

## VALUE ENGINEERING IN CONSTRUCTION OF THE PUBLIC LECTURE BUILDING AND LABORATORY FACULTY OF SOCIAL AND POLITICAL SCIENCES PHASE 2 UPN VETERAN EAST JAVA

Yasinta N. Al Mas<sup>1,\*</sup>, Suhariyanto<sup>2</sup>, Fauzi Akbar Rahmawan<sup>3</sup>

Construction Engineering Manajement Student<sup>1</sup>, Civil Engineering Lecturer<sup>2</sup>, Civil Engineering Lecturer<sup>3</sup>

Email: [yasintanurilalmas@gmail.com](mailto:yasintanurilalmas@gmail.com)<sup>1</sup>, [suhariyanto@polinema.ac.id](mailto:suhariyanto@polinema.ac.id)<sup>2</sup>, [fauziakbar@polinema.ac.id](mailto:fauziakbar@polinema.ac.id)<sup>3</sup>

### ABSTRACT

The construction project of the Public Lecture Building and Laboratory for the Faculty of Social and Political Sciences Phase 2 at UPN "Veteran" East Java aims to support educational and research activities. To improve cost efficiency without compromising the building's function and quality, the Value Engineering (VE) method was applied. This method is used to evaluate the main functions of a project and to find more economical and efficient alternatives in design, materials, or construction methods. The research was conducted through five VE stages: information, function analysis, idea generation, evaluation, and recommendation. The analysis focused on elements with the highest cost contribution, specifically structural beam work and slab work. The Value Engineering results showed that the structural beam work could be replaced with a more efficient alternative. For example, Alternative 1 uses bamboo scaffolding with a diameter of 8–10 cm and a length of 4 m, and beam formwork made of 12 mm plywood. This alternative could save up to IDR 116,148,590.99 from the initial project budget. For slab work, the alternative includes using bamboo scaffolding with the same specifications and 12 mm plywood formwork. These alternatives were applied without reducing the building's quality or function. The implementation of VE has proven effective in supporting decision-making in construction projects, especially for building higher education facilities that require efficiency and sustainability.

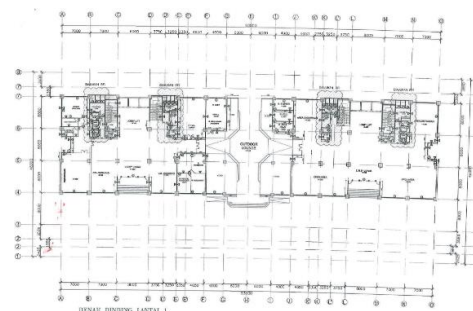
**Keywords :** Value Engineering, cost efficiency, building construction, decision making.

### 1. INTRODUCTION

The implementation of construction projects often encounters various obstacles that lead to delays, causing the completion time to deviate from what is stipulated in the contract documents. Construction is inherently a high-risk field, especially in terms of financial risks due to project delays. Each project typically has a predetermined implementation plan and schedule, detailing when the project should begin and finish, how it will be executed, and how resources will be allocated. However, these plans are based on initial estimates made during the planning phase. Discrepancies between planning and actual field conditions frequently result in delays and increased implementation costs.

According to Andi et al. (2003), there are seven major categories of factors that can potentially affect construction time: labor, materials, equipment, site characteristics, managerial capacity, financial aspects, and external factors such as rainfall intensity, economic conditions, and work-related accidents. Proboyo (1999) adds that project delays are often caused by changes in planning during execution,

poor managerial skills within the contractor's organization, poorly integrated work plans, incomplete drawings and specifications, and the contractor's failure to carry out the work.



**Figure 1.** Section View

The construction project of the Public Lecture Building and FISIP Laboratory Phase 2 at UPN "Veteran" East Java aims to enhance educational facilities and infrastructure, particularly for students and academic staff in medical-related study programs. The building comprises 12 floors

and one basement, with a total floor area of 4,314.8 m<sup>2</sup>. In its implementation, the project requires not only correction of planning or calculation errors but also a cost-efficient approach that maintains quality. Therefore, value engineering is considered a relevant solution. This approach involves reviewing the cost budget plan to identify and eliminate non-essential costs without compromising the quality of materials used.

