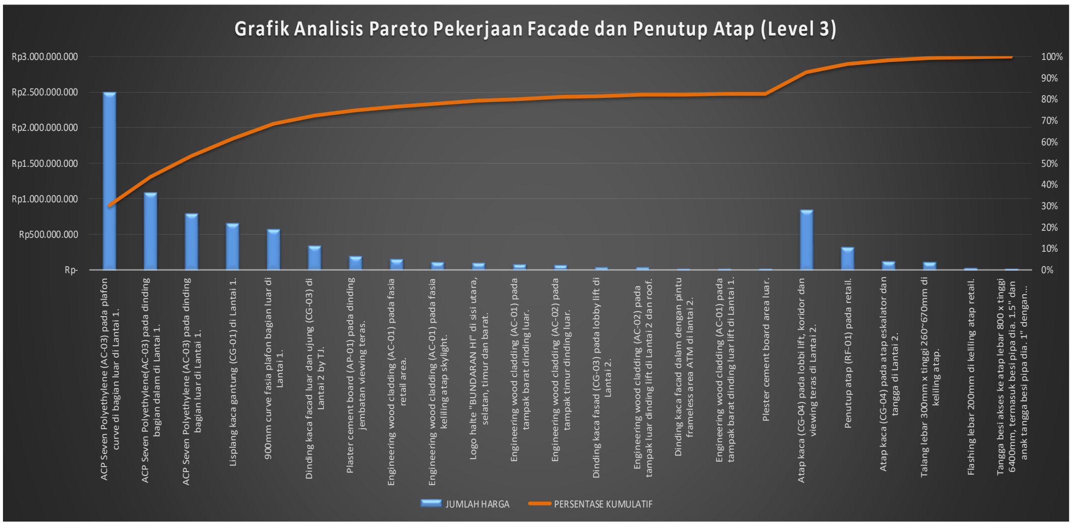


Figure 4.4 Pareto Analysis of Façade and Roofing Work Descriptions (Level 3)

2. Function Analysis Phase
   Based on the results of the Pareto Analysis, four work items were identified as candidates for Value Engineering (VE). These items include:
   a. Aluminium Composite Panel (ACP) Seven Polyethylene
   b. Plaster Cement Board Ceiling Work
   c. Automatic Door System (PSD Ex NABCO)
   d. Primary Steel Structure Work (Steel Beams & Columns)
   Among these four items, and based on discussions with key project stakeholders—such as the design consultant, construction contractor, and the project owner (PT Transportasi Jakarta)—it was agreed that the Façade Aluminium Composite Panel (ACP) Seven Polyethylene work, specifically located at the curved exterior ceiling, interior wall, and exterior wall on the first floor, is the most suitable item to undergo the Value Engineering process.

Tabel 4. 10 Analisis Fungsi (Function Worksheet) Façade Alumunium Composit Panel (ACP)

No	Work Item	Funtion Phase		
		Why	Function	How
1	Façade Panel on Curved Ceiling Area – Exterior, 1st Floor	Protects the upper structure and enhances the building's exterior aesthetics	Serving as both a visual cladding component and a protective shield for the upper structural elements in the bus stop's exterior area	Installed in accordance with the ceiling's curved form, utilizing a framing system tailored to the shelter's architectural design.
2	Façade Panel on Interior Wall – 1st Floor	To provide a clean, modern, and neat interior appearance for user comfort.	As the final interior wall finish to enhance aesthetics and facilitate maintenance.	Using lightweight panels that are either adhered or framed onto the existing wall surface in a modular manner
3	Façade Panel on Exterior Wall – 1st Floor	To protect the wall from weather exposure and unify the visual appearance of the building from the exterior	Functioning as a protective envelope and a defining element of the building's visual identity.	Installed using a framing system or brackets outside the main structure to facilitate easy installation and maintenance.

