

Application Of Value Engineering in Port Wharf Development in Gorontalo

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ABSTRACT

In an archipelagic and developing country like Indonesia, population growth and mobility continue to increase, necessitating extensive infrastructure development. However, significant infrastructure gaps persist, requiring inclusive and sustainable development strategies to ensure equitable benefits across society. This research aims to optimize infrastructure development budgets through value engineering (VE) methodology applied to the Gorontalo Port development project. The study employs a systematic approach using five VE phases: information gathering, creativity, analysis, development, and recommendations, analyzing cost optimization potential compared to Basic Engineering Design (BED) specifications. Data collection involved secondary sources, including Cost Budget Plans (RAB) and Basic Engineering Design drawings, with analysis focusing on pier building optimization and structural repair work optimization. The value engineering analysis produced significant cost optimization potential of IDR 86.83 billion compared to the original BED price of IDR 144.46 billion, resulting in savings of IDR 57.83 billion. The initial cost breakdown totaled IDR 144,466,589,384, which, after VE efficiency efforts, became IDR 86,831,436,530, achieving cost savings of IDR 57,615,152,854 or a 39.19% reduction. The analysis incorporated a 1.6% inflation adjustment for 2025, bringing the total project cost to IDR 89,236,739,514.48. Key value engineering applications included pier length optimization from 150 m to 100 m based on ship visit data analysis, alternative corrosion protection methods using FRP instead of HDPE, and structural repair optimization through alternative supplier selection. This research demonstrates that value engineering methodology effectively reduces construction costs while maintaining quality, specifications, and performance requirements, providing a systematic approach for infrastructure budget optimization in developing countries.

INTRODUCTION

In many developing countries, such as Indonesia, the infrastructure gap is a significant issue (Wahyunto, 2024). Thus, the challenges in infrastructure development are considerable. Various obstacles, such as budget constraints, complex bureaucracy, and governance problems, often hamper the development process (Sapitri et al., 2024). Therefore, an inclusive and sustainable development strategy is needed to ensure that the benefits of infrastructure development can be experienced by all levels of society. Every year, the central and regional governments continue to carry out infrastructure development across every region in Indonesia. However, the budget allocated by the government for infrastructure development fluctuates considerably. This is evident from the infrastructure budget developments in the State Budget of Indonesia from 2016 to 2021. Between 2016 and 2019, the budget for infrastructure tended to increase, while in 2020, the infrastructure budget experienced a

deficit due to the diversion of funds to the health and economic sectors to address the Covid-19 pandemic.

Several methods are widely applied to minimize high costs and relatively long manufacturing times. One effective way to reduce these high costs and shorten the time required to complete a construction project is by using the value engineering (VE) method. Deviations resulting in loss costs are indeed unavoidable, but with good and optimal planning, the risk of such costs can be reduced and even avoided.

The value engineering analysis method has distinct advantages, namely a systematic, neat, and organized approach to analyzing the value of the main problem in relation to its function or use, while remaining consistent with the needs for appearance, reliability, quality, and maintenance of the project. This can guarantee the final deliverable is accountable. Therefore, value engineering is an alternative or the right choice to save budget, making its application essential in construction projects.

Based on this background, several research questions emerge: What work items can be carried out using value engineering (VE) on port docks? How much are the construction costs before and after applying value engineering (VE)? What are the evaluation results obtained after conducting value engineering (VE)? To maintain research focus and alignment with expectations, this study is limited to analyzing data from the port pier development project in Gorontalo, focusing on basic engineering design (BED) and design criteria for the design and build work, with cost evaluation based on the cost budget plan (RAB) data.

This research is conducted with the aim of identifying work items and analyzing costs, while providing evaluation results from value engineering (VE) activities on the port pier development project in Gorontalo. The benefits of this research include understanding the analysis of value engineering calculations according to applicable terms and conditions, recognizing effective and efficient project implementation methods at the port dock, and increasing direct comprehension of value engineering analysis.

RESEARCH METHOD

Stage Preparation

The preparation stage marked the beginning of this research. Activities in this stage included collecting and searching for project data. Additionally, the researchers conducted a literature study using books and journals to serve as reference materials.

Stage Data Collection

Secondary data were collected for this study, including:

- a. **Cost Budget Plan (RAB) Data:** This consisted of the budget data for the Port pier development project in Gorontalo.
- b. **Basic Engineering Design (BED) Drawing:** These were the initial design drawings of the Port pier development project in Gorontalo.