Based on this background, the objectives of this study are: (1) to identify the work items that can be analyzed using value engineering in the construction project of the Public Lecture Building and FISIP Laboratory Phase 2 at UPN "Veteran" Surabaya, (2) to determine the life cycle cost of the project, and (3) to calculate the amount of cost savings resulting from the application of value engineering.

## 2. METHOD

Based on Ramadhan's (2020) analysis, project delays are mainly caused by damage to major equipment, which disrupts overall construction activities, and the slow response of supervisory consultants in providing information and decisions on site. This indicates that both the contractor and the project owner share responsibility for the delays. Meanwhile, Priyo and Hermawan (2010) stated that the Value Engineering method is highly effective in reducing costs in construction projects, especially building projects, by providing alternatives that maintain function and quality while using the budget more efficiently.

Based on these findings, several steps can be taken to reduce project delays: repairing or replacing damaged main equipment, improving communication and decision-making among stakeholders, applying the Value Engineering method to identify cost-saving opportunities without compromising quality, providing training on the importance of timely communication and Value Engineering principles, and conducting regular monitoring and evaluation of project progress, equipment condition, and communication effectiveness. These measures are expected to help the project run more efficiently, on schedule, and within budget.

The value engineering process or procedure is carried out in a systematic framework so that the final results are achieved according to the planned objectives, in the following ways:

Identify problems by gathering information from past plans and ongoing project planning documents. The problem is then formulated based on the facts obtained during problem identification. Assess the object where Value Engineering is to be carried out with reference to the function of the fixed installation. Then, alternative costs are calculated as a result of the study of the function of the object. Perform cost versus function analysis on several alternatives to get the best solution in terms of cost, function, and performance of the installation/object.

After obtaining the selected solution, the Value Engineering results are developed and verified based on valid standards and other previous experiences. Then, the Value Engineering cost is determined based on additional

technical considerations. Finally, Value Engineering is documented and submitted to the owner for approval.

According to Chandra (2014), a Value Engineering work plan is a good tool to complete the study from start to finish. This plan can ensure that all aspects required in the study are properly considered. This work plan divides the study into several elements.

This work plan allows the Value Engineering team to collaborate creatively and analyze changes. It helps the team to choose the best option. The work plan summarizes specific recommendations, and ends with a proposed implementation schedule and a summary of benefits.

The work plan is divided into five (5) different Phases, in the implementation of which the Phases are interconnected.

The five (5) steps of the Value Engineering work plan are as follows:

- Information Phase
- Creative Phase
- Analysis Phase
- Development Phase

According to Chandra (2014) in Armando (2015), one way to determine the focus of value engineering analysis is by applying the Pareto principle. Based on Vilfredo Pareto's theory, 20% of the most important components in a system typically account for 80% of the total cost. By organizing work items from the highest to the lowest cost using a cost breakdown model and plotting a curve of item cost versus cumulative cost, the 80% cost boundary can be identified to help determine which items should be prioritized in the analysis.

The Pareto diagram, as explained by Chandra, is a type of bar chart that visually ranks the frequency or impact of problems or processes from most to least significant, from left to right. This diagram is a common quality management tool used to categorize and simplify complex data, making it easier to identify problems, set priorities, and make informed decisions.

Although the Pareto principle may not always apply exactly in every case, it remains a useful guideline for identifying critical components worth studying. In the Information Phase of value engineering, relevant project data is collected, including design background, assumptions, and cost sensitivities. Typical activities during this phase include gathering key documents (such as project scope, drawings, specifications, and cost data), identifying and prioritizing key issues, understanding the project's scope, schedule, budget, risks, and workforce performance, confirming the most recent project concept, identifying major functions, and establishing project success criteria.