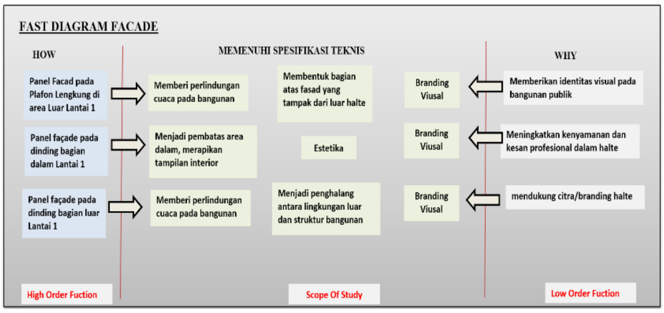


Figure 4.2 Functional Analysis Using FAST Diagram of Aluminium Composite Panel (ACP) Façade

3. Creative Phase

After going through several stages of analysis, it was identified that the item suitable for Value Engineering (VE) is the Aluminium Composite Panel (ACP) Façade. Therefore, the next step is the creative phase, in which several alternative replacements for the original planned design are proposed. In Value Engineering (VE), this approach is used to identify the most efficient and effective combination of materials and installation systems, taking into account the advantages and disadvantages of each option. Some alternative options for the original item are as follows:

Table 4.11 Comparison of Original and Alternative Work Items

No	Merk	Type	Country of Origin	Cost
1	Merk Seven® ACP PE	**Aluminium Composite Panel – Standard (PE Core)** (Exterior & Interior Panel Cladding)	Indonesia	Rp 4.140.973.376
2	Merk Alucobond® A2	**Aluminium Composite Panel – Fire Retardant (FR)** (Exterior & Interior Wall Cladding – A2 Core)	Germany	Rp 5.499.000.000
3	Merk Seven® FR	**Aluminium Composite Panel – Fire Retardant (Class B1)** (ACP Exterior Cladding Fire Retardant)	Indonesia	Rp 4.584.542.040

From the table, three material options were identified as candidates for the creative phase. These alternatives are further analyzed in terms of their specifications, advantages, and disadvantages, compared to the original material, using minimum standard requirements as the basis of comparison.

Table 4.13 Comparison of Aluminium Composite Panel (ACP) Façade Material Specifications)

No	Indicator	Merk Façade ACP					
		Seven® ACP PE		Merk Alucobond® A2		Merk Seven® FR	
		Original	Remarks	Alternatif 1	Remarks	Alternatif 2	Remarks
1	Material	ACP PE (Non-FR)	Poor	ACP A2 (Fire Retardant – Mineral Core)	Good	ACP FR (Fire Retardant – Class B1)	Good
2	Factory Location	Indonesia	Good	Germany	Fair	Indonesia	Good
3	Panel Thickness	4 mm	Good	4 mm	Good	4 mm	Good
4	Core Composition	Polyethylene (Combustible)	Poor	Mineral Core – Class A2 Fire Retardant	Good	FR Composite – Class B1 Fire Retardant	Good
5	Panel Dimension	1220 mm x 2440 mm x 4 mm	Good	1250 mm x 3200 mm x 4 mm	Good	1220 mm x 2440 mm x 4 mm	Good
6	Panel Weight	±5.5 kg/m²	Good	±7.6 kg/m²	Fair	±5.8–6.5 kg/m²	Good
7	Color / Finishing	PVDF Coating	Good	PVDF Coating	Good	PVDF Coating	Good
8	Production Time	±3 days	Good	±5 days (import – limited ready stock)	Fair	±3–4 days	Good
9	Delivery Time	±3 days (local)	Good	±1–2 weeks (imported)	Fair	±3–4 days	Good
10	Installation Time	±5 days (depends on volume)	Good	±5 days (depends on volume)	Good	±5 days (depends on volume)	Good
11	Price	Rp4,140,973,376	Good	Rp5,499,000,000	Poor	Rp4,584,542,040	Fair
12	Fire Resistance Certificate	Not Available	Poor	Available – Class A2 (EN13501-1, ASTM E84)	Good	Available – Class B1 (EN13501-1, ASTM E84)	Good
13	Warranty	10 years (color & weathering)	Good	15 years (color & weathering)	Good	10 years (color & weathering)	Good
14	Visual Aesthetic	Standard – Flat, limited color	Fair	Premium – Neater and more color options	Good	Good – Clean appearance and decent variation	Good

Based on the comparison table of material specifications and its recapitulation, Façade Seven® FR (Alternative 2) demonstrates the best performance, with 13 indicators rated as "Good", 1 indicator rated as "Fair", and no indicators rated as "Poor".

