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Research Paper

Application of Value Engineering (VE) In the CAWANG UKI Corridor Transjakarta Bus Stop Development and Revitalization Project

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ABSTRACT: *In the planning process for the construction and revitalization project of Transjakarta bus stops, cost management techniques are needed which aim to streamline unnecessary costs so that costs can be saved for the project without reducing quality and function. In implementing Value Engineering (VE), 7 stages are carried out including the information stage, function analysis stage, creative stage, evaluation stage, development stage, presentation stage and recommendation stage. In the Pareto analysis, we get specific work items, including 6 work items, namely Steel Beam + Gording and Roof, Steel Beam Column, Steel Ring Balk, 1st Floor Acp Nano Lisplank, Clear Glass Wall T=12Mm Mulion Frame, Automatic Sliding Door (Psd) from the Owner's request for work items that can be carried out by Value Engineering (VE) is Automatic Sliding Door (Psd). It is known that at the creative stage, from the original work item, namely Automatic Sliding Door (Psd) with the brand DC40v 97.5W Brushed Dunkenmotoren, several alternative work items were recommended, including Alternative 1 - DC24v 50W Brushless Motor and Alternative 2 - Dekkson Asd-D120b L4.2m. Based on the Value Engineering (VE) results, the 2 best alternatives were obtained, namely Automatic Sliding Door (Psd) with the Dekkson Asd-D120b L4.2m brand. From the acquisition cost of work items which originally had a value of IDR 1,673,942,077.37 after Value Engineering (VE) was carried out to IDR 1,478,157,477.68 with a saving cost of 11.70% of the Work Items for Building Frames, Doors and Windows & Railing Areas Utama Bus Stop (Level 3) while the original value was IDR 1,896,908,742 after Value Engineering (VE) was carried out to IDR 1,709,798,742 with a saving cost of 1.22% of the Total Project Value.*

KEYWORDS: *Value Engineering (VE), Value Engineering, Bus Stops, Saving Cost*

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I. INTRODUCTION

The development of the times and advances in technology have made human needs increasingly diverse, thus requiring the construction services industry to meet this diversity. One of them is the transportation sector. Transportation is one of the supporting factors for the country's economy, because indirectly transportation is a supporting factor for the distribution sector. A bus stop is a part of a particular road pavement that is used for temporary stops for buses and other public passenger transportation when picking up and dropping off passengers.

Based on the DKI Jakarta Provincial Central Statistics Agency, in 2024 the number of motorized vehicles registered with the Police will be 24,356,667 units. The total number of Transjakarta buses operating throughout January 2024 reached 4,395 units, an increase of 0.90 percent compared to December 2023 and an increase of 14.07 percent compared to January 2023. Meanwhile, throughout January 2024, the number of Transjakarta passengers reached 30,934,491 people, an increase of 6.83 percent compared to December 2023 and experienced an increase of 54.66 percent compared to January 2023.

Transjakarta is the first Bus Rapid Transit (BRT) transportation system in Southeast and South Asia which has been operating since 2004 with the aim of providing faster, more comfortable and affordable transportation services for Jakarta residents. Currently Transjakarta serves 13 (Thirteen) Main Corridors which are integrated with each other and spread throughout the Jakarta area. There are at least 222 (Two Hundred and

Twenty Two) bus stops that serve transit and transfer/exchange passengers with other modes of transportation around Transjakarta stops.

The achievement of 1 million Transjakarta customers per day in February 2020 encourages the need to accelerate the revitalization of Transjakarta bus stops in 2021, considering PT's 2021 – 2025 business plan. Jakarta Transportation is targeting an average daily passenger number of 1.8 million customers in 2025 and 2.3 million customers in 2030. This is reinforced by the assignment from the regional government of DKI Jakarta Province to build and improve DKI's public transportation integration system. Jakarta.

Referring to the development needs above, PT. Jakarta Transportation plans to revitalize and build 20 (twenty) bus stops in 2022, consisting of bus stops spread across the DKI Jakarta area with very tight construction implementation times.

According to Zimmerman and Hart (1982), value engineering is a management technique that tries to use a systematic approach to find the best functional balance between cost, performance and appearance of a project. The method is to improve management and improvement by identifying and eliminating unnecessary costs.

The construction and revitalization of Transjakarta bus stops requires well-planned engineering and project control. In the project planning process, cost is one of the main aspects that cannot be ignored. Rising costs on a construction project can be caused by things that are not needed in the implementation of the construction project. To prevent cost overruns, construction project planners must carry out planning evaluations so that the project to be carried out can achieve the most optimal final value. For this reason, experts created a concept called Value Engineering, which aims to streamline unnecessary costs so that they can save costs for the project without reducing its quality or function.

Value Engineering (VE) is generally carried out on structural work, because it has a large cost weight compared to other work items. This can happen because the design is less effective and causes large expenditures that are less efficient in the structural work plan, resulting in a very large planned budget (RAB).

In the discussion of Value Engineering (VE) above, the researcher used a case study on the UKI Cawang Corridor Transjakarta Bus Stop Development and Revitalization Project. Based on the considerations above, the researcher conducted a study using Value Engineering (VE) Analysis which is expected to obtain a more efficient and effective value from the Cawang UKI Corridor Transjakarta Bus Stop Development and Revitalization Project, so that saving cost can emerge.