According to Ir. Julianus H, MSIE (1995) in Listiono (2011), the zero-one method is a simple decision-making technique used to prioritize functions or criteria. This method compares each function by determining whether it is "more important" (scored as 1) or "less important" (scored as 0) relative to another. By using these comparisons, an index is calculated for each criterion, which then serves as a

reference for evaluating and ranking alternatives. The main advantages of this method are its simplicity and ease of use. In the decision-making phase, two types of zero-one methods are applied: one for determining the weight of each criterion and another for calculating the index values. The value of each alternative is calculated using the formula:

$$= \frac{\text{The number of ranks}}{\text{Total number of ranks}} \times 100 \quad (1)$$

Ranking is done in reverse order, where the most important function is given the highest score. Further details on the calculation process using this method can be found in tables 1 and 2.

**Table 1.** Zero-One Method to Find the Value

No	Funtion	Rank Number	Value	Description
1	Cost	3	50	High Priority
2	Fast Implementation	2	35	Medium Priority
3	Easy	1	15	Low Priority
Total rank number		6	100	

**Table 2.** Zero-One Method to Find the Index

Alternative	A	B	C	Total	Index
A	X	1	1	2	2/3
B	0	X	1	1	1/3
C	0	0	X	0	0

**Table 3.** Existing Research and Emerging Alternatives

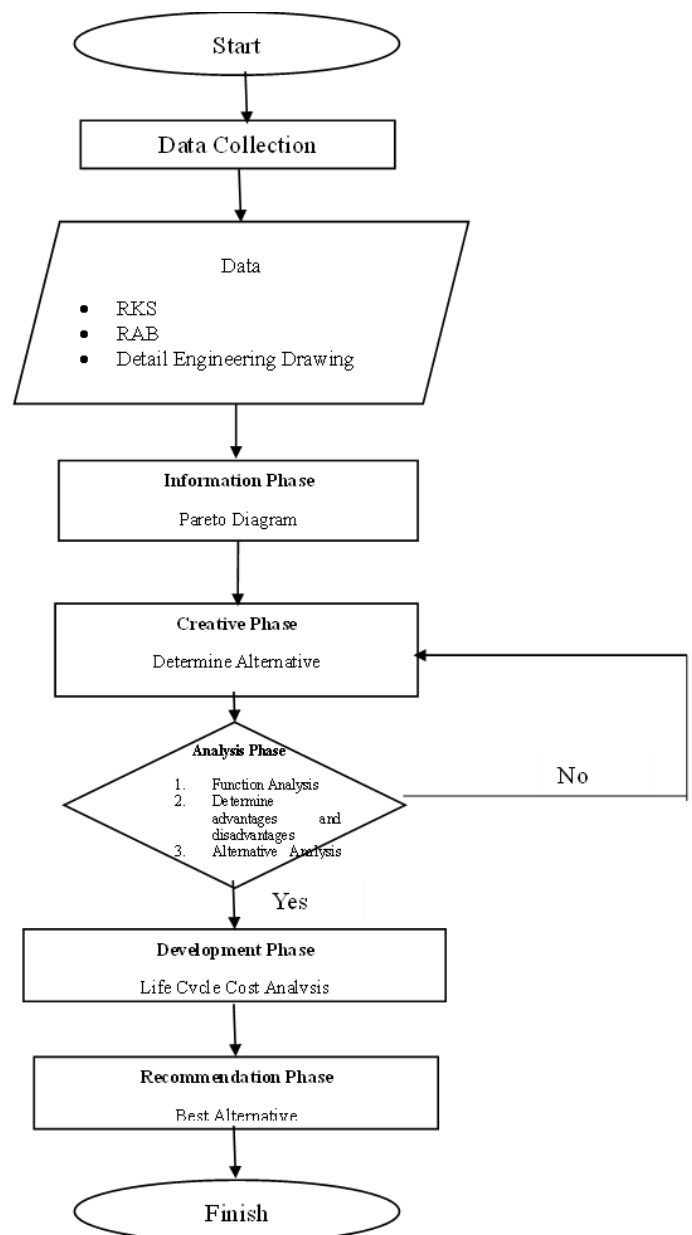
No	Alternatif	Criteria			Total	Description
		1	2	3		
	Value	50	33,33	16,67		
1.	Alt A	Index	Index	Index	ΣX	Index Value
		X	X	X		
2.	Alt B	Index	Index	Index	ΣX	Index Value
		X	X	X		
3.	Alt C	Index	Index	Index	ΣX	Index Value
		X	X	X		