4. Evaluation Phase
   a. Life cycle Cost Analysis (LCCA)

After completing the creative stage, this research proceeds to the evaluation stage to identify the advantages and disadvantages of each proposed alternative, one of which is through Life Cycle Cost Analysis (LCCA). Life Cycle Cost of an item is the total of all expenditures related to the item from the design phase until it is no longer in use. In other words, building cost refers to the expenses incurred throughout the planned service life of the building.

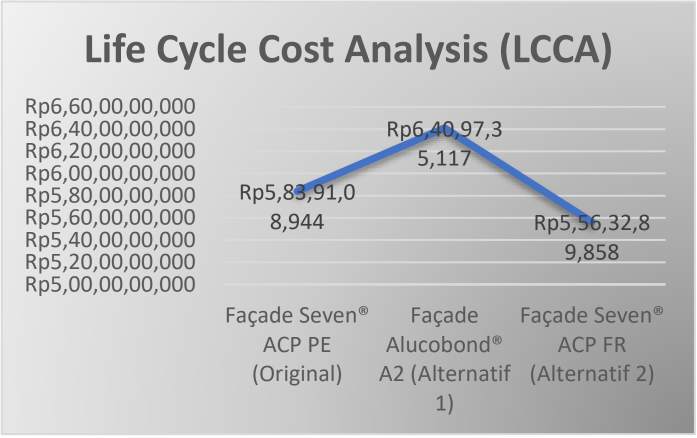


Figure 4.10 Life Cycle Cost Analysis (LCCA) Chart

Based on the results of the Life Cycle Cost Analysis (LCCA), it can be concluded that the Original Work Item has a value of Rp5,839,108,944, Alternative Work Item 1 has a value of Rp6,409,735,117, and Alternative Work Item 2 has a value of Rp5,563,289,858. The most cost-efficient result is found in Façade Seven® ACP FR (Alternative 2), which provides a 5% cost saving.

Table 4.27 Summary of Cost Comparison between Work Items and Project Cost

No	Façade Type	Life Cycle Cost (LCCA)	Total Project Cost	Difference	Percentage
1	Façade Seven® ACP PE (Original)	Rp5,839,108,944	Rp39,279,725,147	–	0.00%
2	Façade Alucobond® A2 (Alternative 1)	Rp6,409,735,117		Rp570,626,173	–1.45%
3	Façade Seven® ACP FR (Alternative 2)	Rp5,563,289,858		Rp275,819,086	0.70%

Based on the cost comparison between the façade work items and the total project cost, it can be concluded that the Façade Seven® ACP PE (Original) has a cost of Rp 5,839,108,944, with no impact (0.00%) on the total project cost. The Façade Alucobond® A2 (Alternative 1) has a cost of Rp 6,409,735,117, resulting in a cost increase of 1.45% to the project. Meanwhile, the Façade Seven® ACP FR (Alternative 2) has a cost of Rp 5,563,289,858, contributing to a cost reduction of 0.70% to the overall project.Therefore, Façade Seven® ACP FR (Alternative 2) offers the lowest cost and the most favorable percentage savings among the options considered.

b. Multi Criteria Analysis (MCA)

Multi-Criteria Analysis (MCA) is a decision-making method used to evaluate various alternatives based on multiple criteria simultaneously. MCA helps compare options by considering factors such as cost, quality, and time, then assigning scores based on the weighted importance of each criterion.

The implementation of weight analysis aims to identify, among the ten variable criteria used, which variables have the most dominant influence compared to others. The weighting process is carried out using the Analytic Hierarchy Process (AHP) method.

Table 4.35 Expert Assessment Averages

No	Criteria Variables	Weight (%)	Original	Alternative 1	Alternative 2
			Façade Seven® ACP PE	Alucobond® A2	Façade Seven® ACP FR
A	COST				
1	Material and distribution cost	12%	11.4	4.2	9,6
2	Payment system & terms	8%	5.6	6.0	6
3	Long-term maintenance cost	10%	4.5	9.0	10
B	QUALITY				
1	Fire resistance certification (A2, B1, NFPA, EN13501)	15%	6.0	14.25	11,25