II. RESEARCH METHODOLOGY

The data collection method in the research on the Application of Value Engineering (VE) in the Cawang UKI Corridor Transjakarta Bus Stop Construction and Revitalization Project was carried out using primary data and secondary data methods,

1. Primary Data
   Primary data sources obtained from expert/expert validation. Primary data collection uses questionnaires.
2. Secondary Data
   Secondary data sources obtained from literature studies, scientific journals, papers and previous research related to Value Engineering (VE).

Data Processing Methods used in research on the Application of Value Engineering (VE) in the Transjakarta Bus Stop Construction and Revitalization Project include the Information Stage, Function Analysis Stage, Creative Stage, Evaluation Stage, Development Stage, Presentation Stage and Recommendation Stage.

Based on Circular Letter Number: 11/SE/Db/2022 concerning Guidelines for the Technical Implementation of Value Engineering (Statement of Value Engineering), at the VE workshop stage, the VE work team is gathered and carries out a series of VE workshop activities, namely:

1. Information Stage, aims to collect as much information as possible regarding the research object. This analysis aims to look for high cost work items;
2. Function Analysis Stage, define components to determine what is needed using Pereto Analysis and fast diagrams;
3. Creative Stage, the stage of building alternative ideas, identifying alternative approaches, also known as the speculative stage;
4. Evaluation Stage, a structured process for selecting the best alternative so that the expected function (project, performance, process, system) can be achieved;
5. Development Stage, alternative documents are selected and developed and aim to prepare written suggestions and recommendations for the selected alternatives;
6. Presentation stage, reporting the results of recommendations for selected alternatives; And
7. Recommendation Stage, decisions regarding the alternatives to be used.

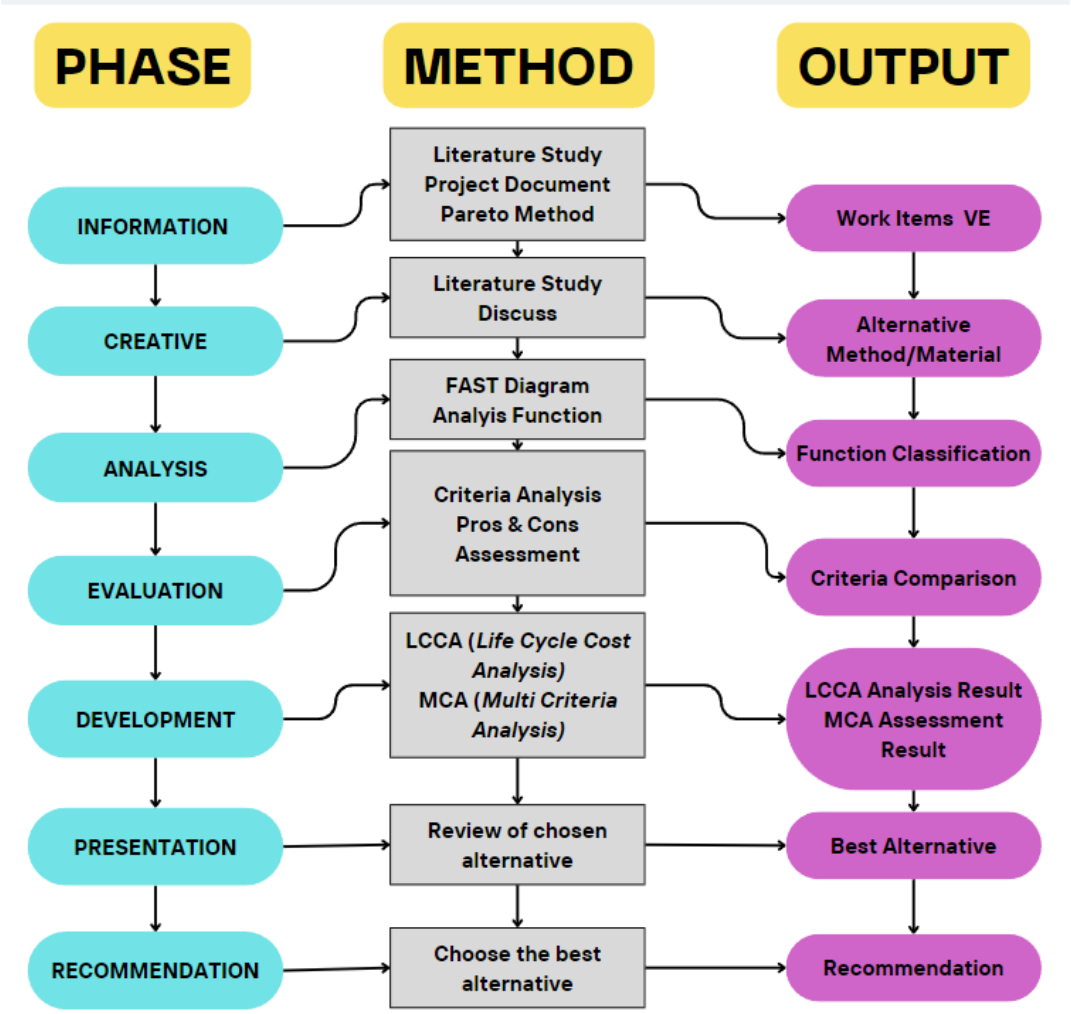

Figure 1. Research Stages

III. RESULTSANDDISCUSSION

3.1 Project Overview

The Transjakarta bus stop is a building as a temporary bus transit area which functions to pick up and drop off passengers located in DKI Jakarta, which connects one bus stop to another. The general data from the Transjakarta Bus Stop Development and Revitalization Project is as follows:

1. Project Name: Construction and Revitalization of Bus Stops Transjakarta
2. Job Location: DKI Jakarta Province
3. Number of Construction: 4 Bus Stops
   - Corridor 14: Tanah Tinggi, Banyamin Sueb, West Sunter Lake A, West Sunter Lake B.
4. Number of Revitalization: 16 Bus Stops
   - Corridor 1: Senayan Roundabout, Grand Mosque, Polda Metrojaya, Hilir Dam, Karet.
   - Corridor 2 : East Cempaka
   - Corridor 3: Grogol 1 and New Bridge, Indosiar
   - Corridor 4: Halimun, Pasar Rumput
   - Corridor 7: Cawang UKI
   - Corridor 9: Semanggi, Grogol 2, Slipi Petamburan, Pancoran Barat.
5. Project Value: IDR 133,531,963,690.00
6. Owner: PT. Jakarta Transportation

After knowing the project data, the Value Engineering (VE) Analysis stages will then be carried out which consists of 7 (seven) stages.

3.2 Information Stage

The information stage is the initial stage of value engineering which functions to collect as much information as possible regarding the research to be studied. In identifying jobs, researchers used the breakdown cost model method. Where the breakdown cost model is a method by sorting work items from largest to smallest, shown by the percentage of each work on the Transjakarta Bus Stop Development and Revitalization Project, which is then continued using Pareto analysis, which can be explained in the following table.

Table 1. Total Cost of Transjakarta Bus Stop Construction and Revitalization Project

No	Name Location	STR & ARS	MEP	Total
1	Bundaran Senayan	5.180.173.682,34	955.331.060,05	6.135.504.742,39
2	Masjid Agung	2.193.835.956,53	569.130.223,48	2.762.966.180,01
3	Polda Metro Jaya	3.210.707.203,94	791.342.556,36	4.002.049.760,29
4	Bendungan Hilir	6.829.797.269,79	1.803.962.401,22	8.633.759.671,01
5	Karet	6.661.885.678,59	1.057.738.242,06	7.719.623.920,66
6	Grogol 1	7.417.154.531,70	1.827.573.267,64	9.244.727.799,34
7	Grogol 2	7.053.082.659,92	2.130.174.251,31	9.183.256.911,23
8	Halimun	2.905.912.703,82	756.022.414,04	3.661.935.117,86
9	Indosiar	4.338.736.084,31	939.705.811,97	5.278.441.896,28
10	Danau Sunter Barat A	3.449.401.640,47	867.836.966,13	4.317.238.606,60
11	Danau Sunter Barat B	3.135.238.154,51	740.549.538,25	3.875.787.692,76
12	Pasar Rumput	3.033.944.302,93	760.783.865,37	3.794.728.168,30
13	Pulomas	2.943.260.162,43	753.079.054,66	3.696.339.217,08
14	Semanggi	6.108.659.571,63	1.939.277.542,20	8.047.937.113,83
15	Slipi Petamburan	6.463.702.359,82	1.113.225.015,97	7.576.927.375,79
16	Tanah Tinggi	4.462.149.799,95	1.004.661.793,51	5.466.811.593,46
17	Jembatan Baru	4.092.254.109,05	845.816.431,39	4.938.070.540,43
18	**Cawang Uki**	**10.473.790.814,34**	**4.850.543.466,41**	**15.324.334.280,75**
19	Benyamin Suaeb	7.545.138.510,77	1.599.635.628,43	9.144.774.139,20
20	Pancoran Barat	7.473.138.501,19	3.253.610.461,52	10.726.748.962,70
	Total	**104.971.963.698,03**	**28.559.999.991,97**	**133.531.963.690,00**

Then, from the results of the Total Cost of the Transjakarta Bus Stop Development and Revitalization Project, a Percentage Weight (%) is created to find out how much of the percentage of expenditure is used to build or revitalize one bus stop. And it was found that the "CAWANG UKI STOCK" had a Percentage Weight Value of 11.48% so that a Value Engineering (VE) Analysis would be carried out from this bus stop.

The Pareto Analysis stage is to analyze the highest costs on the project so that Value Engineering (VE) can be carried out on these items. Pareto's law states: 80% of total costs are contained by 20% of the components. After knowing that the cost value and the largest percentage weight is "CAWANG UKI HALTE" then a Cost Model Breakdown is carried out again after which a Pareto Analysis will be carried out from several Work Items to take the largest value so that the total number of work items has a Weight value of 80% and not less than 20%. The following is a breakdown of the cost model of "CAWANG UKI":

Table 2. Pareto Results 80% of Level 1 Work

No	Project Name (Level 1)	Nominal Amount	Presentation	Cumulative Presentage
1	Architectural Jobs	5.631.206.983	36,75%	36,75%
2	Structural Work	4.167.026.732	27,19%	63,94%
3	Indoor Transportation Work	2.604.400.000	17,00%	80,93%
4	Electrical Work	1.481.427.979	9,67%	90,60%
5	Generator Work	332.560.800	2,17%	92,77%
6	Plumbing Work	203.846.721	1,33%	94,10%
7	Preparatory work	191.852.839	1,25%	95,35%
8	Signage Work	151.700.000	0,99%	96,34%
9	Planning Work	137.621.385	0,90%	97,24%
10	Sound Work	107.180.154	0,70%	97,94%
11	Demolition Work	98.719.375	0,64%	98,59%
12	Occupational Safety and Health Management System (SMK3)	75.407.000	0,49%	99,08%
13	Air Conditioning Work	58.097.082	0,38%	99,46%
14	Data/Internet Jobs	30.998.140	0,20%	99,66%
15	Apar Jobs	12.561.130	0,08%	99,74%
16	Septictank Work (Biotech)	10.472.000	0,07%	99,81%
17	Park Jobs Impacted	11.326.500	0,07%	99,88%
18	Cctv Jobs	8.999.460	0,06%	99,94%
19	Interior Jobs	8.930.000	0,06%	100,00%
	Total	**15.324.334.281**	**100%**	**80,93%**