Analysis Stage

At this stage, two analyses were conducted:

1. Optimization of the pier building
2. Optimization of structural repair work

Recommendation Stage

In this stage, two analyses were carried out:

1. Value engineering (VE) cost estimates
2. Assessment of the magnitude of construction cost deviations

Conclusion and Suggestion Stage

This final stage presented the results obtained from conducting the value engineering analysis on the port development project in Gorontalo.

RESULTS AND DISCUSSION

Work Which done Value Engineering

Three main work categories were identified for value engineering application:

1. Pier Addition Work
2. Work Pole Corrosion Protection
3. Work Pier Structure Repair

Value Engineering No.1: Pier Length Optimization Aspect

Table 1. Value Engineering No.1: Aspects Optimization of Pier Length

VE RECOMMENDATION NO.1	
ASPECTS OF OPTIMIZATION OF WHARF LENGTH	
Basic Concepts	
Addition plans development dock segments 7, 8 & 9 are as much as 150 m	
Recommendation Concept	
<ul style="list-style-type: none"> - Calculation long new ship dock based on visit data boat for the last 2 years (2022 & 2023) - Need long new pier for stage beginning indicated need of 100 m - Optimization long new pier of 50 m 	
Profit	Loss
- Construction prices at this stage early cheaper	- Need setup visiting ships in conditions If moored ship is a container with a weight of 30,000 DWT
Cost Summary	Cost
BED planning costs	Rp. 111 . 638 . 313 . 67 1
After Value Engineering	Rp. 62,379,970,202
Saving	Rp. 49,258,343,468

Basic Concepts

The basis of long the new dock (segment 7, 8, & 9) is following the development that has been planned in the RIP document. In the RIP, the planned ships that will operate are Container ships with a weight of 30,000 DWT and Cargo ships of 10,000 DWT with the needs long dock is as much as 150 m.



Figure 1. Layout of AGIT Port Development Phase 1

Value Engineering Recommendation Basics

Optimization of a long new dock counted based on operational data visit ships at AGIT port for the past 2 years. Visit data This ship is one of the bases determine long pier. But VE team remains entering long data ship according to the RIP document. The following is long data table ships visiting AGIT ports and length data ship on the RIP document.

**Table 2. Ship Length Data (LOA) period Year 2023
DATA CALL KAPAL PELABUHAN ANGGREK JAN-JUN 2023**

NO	SHIP NAME	SHIP TYPE	SIZE		ORIGINAL HARBOR	DESTINED HARBOR
			LOA (M)	GT (TON)		
1	KM. SINAR MAHKOTA	CARGO	83,36	1,999	BIRINGKASSI	BIRINGKASSI
2	MT. ERICA 10	CURAH	112,2	4.124	PORT KLANG	TANJUNG WANGI
3	MT. PUSAKA PRIMA	CURAH	106,18	4.268	SINGAPORE	SAMARINDA
4	MT. HARAPAN BARU	CURAH	109,99	5.072	SINGAPORE	PORT KLANG
5	KM. TANTO TANGGUH	CONTAINER	144	9.380	BITUNG	TG. PRIOK
6	KM. TANTO SALAM	CONTAINER	137,3	10.461	BITUNG	TG. PRIOK
7	KM. TANTO SEJAHTERA	CONTAINER	137	10.461	BITUNG	TG. PRIOK
8	KM. MERATUS WAKATOBI	CONTAINER	146	11.512	BITUNG	TG. PRIOK
9	KM. MERATUS MAMIRI	CONTAINER	149,55	11.964	BITUNG	TG. PRIOK
10	KM. MERATUS MALINO	CONTAINER	149,6	11.964	BITUNG	TG. PRIOK
11	KM. TANTO JAYA	CONTAINER	147	13.346	BITUNG	TG. PRIOK
12	KM. MERATUS MEDAN 1	CONTAINER	161,25	13.853	BITUNG	TG. PRIOK
13	KM. SHORYU 79	CURAH	75,91	1,475	TAHUNA	CIREBON
14	KM. LINTAS DAMAI 1	CURAH	79,96	1,741	SANGATA	TG EMAS
15	KM. PUNDI REJEKI	CURAH	81,5	1,803	GORONTALO	CIREBON
16	KM. SEGARA IBU	CURAH	82,8	1,996	OBI ISLAND	BANJARMASIN
17	KM. BAHARI 35	CURAH	88,8	2,274	SANGATA	CIREBON
18	MV. NEWSUN GREEN	CURAH	99,92	4,022	DAVAO PHILIPPINES	BATANGAS LUZON