2	Weather durability and lifespan	10%	4.0	8.0	7,5
3	Potential technical issues on site	7%	3.5	4.9	5,25
4	Compatibility with construction system & installation method	6%	3.9	4.2	4,5
5	Aesthetic value and production consistency	6%	3.0	3.9	4,2
6	Sustainability & environmental footprint	6%	3.3	4.5	4,5
C	TIME				
1	Material delivery time	7%	5.25	3.5	5,25
2	Installation speed	7%	4.9	3.85	4,9
3	Periodic maintenance duration	6%	1.8	3.3	3,3
	Total MCA Score	100%	57	70	76

Based on the average expert assessments from the Multi-Criteria Analysis (MCA) of the Aluminium Composite Panel (ACP) works, the selected item is Alternative 2, using Façade Seven® ACP FR material, with a total average score of 76%.

5. Development Phase

a. Risk Analysis

Risk analysis is the process of assessing identified risks with the aim of estimating the likelihood of occurrence and the magnitude of their impact. This process is carried out to determine the level or status of existing risks so that appropriate mitigation measures can be taken. Risk assessment plays a vital role in management systems, especially in anticipating potential threats to a project or activity.

Table 4.40 Priority Scale

No	Likelihood Level	Probability Description
1	Very Rare	1–2 Occurrences per Project
2	Rare	3–5 Occurrences per Project
3	Occasional	5–8 Occurrences per Project
4	Frequent	8–10 Occurrences per Project
5	Very Frequent	More than 10 Occurrences per Project

Table 4.41 Impact Scale

No	Level of Consequence	Impact Description
1	Very Low	Negligible impact on the project
2	Low	Minor impact on the project
3	Moderate	Noticeable impact on the project
4	High	Significant impact on the project
5	Very High	Very significant impact on the project

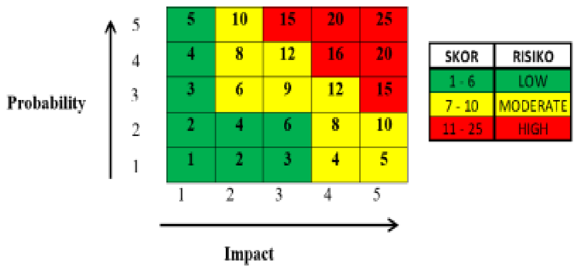


Figure 4.6 Risk Matrix (Probability and Impact)

Subsequently, the Risk Matrix Form was completed by five experts, and the results are presented in the table below:

Table 4.47 Recap of Average Probability and Impact Scores from 5 Experts

Variabel	Risk Description	Nilai		Score	Risk Level
		Probability	Impact		
A	TECHNICAL ASPECTS				
X1	Design errors	3.0	2.0	6.00	LOW
X2	Errors in applying construction installation standards	3.2	4.2	13.44	HIGH

X3	Errors in interpreting shop drawings in the field	1.4	3.4	4.76	LOW
X4	Installation work quality not meeting specifications	3.4	4.4	14.96	HIGH
X5	Inaccurate material delivery schedule planning	2.4	3.0	7.20	MODERATE
X6	Errors or mismatches in joint details between façade and building structure	2.0	3.8	7.60	MODERATE
X7	Waterproofing failure leading to leakage	2.4	3.8	9.12	MODERATE
B	ENVIRONMENTAL ASPECTS				
X8	Noise and air pollution around residential areas due to construction work	2.2	2.6	5.72	LOW
C	OHS ASPECTS (Occupational Health and Safety)				
X9	Work-related accidents	1.8	4.8	8.64	MODERATE
X10	Lack of insurance coverage for workers	2.6	3.2	8.32	MODERATE
X11	Safety equipment failure (scaffolding, gondola, safety nets)	2.2	2.8	6.16	MODERATE
D	SOCIAL ASPECTS				
X12	National security instability affecting project performance	1.2	3.2	3.84	LOW
E	FINANCIAL & COST ASPECTS				
X13	Inaccurate cost estimation	2.0	3.2	6.40	MODERATE
X14	Potential increase in material prices	2.0	3.4	6.80	MODERATE
X15	Rising costs due to non-technical factors	2.2	2.6	5.72	LOW
X16	Increase in unit price of materials or labor	2.6	3.2	8.32	MODERATE
X17	Difficulties in compensation process (e.g., surrounding property damage due to project work)	1.8	2.8	5.04	LOW
X18	Contract completion failure by contractor	1.8	4.2	7.56	MODERATE
F	TECHNOLOGY & RESOURCES ASPECTS				
X19	Material damage during storage at the project site	2.8	3.0	8.40	MODERATE
X20	Material volume discrepancies (over/under supply)	2.6	3.0	7.80	MODERATE
X21	Equipment failure	2.2	2.6	5.72	LOW
X22	Need for appropriate technology to carry out the work	2.4	2.6	6.24	MODERATE
X23	Inadequate supporting facilities and utilities (electricity, water, access roads)	2.0	2.8	5.60	LOW
G	POLICY & REGULATION ASPECTS				
X24	Errors in estimating long-term operation and maintenance costs	2.8	4.2	11.76	HIGH
X25	Errors in estimating job completion time	2.6	3.0	7.80	MODERATE
X26	Execution methods that are incorrect or not in accordance with applicable regulations	3.2	4.2	13.44	HIGH
X27	Regulatory or standards changes related to materials or construction methods	1.8	4.0	7.20	MODERATE