From the results of the table above, the total amount of Level 1 construction costs is Rp. 15,324,334,281,- with the results of the Pareto analysis, namely for Structural Work which has a construction cost of Rp. 4,167,026,732,- with a percentage result of 27.19% and Architectural Work which has construction costs amounted to IDR 5,631,206,983,- with a percentage yield of 36.75%.

From the results of the Pareto analysis for level 1, level 2 and level 3, it is known that the selected work items are Frame, Door and Window & Railing Work in the Main Bus Stop Building Area. The following is a breakdown of the cost model for level 3 work for frame, door and window & railing work in the main bus stop building area which will be detailed as follows:

Table 3. Pareto Results 80% of Frame, Door and Window & Railing Work in the Main Bus Stop Building Area (Level 3 Work)

No	Job description	Unit	Volume	Unit price	Nominal Amount	Presentation	Cumulative Presentation
1	Automatic Sliding Door (Psd)	unit	18,00	74.450.000	1.340.100.000	76,07%	76,07%
2	Railling Alumunium Glass Clear Hight 1100Mm + Handrail	m'	105,55	1.260.000	132.993.000	7,55%	83,61%
3	Clear Glass Frame 2400mm Height	m'	30,50	3.272.700	99.817.350	5,67%	89,28%
4	Escalator Side Stair Railing	m'	21,44	1.918.800	41.139.072	2,34%	91,61%
5	Bumper Rubber	unit	18,00	2.219.600	39.952.800	2,27%	93,88%
7	Gutter Below Psd	unit	18,00	1.920.000	34.560.000	1,96%	95,84%
9	Stair Void Railing (1100mm High Clear Glass Aluminum + Handrail)	m'	16,80	1.260.000	21.168.000	1,20%	97,05%
10	Railing Hollow Stainless Steel Emergency Door Stairs	m'	5,20	1.918.800	9.977.760	0,57%	97,61%
11	Single Glass Sliding Door Uk.1000X2150Mm (P2B)	unit	2,00	4.375.700	8.751.400	0,50%	98,11%
13	Single Door Sliding 1000X2400Mm (P4 Sliding 100Cm)	unit	3,00	2.833.820	8.501.460	0,48%	98,59%
15	Emergency Door Exit Ss Hairline 1200X1100 (P1)	unit	2,00	2.730.000	5.460.000	0,31%	98,90%
17	Glass Doors And Glass Windows 2900X2600Mm (Pj2)	unit	1,00	5.375.300	5.375.300	0,31%	99,21%
19	Swing Toilet Door Uk. 1000X2400Mm (P3)	unit	1,00	4.442.700	4.442.700	0,25%	99,46%
20	Janitor Door 700 x 2500 (PT 2)	unit	1,00	4.231.100	4.231.100	0,24%	99,70%
22	Floor Manhole Door (M1)	unit	1,00	2.128.000	2.128.000	0,12%	99,82%
23	Disability Door (Dd)	unit	1,00	1.638.000	1.638.000	0,09%	99,91%
24	Bovenlight 500X700 Mm (Bv)	unit	3,00	514.700	1.544.100	0,09%	100,00%
Total					**1.761.780.042**	**100%**	

From the results of the table above, the total construction costs for Frame, Door and Window & Railing Work in the Main Building Area of Level 3 Bus Stop are IDR 1,761,780,042,- with the results of the Pareto analysis, namely for the Automatic Sliding Door (Psd) which has a construction cost of IDR 1,340,100,000,- with a percentage yield of 76.07%.

3.3 Function Analysis Stage

This stage carries out a function analysis to identify functions that are not absolutely necessary, so that the cost of these functions can be reduced. And don't forget to detail the specifications for the materials that will later be used as alternative materials for the Automatic Sliding Door (Psd) work. Thus function analysis can reduce project costs

3.3.1 Original Material

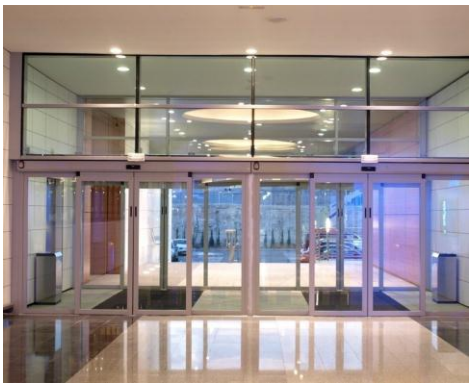

Figure 2. Brand DC40v 97,5W Brushed Dunkenmotoren

3.3.2 Alternative Materials 1

Figure 3. Brand DC24v 50W Brushless Motor

3.3.3 Alternative Materials 1

Figure 4. Brand Dekkson Asd-D120b L4.2m

Table 4. Comparison of Automatic Sliding Door (Psd) Material Specs

No	Indicator	Automatic Sliding Door (Psd)		
		DC40v 97,5W Brushed Dunkenmotoren	DC24v 50W Brushless Motor	Dekkson Asd-D120b L4.2m