Based on Table 3, the value of *x* is obtained by multiplying the index by the temporary weight. The total sum of these values (Σ*x*) represents the overall weight of all alternatives. This final value serves as a decision-making tool that effectively integrates both qualitative criteria (which cannot be measured) and quantitative criteria (which can be measured), allowing for a more comprehensive evaluation.

In addition to this, *Life Cycle Costing* (LCC) is an

important technique used to assess the total cost of a building or facility throughout its entire lifespan. Initially developed for building maintenance purposes, LCC has evolved into a robust method for comparing costs during both the design phase and the operation and maintenance stages of buildings, factories, and industrial plants. It supports long-term decision-making by enabling the comparison of various alternatives based on their total life-cycle expenses, not just their initial costs. Since capital costs typically represent only around 30% of a building's total cost over its lifetime, managing costs effectively during the early design phase becomes crucial to ensure optimal long-term value and performance.

To facilitate the process Phases in the study, a flowchart of the value engineering study can be made in Figure 2.



**Figure 2.** Flow Chart

### 3. RESULT AND REVIEW

#### Information Phase

The information phase is the initial phase in value engineering planning. This phase aims to gather as much information as possible regarding the project design, starting from general project data to analyzing data related to work items, identifying the study items, and obtaining the work items for which alternatives have been explored during the creative phase and data analyzed during the analysis phase.

Project Name	: Construction of Joint Public Lecture Building and Laboratory Faculty of Social and Political Sciences Phase 2 UPN "Veteran" East Java
Project Location	: Jl. Rungkt Madya No.1, Gn. Anyar, Kec. Gn. Anyar, Surabaya, East Java, 60294
Owner of the Project	: UPN Veteran, East Java
Category	: Education Building
Contract Value	: Rp. 186.307.987.000
Contract Date	: March 29, 2023
Assignor	: Universitas Pembangunan Nasional East Java
Type of Contract	: Unit Price Contract
Contractor	: PT. PP (Persero) Tbk.
Consultant of Management Construction	: PT. Saranabudi Prakarsaripta

#### Identification of Work Items

To identify high-cost work items, it is necessary to conduct an identification of those items. The method used is by creating a cost model. The breakdown analysis of work items refers to the detailed breakdown of items, ranked from the highest to the lowest cost.

The following is a presentation of the results of the pareto analysis of the overall total project cost.

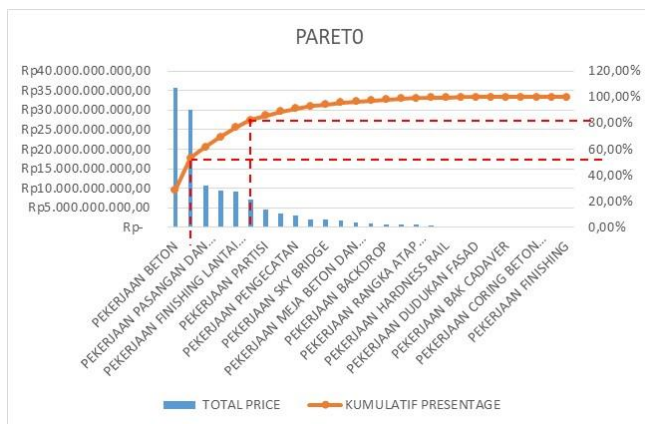


Figure 3. Pareto Diagram

From the Pareto Diagram above, work items that have large costs are concrete work and facade work. After the breakdown analysis is completed, a pareto analysis is carried out which aims to determine the highest cost in the project which has the potential for value engineering analysis. Pareto law applies: 80% of the total cost is contained by 20% of its components.