After knowing the results of the evaluation of the probability and impact values of the risk variables, 4 risk categories and risk events are obtained, including the following:

1. Errors in applying standard installation construction methods
2. Installation work quality not meeting specifications
3. Errors in estimating long-term operation and maintenance costs
4. Execution methods that are incorrect or not in accordance with applicable regulations

So that there are several mitigation treatments to minimize the occurrence of risk and even significantly reduce the risk. The following are the results of the "Risk Cost" and "Risk Handling" analysis described in the table below:

Table 4. 49 Comparison Results of Risk Cost Analysis and Risk Handling Costs

No	Name	Risk Cost	Alternative 2 (Initial Cost)	Risk Cost+Alternative 2	Difference	Percentage
1	Risk Cost	Rp1.467.053.453		Rp7.030.343.311	Rp-	
2	Risk Handling Cost	Rp115.000.000	Rp5.563.289.858	Rp5.678.289.858	Rp1.352.053.453	24%

From the results of the comparison of Risk Costs and Risk Handling Costs on Alternative Work Item 2 (Façade Seven® ACP FR), it is known that the total cost is IDR 7,030,343,311 while the calculation of the Risk Handling Cost is IDR 5,678,289,858. So that the savings obtained from the costs that should be incurred are IDR 1,352,053,453 with a percentage value of 24%.

The results of the risk handling obtained are not included in the contract because there are no laws or regulations related to the addition of experts during the work but this analysis will be a correction.

6. Presentation Phase

The total cost of Level 3 work on Façade and Roof Covering work is IDR 8,204,167,889, - with the results of pareto analysis, namely the Aluminum Composite Panel (ACP) work has the largest percentage with each work item. ACP Seven Polyethylene (AC-03) work on the curve ceiling on the outside on Floor 1 has a cost of Rp 2,496,028,357 with a percentage of 30.42%, ACP Seven Polyethylene (AC-03) work on the inner wall on Floor 1 has a cost of Rp 1,088,332,746, with a percentage of 13.27%, and ACP Seven Polyethylene (AC03) work on the outer wall on Floor 1 with a percentage of 9.73%. So the Aluminum Composite Panel (ACP) work has a total cost of Rp4,140,973,376 with a percentage of 53.42%.

Based on the results of the Pareto Analysis, four work items were identified as candidates for Value Engineering (VE). These items include:

a. Aluminium Composite Panel (ACP) Seven Polyethylene
b. Plaster Cement Board Ceiling Work
c. Automatic Door System (PSD Ex NABCO)
d. Primary Steel Structure Work (Steel Beams & Columns)

Among these four items, and based on discussions with key project stakeholders—such as the design consultant, construction contractor, and the project owner (PT Transportasi Jakarta)—it was agreed that the Façade Aluminium Composite Panel (ACP) Seven Polyethylene work, specifically located at the curved exterior ceiling, interior wall, and exterior wall on the first floor, is the most suitable item to undergo the Value Engineering process.