		Original	Alternative 1	Alternative 2
1	Material	German - Indonesia	German - Indonesia	Indonesia
2	Factory Location	German	German	Indonesia
3	Heavy	≤ 160 Kg x 2	≤ 150 Kg x 2	≤ 120 Kg x 2
4	Size	750 mm x 1800 mm	750 mm x 1600 mm	650 mm x 1300 mm
5	Thickness	*Temperd Glass* 12 mm	*Temperd Glass* 12 mm	*Temperd Glass* 10 mm
6	Machine	Automatic Sliding Door (Psd)	Automatic Sliding Door (Psd)	Automatic Sliding Door (Psd)
7	Delivery time	Long (> 15 Days Pre Order)	Long (> 15 Days Pre Order)	Fast (6 Days Pre Order)
8	Sensor	Yes	Yes	Yes
9	Cost	Rp 74.450.000	Rp 70.140.000	Rp 65.000.000
10	Periodic Maintenance	10 Tahun	10 Tahun	10 Tahun

3.3.4 Function Worksheet

Table 5. Function Worksheet

No	Work Items	Function Phase Study		
		Why?	Function	How?
1	 *Automatic Sliding Door* (Psd)	Can protect against external dangers such as broken glass in the event of an accident and so on.	Has the main function as access in and out of the bus stop building to Transjakarta buses. As a connecting door from the bus stop building to the Transjakarta bus.	Make the aesthetic level of the bus stop building more charming and elegant.

3.3.4 Fast Diagram

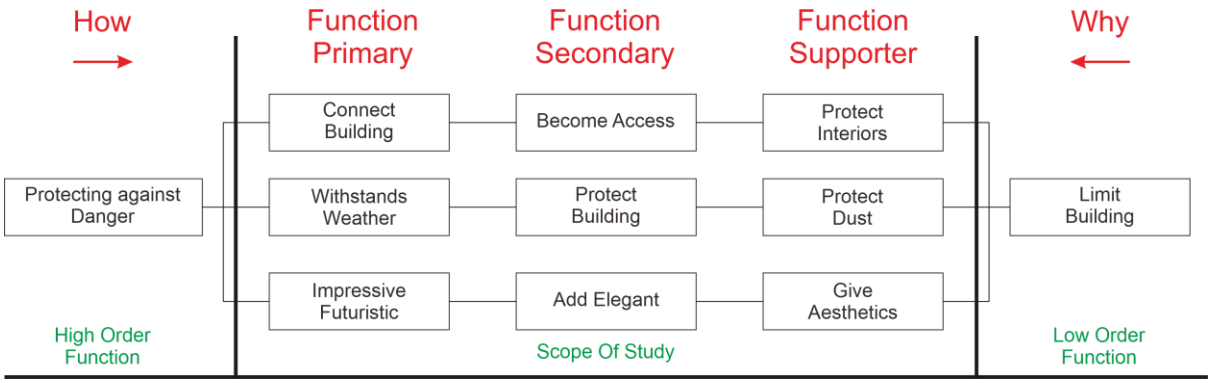

Figure 5. Fast Diagram

3.4 Creative Stage

After carrying out several stages of analysis, it can be seen that the work item that is feasible to carry out Value Engineering (VE) is Automatic Sliding Door (PSD), so the next stage is the creative stage where alternatives will be carried out to replace the initial design. In Value Engineering (VE) it can be used to identify

the most efficient and effective composition, starting from the advantages and disadvantages of each material to be analyzed. Some alternatives to Original work items include the following:

Table 6. Original Work Items with Alternatives

No	Brand	Clasification	Made	Cost
1	DC40v 97,5W Brushed Dunkenmotoren	Original	German	IDR 1.340.100.000,-
2	DC24v 50W Brushless Motor	Alternative 1	German	IDR 1.262.520.000,-
3	Dekkson Asd-D120b L4.2m	Alternative 2	Indonesia	IDR 1.170.000.000,-

The basis for choosing an Automatic Sliding Door (Psd) in construction projects is that it is effective in terms of construction time and relatively easier maintenance than original work items, the age of the work item can also be achieved equal to the planned age of the bus stop building, namely 50 years.

The table above explains that, there are 3 work items that will be analyzed that can be carried out at the creative stage and then explained regarding the comparison of specs and also the advantages and disadvantages of the materials selected as alternatives with minimum standards.

Table 7. Comparison of the Advantages and Disadvantages of Automatic Sliding Doors (Psd)

No	Indikator	Merk ***Automatic Sliding Door*** **(Psd)**			
		Standar Minimum	DC24v 50W Brushless Motor	DC40v 97,5W Brushed Dunkenmotoren	Dekkson Asd-D120b L4.2m
			Original	Alternative 1	Alternative 2
1	Material	Indonesia / Overseas	Difficult to reach	Difficult to reach	Difficult to reach
2	Factory Location	Indonesia / Overseas	Difficult to monitor	Difficult to monitor	Easy to monitor
3	Heavy	≤ 100 Kg x 2	Exceeds standards	Exceeds standards	Exceeds standards
4	Size	650 mm x 1300 mm	Exceeds standards	Exceeds standards	According to standards
5	Thickness	*Temperd Glass* 8 mm	Exceeds standards	Exceeds standards	Exceeds standards
6	Machine	Automatic Sliding Door (Psd)	According to standards	According to standards	According to standards
7	Delivery time	1 Week	Too long	Too long	According to target
8	Sensor	Must Have	Exceeds standards	Exceeds standards	Exceeds standards
9	Cost	Rp 55.000.000	Expensive	Expensive	Expensive
10	Periodic Maintenance	8 Years	Exceeds standards	Exceeds standards	Exceeds standards

From the results of the comparison of 3 Automatic Sliding Door (Psd) brands, both in terms of spec comparison and comparison of advantages and disadvantages, it was found that Alternative 2 with the Dekkson Asd-D120b L4.2m brand is the best among the others.