#### Function Analysis

The FAST (Function Analysis System Technique) method is an analytical tool used to develop optimal designs when applied correctly. A FAST diagram helps identify the functions of each component before conducting a deeper functional analysis. This analysis aims to distinguish between basic and secondary functions and to evaluate the relationship between cost and benefit (worth). The goal is to identify items with unnecessary or excessive costs.

If the ratio of cost to worth is greater than 1, the work item should be analyzed further using Value Engineering. In this context, *cost* refers to the estimated expense needed to perform a function, while *worth* is the minimum cost required to achieve the same function effectively.

Using available data, a function analysis was conducted to compare the cost-to-worth ratio of structural components, specifically columns and beams. Columns serve as load-bearing elements that support beams and transfer compressive forces throughout the structure.

Table 4. Function Analysis of Beam Structural Work

No	Desc	V	N	Func	Cost (Rp.)	Worth (Rp.)
1	Formwork	Cast	Beam	S	224.340	
2	Steel	Distribute	Beam	B	14.760	14.760
3	Concrete	Distribute	Load	B	1.069.470	1.069.470
Total					1.308.570	1.084.230

#### Creative Phase

The creative phase is the stage where ideas are explored by generating as many alternatives as possible to find various potential solutions.

According to Dell'Isola (1975), there are two main creativity techniques based on free association:

##### a. Brainstorming

This is a group discussion method where participants from different backgrounds share ideas freely. Each person's thoughts may inspire others, helping to generate a wide range of solutions related to a specific function.

##### b. Gordon Technique

This technique also encourages free idea generation, but only the group leader knows the actual problem. This method helps reduce bias and allows participants to think more openly.

In this study, the brainstorming technique is used to collect ideas without judging or evaluating them during the session. The process involves the following steps:

1. Eliminate items with only secondary functions.
2. Propose replacements for basic functions.
3. Select the best alternatives for further analysis in the next phase.

Based on this process, the following alternatives are

proposed:

**Beam Structural Work Alternatives:**

- *Alternative 1:* Bamboo scaffolding (8–10 cm diameter, 4 m long); beam formwork using 12 mm plywood.
- *Alternative 2:* Galvanized ringlock scaffolding with specifications: vertical ringlock (2 m x 3.2 mm), horizontal ledger (914 cm x 3.2 mm and 1.8 m x 3.2 mm), Asiba metal plank (2 m x 1.2 mm); beam formwork using the Kumkang system.

**Analysis Phase**

In the analysis phase, both the original design and the proposed alternatives from the previous phase are reviewed by evaluating their advantages and disadvantages. This process includes the following steps:

- Calculating the weight of each work criterion,
- Listing all proposed alternatives,
- Quickly reviewing and eliminating alternatives that are clearly not feasible.

The alternatives are then assessed based on weighted criteria, including cost, construction time, ease of implementation, durability, and strength. After evaluating these factors, the most feasible alternatives for value engineering are selected by considering:

- Design limitations or specifications of the work components,
- The cost and function of each alternative.

Finally, the selected alternatives are further analyzed for their benefits and drawbacks. Key considerations include:

- Cost savings,
- Weather resistance,
- Ease of implementation,
- Durability and structural strength.

**Table 5. Weighting of Criteria for Beam Work**

Criteria	Criteria Number	I	II	III	IV	Total	Rank	Weight (%)
Cost Saving	I	X	1	1	1	3	4	40
Weather Resistance	II	0	X	1	1	2	3	30
Ease of Implementation	III	0	0	X	1	1	2	20
Durability of Strength	IV	0	0	0	X	0	1	10

**Table 6. Analysis Results of Alternative Prices for Beam Formwork Work**

Component	Volume	Unit	Unit Price (Rp.)	Total Price (Rp.)
Alternative A0	15001,82	M2	224.340,00	3.365.508.298,80
Alternative A1	15001,82	M2	216.598,00	3.249.364.208,36
Alternative A2	15001,82	M2	301.175,00	4.518.173.138,50