19	MV. PHUONG NAM 1	CURAH	102,7	4,079	MINDANAO	CEBU
20	MV. THAN THUY	CURAH	102,79	4,095	BATAAN PHILIPPINES	BATAAN MARIVELES
21	MV. AQUAMARINE	CURAH	102,79	4,095	CEBU	BATANGAS
22	MV. MD SUN	CURAH	105,68	4,353	CAGAYAN DE ORO	CEBU
23	MV. DOLPHIN	CURAH	101,3	4,963	KUCHING	BATANGASLUZON
24	MV. MP STAR	CURAH	113,2	5,444	DAVAO PHILIPPINES	BATANGAS LUZON
25	KM. SPIRIT SEJATI	CURAH	100,33	6,448	TG PERAK	CIGADING
26	MV. RED SAKER	CURAH	117,8	6,550	LAHAP DATU, SABA	MATAAN MARIVELES
27	MV. THANG LONG	CURAH	99,97	6,715	DAVAO PHILIPPINES	BATANGAS LUZON
28	MT. THERESA ORION	CURAH	128,72	7,745	GLADSTONE	PULUPANDAN

Table 3. Ship Length Data (LOA) period Year 2022
DATA CALL KAPAL PELABUHAN ANGGREK 2022

NO	SHIP NAME	SHIP TYPE	SIZE		ORIGINAL HARBOR	DESTINED HARBOR
			LOA (M)	GT (TON)		
1	KM. MERATUS WAKATOBI	CONTAINER	146,00	11,512	BITUNG	TG. PRIOK JKT
2	MT. ELIM	CURAH	135,53	9,240	SINGAPORE	VUNGTAU
3	KM. MERATUS MEDAN 1	CONTAINER	161,85	13,853	BITUNG	TG. PRIOK JKT
4	KM. MERATUS WAINGAPU	CONTAINER	146,00	11,512	BITUNG	TG. PRIOK JKT
5	KM. TANTO TANGGUH	CONTAINER	144,83	9,380	BITUNG	TG. PRIOK JKT
7	MT. DA KUN SHAN	CURAH	106,84	5,493	KOREA SELATAN	PONTOLOAN
9	KM. TANTO JAYA	CONTAINER	146,00	13,346	BITUNG	TG. PRIOK JKT
11	KM. STAR SEJATI	CURAH	97,73	2,484	WEDA	CIGADING
14	MV. J. LUCK	KARGO	110,67	7442	SHANGHAI, CINA	PANTOLOAN
16	TB. HAKO 50	CURAH	28,30	174	NUNUKAN	SAMARINDA
17	TK. MAJU BERKAH		70,15	1,446		
18	MV. VTC PHOENIX	CURAH	153,20	14,851	KO SHICAN, THAILAND	MOROWALI
19	KM. MERATUS MAKASSAR	CONTAINER	149,55	11,946	BITUNG	TG. PRIOK JKT
20	KM. TANTO SEJAHTERA	CONTAINER	137	10.461	BITUNG	TG. PRIOK JKT
25	KM. SALIM MUJUR 1	CARGO	78,96	1,638	BIRINGKASSI	BITUNG
26	KM. AMRITA VII	CURAH	99,92	5,753	WEDA	TG. EMAS SEMARANG

28	KM. SRIWIJAYA MAJ	CURAH	85,00	2,955	MOROWALI	CIGADING
31	MT. JAYA OCEAN	CURAH	102,51	4275	SINGAPORE	SORONG
32	KM. MERATUS MALINO	CONTAINER	149,55	11,964	BITUNG	TG. PRIOK JKT
40	KM. ANUGERAH MANDIRI 8	CURAH	82,65	1,592	GORONTALO	BANJARMASIN
46	MT. LG ASPHALT 2	CURAH	99,50	5,051	TELUK PALU	SINGAPORE
48	KM. TANTO SALAM	CONTAINER	137,30	10,461	BITUNG	TG. PRIOK JKT
49	KM. ARTHA PRIMA	CURAH	62,15	982	DARUBA	BANJARMASIN
53	KM. AMRTA VII	CARGO/CURAH	99,92	5.753	BIRINGKASSI	BIRINGKASSI
54	KM. TANTO SEMANGAT	CONTAINER	140	8.612	BITUNG	TG PRIOK JKT
66	MT. BON CHALLENGER	CURAH	128,60	8.581	BATANGAS LUZON	BATANGAS LUZON
73	KM. OSAKA	CARGO	47,50	554	BIRINGKASSI	BIRINGKASSI
80	MV. PHUONG DONG 10	CURAH	102,79	4.219	LONG AN	CEBU
82	MT. PUSAKA GEMILANG	CURAH	97,25	3,811	PARE-PARE	SINGAPORE