3.5 Evaluation Stage

After carrying out the creative stage, then carry out the evaluation stage to find out the advantages and disadvantages of several of these alternatives. The following is a comparison between the advantages and disadvantages of each work item:

3.5.1 Life Cycle Cost Analysis (LCCA)

Life Cycle Cost of an item is the sum of all expenses related to the item from the time it is designed until it is no longer used. In other words, building costs are costs over the planned life of the building. Therefore, Life Cycle Cost Analysis (LCCA) can be formulated as below.

LCCA = Initial Cost + O/M Cost + Replacement Cost - Residual Value

The Life Cycle Cost Analysis (LCCA) plan is a plan regarding the proposed expenditure on a construction project throughout the life of the project. The implementation of development, starting from the idea, feasibility study, planning, implementation, to maintenance and demolition operations requires various costs. Life Cycle Cost Analysis (LCC) is used to calculate alternatives based on cost criteria.

Table 8. Calculation Assumptions of Automatic Sliding Doors (Psd)

No	Indicator	Original		Alternative 1		Alternative 2		Information
		Volume	Unit	Volume	Unit	Volume	Unit	
1	Amount	18	Unit	18	Unit	18	Unit	
2	Building Age	50	thn	50	thn	50	thn	permen PUPR no 45/2007
3	Interest Rate Value	12,0	%	12,0	%	12,0	%	(kredit kontruksi/ web PUPR)
4	Inflation Value	4,25	%	4,25	%	2,61	%	web Trading Ekonomic rate (Jerman)
5	Material Increase Costs	5,00	%	5,00	%	5,00	%	web BPS
6	Total Interest	21,25	%	21,25	%	19,61	%	
7	O/M Costs	2,5	%	2,5	%	2,5	%	(permen PUPR no 24/PRT/M/2008)
8	Periodic Replacement Costs	10	thn	10	thn	10	thn	Beberapa komponen 10 %
9	Salvage Value	40	%	40	%	40	%	asumsi (Item Pekerjaan Original)
10	Component Age	10	thn	10	thn	10	thn	

Next, after carrying out the calculations, carry out (Life Cycle Cost Analysis/LCCA) as follows:

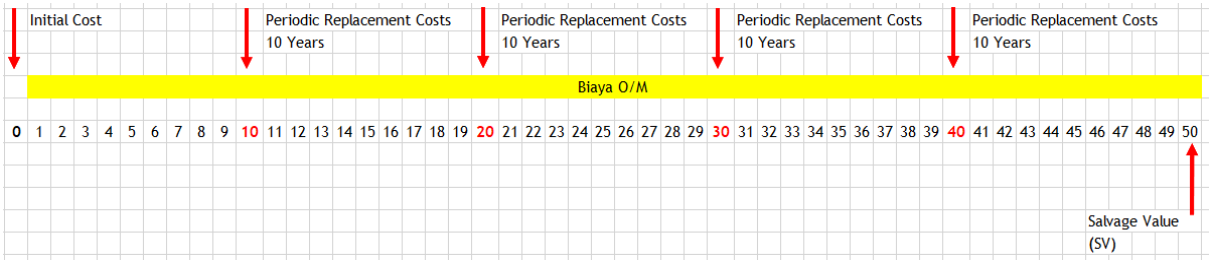

Figure 6. Life Cycle Cost Analysis (LCCA) Calculation

Table 9. Life Cycle Cost Analysis (LCCA) Calculation Recap

No	Name	*Life Cycle Cost Analysis* (LCCA)	Saving Cost Difference	Saving Cost Presentation
1	Original (DC40v 97,5W Brushed Dunkenmotoren)	Rp 1.673.942.077,37	Rp 0,00	0%
2	Alternatif 1 (DC24v 50W Brushless Motor)	Rp 1.577.109.044,63	Rp 96.833.032,73	5,78%
3	Alternatif 2 (Dekkson Asd-D120b L4.2m)	Rp 1.478.157.477,68	Rp 195.784.599,69	11,70%