**Table 7. Analysis of Advantages & Disadvantages of Formwork Work for Beams**

No	Compotition	Advantage	Disadvantage
A0	12mm plywood formwork, scaffolding using ringlock	Scaffolding installation is more flexible; Does not require specialized skilled labor for installation	Generates leftover material waste; Not weather-resistant; Longer installation time
A1	Beam scaffolding using bamboo with a diameter of 8–10 cm and a length of 4 m; Beam formwork using 12 mm plywood	Lower cost; More flexible scaffolding installation; Doesn't require specialized skilled labor	Limited strength and durability; Generate leftover material waste; Not weather-resistance
A2	Beam scaffolding using galvanized ringlock specifications: vertical ringlock 2 m x 3.2 mm; horizontal ringlock ledger 914 cm x 3.2 mm; horizontal ringlock ledger 1.8 m x 3.2 mm; metal plank Asiba board 2 m x 1.2 mm; beam formwork using the Kumkang system.	Lower cost; Material can be reused; Weather-resistant	Higher initial cost; Requires specialized skilled labor

**Table 8. Cost Savings Preference for Beam Structural Work**

Alternative	Composition	Preference
Alternative A0	12mm plywood formwork, scaffolding using ringlock	A0 < A1; A0 > A2
Alternative A1	Beam scaffolding using bamboo with a diameter of 8–10 cm and a length of 4 m; Beam formwork using 12 mm plywood	A1 > A0; A1 > A2
Alternative A2	Beam scaffolding using galvanized ringlock specifications: vertical ringlock 2 m x 3.2 mm; horizontal ringlock ledger 914 cm x 3.2 mm; horizontal ringlock ledger 1.8 m x 3.2 mm; metal plank Asiba board 2 m x 1.2 mm; beam formwork using the Kumkang system.	A2 < A0; A2 < A1

**Table 9. Weather Resistance Preference for Beam Structural Work**

Alternative	Composition	Preference
Alternative A0	12mm plywood formwork, scaffolding using ringlock	A0 < A1; A0 < A2
Alternative A1	Beam scaffolding using bamboo with a diameter of 8–10 cm and a length of 4 m; Beam formwork using 12 mm plywood	A1 > A0; A1 < A2
Alternative A2	Beam scaffolding using galvanized ringlock specifications: vertical ringlock 2 m x 3.2 mm; horizontal ringlock ledger 914 cm x 3.2 mm; horizontal ringlock ledger 1.8 m x 3.2 mm; metal plank Asiba board 2 m x 1.2 mm; beam formwork using the Kumkang system.	A2 > A0; A2 > A1

**Table 10.** Ease of Construction Preference for Beam Structural Work

Alternative	Composition	Preference
Alternative A0	12mm plywood formwork, scaffolding using ringlock	A0 > A1; A0 < A2
Alternative A1	Beam scaffolding using bamboo with a diameter of 8–10 cm and a length of 4 m; Beam formwork using 12 mm plywood	A1 < A0; A1 < A2
Alternative A2	Beam scaffolding using galvanized ringlock specifications: vertical ringlock 2 m x 3.2 mm; horizontal ringlock ledger 914 cm x 3.2 mm; horizontal ringlock ledger 1.8 m x 3.2 mm; metal plank Asiba board 2 m x 1.2 mm; beam formwork using the Kumkang system.	A2 > A0; A2 > A1

**Table 11.** Strength Preference for Beam Structural Work

Alternative	Composition	Preference
Alternative A0	12mm plywood formwork, scaffolding using ringlock	A0 > A1; A0 < A2
Alternative A1	Beam scaffolding using bamboo with a diameter of 8–10 cm and a length of 4 m; Beam formwork using 12 mm plywood	A1 < A0; A1 < A2
Alternative A2	Beam scaffolding using galvanized ringlock specifications: vertical ringlock 2 m x 3.2 mm; horizontal ringlock ledger 914 cm x 3.2 mm; horizontal ringlock ledger 1.8 m x 3.2 mm; metal plank Asiba board 2 m x 1.2 mm; beam formwork using the Kumkang system.	A2 > A0; A2 > A1