Table 4. Ship Length Data (LOA) in the RIP document

Description	Containers	Cargo
Planned vessel deadweight (DWT)	30,000	10,000
Planned vessel length (m)	225	145
Beam or vessel width (m)	32	20
Draft or depth (m)	13	9
Average vessel load (TEU's --- Tons)		
a. Cargo (Tons)		3,500
b. Bulk (Tons)		4,000
c. Containers (TEU's)	1,000	
Operational hours (hours)	24	24
Number of days per year (days)	365	365

Source: Consultant Analysis, 2021

The VE team identified type of boat as well as long boat maximum from each category nya. After doing identification long ship, the calculation process is carried out need long pier with the formula taken from source document book planning port (Bambang Triatmodjo) quoted from the given equation from IMO (International Maritime Organization).

$$L_p = nL_{oa} + (n + 1) \times 10\% \times L_{oa}$$

dengan :

L_p : panjang dermaga

L_{oa} : panjang kapal yang ditambat

n : jumlah kapal yang ditambat

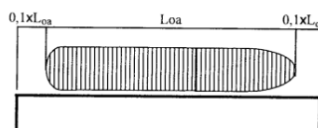


Figure 3. IMO (International Maritime Organization)

Here is the table results determination long boat maximum and each type the ship for the next done simulation need long pier. Simulation done with the system calculation of 2 ships docked.

Table 5. Classification of Maximum Ship Length

Code	Type of Vessel	Max. Vessel Length (m)
A	BULK	153
B	CARGO	110
C	CONTAINER	162
D	CARGO BED	145
E	CONTAINER BED	225

Table 6. Pier Length Requirements

No.	Docking Scenario	Required Length (m)
1	A+A	367.2
2	A+B	315.6
3	A+C	378
4	B+B	264
5	B+C	326.4
6	C+C	388.8
7	A+D	357.6
8	B+D	306
9	B+E	402
10	C+D	368.4
11	D+D	348

Based on table data above, in scenarios no. 1 – 11, it is indicated need long pier for stage beginning is of 402 m. This data was taken based on needs data long dock maximum.

- Need long new pier stage beginning = 402 m
- Long condition dock existing = 303 m
- Need extension (1 – 2) = 99m = **100m**

From the calculation indicated that need long the new pier is of 100 m. so from plan extension 150 m pier, VE team proposes for optimization extension The pier for stage 1 is 50m. For costs incurred for the development and widening work of the pier at the stage the beginning can be seen in the table below.

Construction Price of Pier Development per m²

➤ Construction price per m²

$$= \frac{\text{Harga Total Pengembangan Dermaga baru (7,8 \& 9)}}{\text{Luasan dermaga Baru (7,8 \& 9)}}$$

$$= \frac{\text{Rp.111,638,313,670.53}}{4474.125 \text{ m}^2} = \text{Rp. 24,951,988.08 / m}^2$$

Development Prices Pier 7 & 8

- Area of Pier 7 & 8 = 2500 m²
- Need cost construction
 = 2500 m² x Construction price
 = Rp. 62,379,970,200

The costs in the calculation above do not include the cost of corrosion protection of the poles and the cost of repairing the structure because the VE process has been carried out on other activities.

Value Engineering Recommendations

Based on RIP data and operational data visiting ship During the last 2 years, the VE team has been optimizing long new pier from 150m to 100m. For simulation layout long new pier can seen in

the following image.