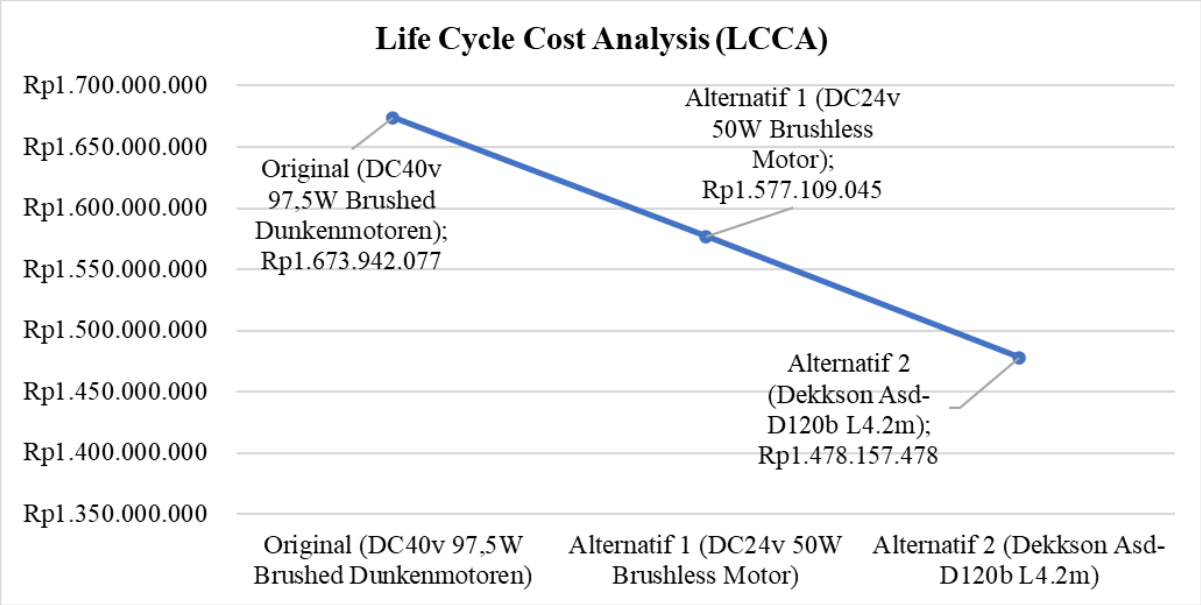

Figure 7. Life Cycle Cost Analysis (LCCA) Calculation Recap

From the results of the Life Cycle Cost Analysis (LCCA) calculation, it can be concluded that the Original Work Item has a value of IDR 1,673,942,077.37; Alternative Work Item 1 has a value of IDR 1,577,109,044.63 and Alternative Work Item 2 has a value of IDR 1,478,157,477.68. And the cheapest calculation result is Alternative Work Item 2 (Dekkson Asd-D120b L4.2m).

3.5.2 Multi Criteria Analysis (MCA)

Multi Criteria Analysis (MCA) is a method used to evaluate and compare several alternatives based on various criteria. In the multi-criteria analysis method, the criterion variable must first be identified which will be used as a comparison of the alternatives to be selected. Various criteria will then be used to determine the selected segment alternatives, namely as follows:

Table 10. Criterion Variable

No	Criterion Variable
1	Material
2	Factory Location
3	Heavy
4	Size
5	Thickness
6	Machine
7	Delivery time
8	Sensor
9	Cost
10	Periodic Maintenance

Table 11. Criteria Values and Weights

No	Indikator	***Automatic Sliding Door* (Psd)**		
		DC40v 97,5W Brushed Dunkenmotoren	DC24v 50W Brushless Motor	Dekkson Asd-D120b L4.2m
		Original	Alternative 1	Alternative 2
1	Material	0	0	1
2	Factory Location	0	0	1

No	Indikator	***Automatic Sliding Door* (Psd)**		
		DC40v 97,5W Brushed Dunkenmotoren	DC24v 50W Brushless Motor	Dekkson Asd-D120b L4.2m
		Original	Alternative 1	Alternative 2
3	Heavy	0	0,5	1
4	Size	1	0,5	0
5	Thickness	1	1	0
6	Machine	1	1	1
7	Delivery time	0	0	1
8	Sensor	1	1	1
9	Cost	0	0	1
10	Periodic Maintenance	1	1	1
	Nilai	5	5	8
	Bobot	50%	50%	80%

From the table above, the values and weights obtained from Multi Criteria Analysis (MCA) per type of Automatic Sliding Door (Psd) work item are selected, namely Alternative Work Item 2 (Dekkson Asd-D120b L4.2m) with a value of 8 points and a weight of 80% .

3.6 Development Stage

3.6.1 Risk Analysis

Risk Analysis is the process of assessing identified risks, in order to estimate the possibility of their occurrence and the magnitude of their impact, to determine the level or status of the risk.

The aim of implementing risk assessment is to identify, measure and control risks as well as monitor Risk Assessment performance and integrate the risk assessment process into planning, implementation and performance evaluation. The data used for risk assessment is data about impact and probability.

Considering that disasters are an unavoidable risk, mitigation is an important thing that needs to be known to at least reduce the impact of disasters. Mitigation is a step that has a number of procedures and stages to reduce the risk and impact of a disaster. The following is a table of risk criteria variables for the UKI Cawang Corridor Transjakarta Bus Stop Development and Revitalization Project:

Table 12. Evaluation of Probability Values and Impact of Risk Variables

Variabel	Risk Categories and Events	Mark		Score	Information
		Probability	Impact		
A	TECHNICAL ASPECTS				
X1	Error in design	2	1	2	Low
X2	Errors in applying standard construction methods	3	2	6	Moderate
X3	Errors in applying field work drawings	2	2	4	Low
X4	The quality of the installation work does not meet specifications	4	4	16	High
X5	Making material delivery schedules that are less accurate and thorough	2	3	6	Low
B	ENVIRONMENTAL ASPECTS				
X6	Noise and air pollution around residents' homes	2	2	4	Low
C	SECURITY ASPECTS OF WORK SAFETY				