Based on the cost comparison between the façade work items and the total project cost, it can be concluded that the Façade Seven® ACP PE (Original) has a cost of Rp 5,839,108,944, with no impact (0.00%) on the total project cost. The Façade Alucobond® A2 (Alternative 1) has a cost of Rp 6,409,735,117, resulting in a cost increase of 1.45% to the project. Meanwhile, the Façade Seven® ACP FR (Alternative 2) has a cost of Rp 5,563,289,858, contributing to a cost reduction of 0.70% to the overall project.Therefore, Façade Seven® ACP FR (Alternative 2) offers the lowest cost and the most favorable percentage savings among the options considered.

Based on the average expert assessments from the Multi-Criteria Analysis (MCA) of the Aluminium Composite Panel (ACP) works, the selected item is Alternative 2, using Façade Seven® ACP FR material, with a total average score of 76%.

From the results of the comparison of Risk Costs and Risk Handling Costs on Alternative Work Item 2 (Façade Seven® ACP FR), it is known that the total cost is IDR 7,030,343,311 while the calculation of the Risk Handling Cost is IDR 5,678,289,858. So that the savings obtained from the costs that should be incurred are IDR 1,352,053,453 with a percentage value of 24%.

The results of the risk handling obtained are not included in the contract because there are no laws or regulations related to the addition of experts during the work but this analysis will be a correction. 24%.

7. Recommendation/Implementation Phase

From the results of the calculation of several stages of Value Engineering, it is found that Alternative Work Item 2, namely Façade Seven® Aluminum Composite Panel - Fire Retardant work, is chosen as a replacement for the Original Work Item, namely Façade Seven® Aluminum Composite Panel Polyethylene. Although the cost of Seven® ACP Fire Retardant is slightly higher than Façade Seven® Polyethylene, this selection is based on functional considerations and superior safety aspects. FR (Fire Retardant) material has better fire resistance, thus making a positive contribution to the overall protection of the building, especially in public buildings such as TransJakarta bus stops (HI Roundabout Bus Stop) which have high intensity of use.

In terms of quality and technical specifications, Seven® ACP Fire Retardant meets fire safety standards in accordance with fire-resistant building regulations. In addition, the product availability and installation methods are relatively the same as the Polyethylene type, so it does not cause significant additional time or complexity of work. Therefore, this replacement is considered a technically feasible, economically viable alternative in the long term, as well as providing added value in terms of safety and project sustainabilityproyek.

IV. CONCLUSION

1. This research proves that the systematic and structured application of the Value Engineering (VE) method is capable of producing a fire-resistant façade material selection decision that is superior in technical, economic, and sustainability aspects. VE is applied through seven formal stages: information, function analysis, creativity, evaluation, development, presentation, and recommendation, with the object of study at the HI Roundabout TransJakarta Bus Stop. Pareto analysis shows that façade works fall into the category of critical works with significant cost weights, making it feasible to be studied with a VE approach to obtain added value for the project as a whole
2. Alternative recommendations on the Construction and Revitalization of TransJakarta BRT Shelters (HI Roundabout Shelter) after Value Engineering (VE) of the original work item, namely Façade Seven® ACP PE (Original) are as follows:

a) Façade Alucobond® A2 (Alternative 1)
b) Façade Seven® FR (Alternative 2)

The analysis shows that Alternative 2 (Seven® ACP FR) is the best option. Based on the Life Cycle Cost Analysis (LCCA) calculation, the total cost of Original (Seven® ACP PE) is obtained: Rp 5,839,108,944, Alternative 1 (Alucobond® A2): IDR 6,409,735,117, and Alternative 2 (Seven® ACP FR): IDR 5,563,289,858. The use of Seven® ACP FR provides a 5% cost saving on façade work items compared to the original material. In comparison to the total project cost, the original façade material does not provide a reduction in project cost (0.00%), while Alternative 1 (Alucobond® A2) actually increases the project cost by 1.45%, and Alternative 2 (Seven® ACP FR) results in a project cost reduction of 0.70%, making it the most economical alternative overall. From the risk analysis results, it was found that the use of Seven® ACP FR was also superior. The total cost of LCCA with risk is IDR 7,471,223,369.42, while the cost of LCCA with risk handling is IDR 5,897,558,846.65. The difference between the two reached IDR 1,573,664,522.77, which reflects a savings of 21.06% if risks are managed appropriately.

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