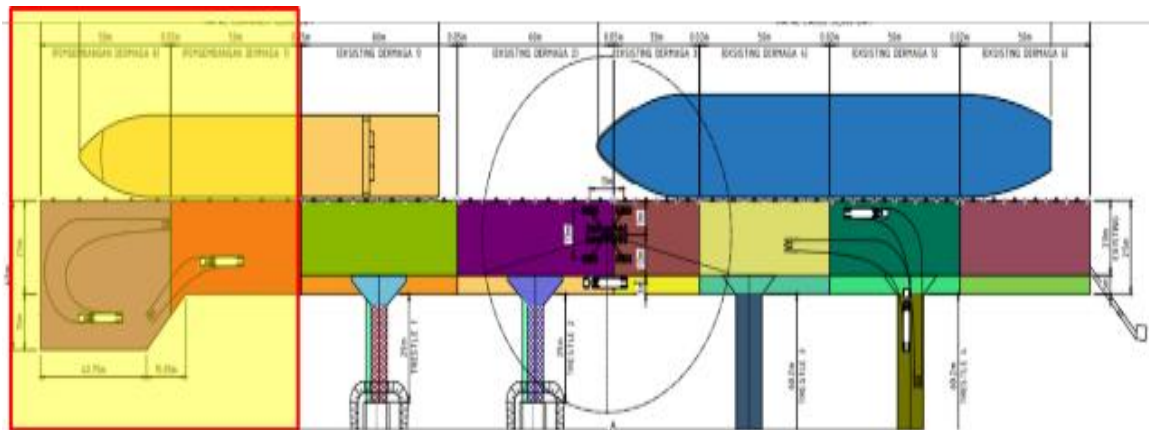


Figure 4. Optimization Layout of Pier Length to 100 m

Value Engineering No.2: Pile Corrosion Protection

Table 7. Value Engineering No.2: Pile Corrosion Protection

**VE RECOMMENDATION NO.2
POLE CORROSION PROTECTION**

Basic Concepts	
The methods used in corrosion protection of new piles are the HDPE method and cathodic installation.	
Recommendation Concept	
FRP method selection and installation cathodic on new piles	
Profit	Loss
- Cheaper price - Longer durability	
Cost Summary	Cost
BED planning costs	Rp. 22,044.9 5 5. 713
After Value Engineering	Rp. 15,144,803,336
Saving	Rp. 6,900,152,377

Basic Concepts

The methods used in corrosion protection of new piles are the HDPE method and cathodic installation. The effectiveness of this method is as follows:

HDPE Jacketing:

- Protecting tidal areas
- Water at risk enter through gap belt
- Risk shift / down

Cathodic Protection:

- Functioning avoid corrosion on the pole stake submerged in water
- Age 4 years (less than effective Because usually 1-2 years lost / damaged)

Value Engineering Recommendation Basics

Based on a comparison of the effectiveness of the FRP and cathodic protection methods, it is more optimal to provide corrosion protection. to the new piles. The following table shows comparison for use protection in the splash zone (ebb and flow) area. The VE team selected using FRP as its protection because one of them own Power sticky strong and fairly good density if compared to HDPE which is risky own gap and shift.

Table 8. PE Jacketing & FRP Wrapping Methods

Here is the information from the image, presented in a table format:

MERK	SPESIFIKASI	PE Jakceting	FRP Warping
Methods		Wrapping	Wrapping
Type		HDPE with petrol tape	Eglass Unidirectional
Manufactur		Wika	FYFE
Product		HDPE Jacketing	Tyfo Eglass She 51A
			Tyfo SW underwater
Technical Properties			
Thickness Ultimate	mm	1.2 (1 Ply)	2.0 (2 Ply)
Density	g/mL	0.94	1.5
Elongation (%)	ASTM D3039	3.5	2
Adhesion (Mpa)	ASTM D4541	<2	>3
ADVANTAGES			
CHEMICAL			
- Alkali		Very Good	Very Good
- Mild Acid		Low	Very Good
- Strong Acid		Low	Good
- Hydrocarbon		Poor	Very Good
- Salts		Very Good	Very Good
- Teritip/kerang		Very Good	Very Good
PHYSICAL			
- Tahan Ombak Besar		Very Good	Very Good
- Easy Installation			
- Above Water		Medium	Good
- Under Water		Medium	Good
- Resist Corrosion Rate		Medium	Very Good
- Cannot be stolen		Low	Very Good
- Compatible with Catodic		Yes	Yes
- Design Life	Years	20	20
- Warranty	Years	5	5
COMMERCIAL			
AVG Price	IDR (million) / m2	2	2.7

Source: Vendor

For pole stakes in submerged areas with sea water, the VE team remains using sacrificial anode in method its protection with a usage period of 10 years. This is for help reduce cost construction at stage beginning.

Value Engineering Recommendations

An alternative method for Pile Corrosion Protection is to use the FRP method in tidal areas and installation cathodic on new piles.