Variabel	Risk Categories and Events	Mark		Score	Information
		Probability	Impact		
X7	Work accidents occur	3	2	6	Moderate
X8	Insurance for every worker	2	2	4	Low
D	SOCIAL ASPECT				
X9	National security instability affecting project performance	2	1	2	Low
E	FINANCING AND FINANCE ASPECTS				
X10	Inaccurate construction cost estimates	3	2	6	Moderate
X11	The possibility of an increase in material prices due to inflation and cost escalation	3	2	6	Moderate
X12	Increased costs for non-technical factors	2	2	4	Low
X13	Increase in unit price	2	2	4	Low
X14	The compensation process is difficult to implement	3	3	9	Moderate
X15	Failure to complete the work contract by the contractor	3	4	12	Moderate
F	TECHNOLOGICAL AND RESOURCE ASPECTS				
X16	Material damage during the storage process	2	3	6	Low
X17	The volume of material does not match what was ordered	2	2	4	Low
X18	Equipment damage that results in delays	2	2	4	Low
X19	The need for adequate technology for complex work	3	2	6	Moderate
X20	Availability of supporting facilities and utilities (electricity, etc.)	2	4	8	Moderate
G	POLICY AND REGULATORY ASPECTS				
X21	Error estimating operating and maintenance costs	4	4	16	High
X22	Time estimation error	2	3	6	Low
X23	Wrong implementation method	4	4	16	High

After knowing the results of the evaluation of the probability values and impacts of the risk variables, 3 risk categories and events were obtained, including the following:

1. The quality of installation work does not meet specifications;
2. Errors in estimating operating and maintenance costs; And
3. Wrong implementation method.

3.7 Presentation Stage

From the results of the Life Cycle Cost Analysis (LCCA) calculation, it can be concluded that the Original Work Item has a value of IDR 1,673,942,077.37; Alternative Work Item 1 has a value of IDR 1,577,109,044.63 and Alternative Work Item 2 has a value of IDR 1,478,157,477.68. And the smallest calculation result is Alternative Work Item 2 (Dekkson Asd-D120b L4.2m) with a percentage value of 11.70%.

From the results of the Multi Criteria Analysis (MCA) analysis, the value and weight obtained from the comparison per type of Automatic Sliding Door (Psd) work brand is Alternative Work Item 2 (Dekkson Asd-D120b L4.2m) with a value of 8 points and a weight of 80%.

From the results of the comparison of Risk Analysis Costs and Risk Handling Costs for Alternative Work Item 2 (Dekkson Asd-D120b L4.2m), it is known that the total Risk Analysis Cost is IDR 2,188,542,390. Meanwhile, the results of the calculation of Risk Handling Costs were IDR 1,794,798,742, so that the total savings from the costs that should have been incurred were IDR 393,743,648 with a savings percentage value of 21.94%.

Based on the Value Engineering (VE) results, the 2 best alternatives were obtained, namely Automatic Sliding Door (Psd) with the Dekkson Asd-D120b L4.2m brand. From the acquisition cost of work items which originally had a value of IDR 1,673,942,077.37 after Value Engineering (VE) was carried out to IDR 1,478,157,477.68 with a saving cost of 11.70% of the Work Items for Building Frames, Doors and Windows & Railing Areas Utama Bus Stop (Level 3) while the original value was IDR 1,896,908,742 after Value Engineering (VE) was carried out to IDR 1,709,798,742 with a saving cost of 1.22% of the Total Project Value.

3.7 Recommendatio Stage

From the results of various analysis calculations, it was found that Alternative Work Item 2 with the name Automatic Sliding Door (Psd) Work Item with the Brand Dekkson Asd-D120b L4.2m, was chosen as a replacement for the Original Work Item with the name Automatic Sliding Door (Psd) Work Item with Brand DC24v 50W Brushless Motor. Which has a difference in work costs which originally had a value of IDR 1,896,908,742 with a saving cost of 0.00%, changing to IDR 1,709,798,742 with a saving cost of 1.22% of the Total Project Value of IDR 15,324,334,280.75.

IV. CONCLUSION

1. There are 6 work items that can be carried out by implementing Value Engineering (VE) in the construction and revitalization project of the Transjakarta Bus Stop in the Cawang UKI corridor, namely Steel Beam + Gording and Roof, Steel Beam Column, Steel Ring Balk, 1st Floor Acp Nano Lisplank, Clear Glass Wall T=12Mm Mulion Frame, Automatic Sliding Door (Psd) which from the Owner's request for work items that can be carried out by Value Engineering (VE) is Automatic Sliding Door (Psd).
2. Alternative recommendations for the construction and revitalization project for the Transjakarta Bus Stop in the Cawang UKI corridor after carrying out Value Engineering (VE) from the original work item, namely Automatic Sliding Door (Psd) with the DC40v 97.5W Brushed Dunkenmotoren brand, including:
   a. Alternative 1 - DC24v 50W Brushless Motor
   b. Alternative 2 - Dekkson Asd-D120b L4.2m
3. Based on the Value Engineering (VE) results, the 2 best alternatives were obtained, namely Automatic Sliding Door (Psd) with the Dekkson Asd-D120b L4.2m brand. From the acquisition cost of work items which originally had a value of IDR 1,673,942,077.37 after Value Engineering (VE) was carried out to IDR 1,478,157,477.68 with a saving cost of 11.70% of the Work Items for Building Frames, Doors and Windows & Railing Areas Utama Bus Stop (Level 3) while the original value was IDR 1,896,908,742 after Value Engineering (VE) was carried out to IDR 1,709,798,742 with a saving cost of 1.22% of the Total Project Value.

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