Value Engineering No.3: Structural Repair

Table 9. Value Engineering No.3: Improvement Structure

**VE RECOMMENDATION NO.3
STRUCTURAL REPAIR**

Basic Concepts	
Structural repairs in the form of chipping , grouting and injection on existing structures	
Recommendation Concept	
Selection of alternative repair suppliers by calculating the recommended volume according to segment	
Profit	Loss

- Cheaper price
- Longer durability

Cost Summary	Cost
BED planning costs	Rp. 10,763,320,000
After Value Engineering	Rp. 9,306,662,992
Saving	Rp. 1,458,657,008

Basic Concepts

Referring to Basic Engineering Design (BED), the method used for structural repairs is in the form of chipping, grouting and injection on existing structures.

Value Engineering Recommendation Basics

Alternative suppliers of structural repairs provide more detailed work details, namely scaffolding, chipping, formwork, grouting ex Stronggrout G70 Premix, Stronggrout injection. EP10 and Finishing.

Value Engineering Recommendations

The volume calculated for this alternative supplier for structural repairs is to calculate the volume according to its segment, with the total cost for each segment as follows:

Table 10. Structural Repair Costs for each segment

No	Activity	Total cost
1	Preparatory work	140,000,000
2	Pier 1	1,172,949,650
3	Pier 2	1,066,865,046
4	Pier 3	971,420,572
5	Pier 4	855,796,962
6	Pier 5	867,438,030
7	Pier 6	499,668,682
8	Trestle 1	757,748,060
9	Trestle 2	790.177.674
10	Trestle 3	1,353,368,870
11	Trestle 4	831.229.446
Total cost		9,306,662,992

Construction Cost Deviation

There is a difference between the initial value and the value engineering results of:

Table 11. Construction Cost Deviation

No	Work Items	Total Cost (BED)	Total Cost (VE)	Deviation
1	Dock Work	111,638,313,671	62,379,970,202	49.258.343.468
2	Pole Corrosion Protection	22,044,955,713	15,144,803,336	6.900.152.377
3	Structural Repair	10,763,320,000	9,306,662,992	1,458,657,008
Total cost		144,446,589,384	86,831,436,530	57,615,152,854

Value Engineering analysis on several work items, a deviation was obtained from the total project plan value of Rp. 57,615,152,854 from the optimization of the length of the pier, cost savings of Rp. 62,379,970,202 were obtained, the corrosion protection item for the piles was Rp. 15,144,803,336, and the structural repair item was Rp. 9,306,662,992.

Cost Increase Due to Inflation

The cost of work will increase due to several factors including: Increases in the price of goods and services, Increases in Fuel Oil and Increases in Bank Interest, the value of this increase is The

Institute for Development of Economics & Finance (Indef) estimates that inflation as of May 2025 will be in the range of 1.6%. The value of the work is:

Table 12. Increase in Costs Due to Inflation

No.	Work Items	Total Cost (BED)	Total Cost (VE)	Total Cost (VE) due to Inflation
1	Dock Work	111,638,313,671	62,379,970,202	64,394,049,725.23
2	Pole Corrosion Protection	22,044,955,713	15,144,803,336	15,387,120,189.38
3	Structural Repair	10,763,320,000	9,306,662,992	9,455,569,599.87
Total cost		144,446,589,384	86,831,436,530	89,236,739,514.48

the value engineering analysis cost after adding the cost to the increase in inflation in 2025 of 1.6% of the cost of each work item so that the total project cost is Rp. 89,236,739,514.48.

CONCLUSION

The value engineering (VE) analysis on this project employed a structured approach that involved collecting secondary data such as RAB and DED, followed by thorough evaluations of work components, unit prices, and methods to uncover optimization possibilities. This approach enabled the VE team to propose recommendations that generated significant cost savings—Rp62.38 billion from pier extension optimization, Rp15.14 billion from corrosion protection improvements, and Rp9.31 billion from structural repair alternatives—totaling Rp86.83 billion in potential reductions. Compared to the initial Basic Engineering Design (BED) budget of Rp144.47 billion, these optimizations achieved savings of Rp57.62 billion, or 39.19%, with the adjusted 2025 cost accounting for inflation still substantially lower at Rp89.24 billion. The findings highlight the effectiveness of implementing value engineering in high-value construction projects, as it encourages innovative, budget-efficient solutions while preserving performance standards through a combination of functional analysis, cost-benefit assessment, and performance optimization. It is strongly recommended that future similar-scale projects adopt value engineering to maximize resource allocation and improve financial outcomes. For future research, it would be beneficial to explore the application of value engineering in other types of infrastructure projects and to assess long-term performance impacts of VE-driven design modifications to further validate and enhance its practical benefits.

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