**Table 12.** Alternative Index Value of Beam Work in Terms of Cost Savings

Alternative	A0	A1	A2	Total	Index
A0	X	1	0	1	0,33
A1	1	X	1	2	0,67
A2	0	0	X	0	0

**Table 13.** Alternative Index Value of Beam Work in Terms of Weather Resistance

Alternative	A0	A1	A2	Total	Index
A0	X	0	0	0	0
A1	1	X	0	1	0,33
A2	1	1	X	2	0,67

**Table 14.** Alternative Index Value of Beam Work in Terms of Ease of Implementation

Alternative	A0	A1	A2	Total	Index
A0	X	0	0	0	0
A1	1	X	0	1	0,33
A2	1	1	X	2	0,67

**Table 15.** Alternative Index Value of Beam Work in Terms of Strength

Alternative	A0	A1	A2	Total	Index
A0	X	1	0	1	0,33
A1	0	X	0	0	0
A2	1	1	X	2	0,67

The data on criteria weights and alternative index values that have been obtained can be used to determine which alternative is the most efficient by using the evaluation matrix method, which will be presented in the following table.

**Table 16.** Evaluation Matrix of Beam Work Alternatives

Alternative	Criteria & Weight				Total
	I	II	III	IV	
	40	30	20	10	
A0	0,33	0,00	0,00	0,33	16,53
Weight x Index	13,2	0,00	0,00	3,3	
A1	0,67	0,33	0,33	0,00	43,3
Weight x Index	26,8	9,9	6,6	0,00	
A2	0,00	0,67	0,67	0,67	40,2
Weight x Index	0,00	20,1	13,4	6,7	

The data shows that the order of the most efficient design alternatives is Alternative 1, Alternative 2, and Alternative A0 (initial design). Therefore, Alternative 1 is identified as the best design, which uses beam scaffolding made of bamboo with a diameter of 8–10 cm and a length of 4 m, and beam formwork using 12 mm plywood.

Thus, it can be concluded that the cost difference between the initial design and the selected design is as follows:

**Table 17. Price Comparison**

Sub-Work	Design	Price (Rp.)
Beam Structural Work	Initial Design	14.333.901.789,50
	Selected Design	14.217.734.395,64

**Development Phase**

In this phase, the selected alternative that received the highest ranking from the previous analysis phase will undergo a life cycle cost (LCC) calculation.

In the life cycle cost (LCC) calculation, the following assumptions will be considered for each work item throughout the LCC period.

**1. Construction Cost**

The unit price analysis used is adjusted to the base prices applicable at the time the alternatives were developed. The reference used in this study is taken from the Basic Unit Price of Activities (HSPK) of the Surabaya City Government for the 2023 Fiscal Year.

**2. Design Adjustment (Review) Cost**

Adjustment of the planning product to match field conditions is limited to a maximum of 30% of the planning product value, based on the project's technical specifications. If it exceeds 30%, the planning is considered a failure. Therefore, it is assumed that the percentage for the review cost is 15% of the construction cost, or half of the maximum percentage allowed.

**Life Cycle Cost (LCC) Calculation for Beam Structural Work**

**Table 18.1 For Alternative A0 (eksisting method)**

- Construction Cost	=	Work volume x AHSP
	=	15001,82 x Rp. 224.340,00
	=	Rp
	=	3.365.508.298,80
- Review Cost (15%)	=	15% x Construction Cost
	=	15% x Rp. 3.365.508.298,80
	=	Rp
	=	504.826.224,82
- LCC	=	Construction Cost + Review Cost
	=	Rp. 3.365.508.298,80 + Rp. 504.826.224,82
	=	Rp
	=	3.870.334.543,62

**Table 18.2 For Alternative A1 ( Selected Alternative )**

- Construction Cost	=	Work volume x AHSP
	=	15001,82 x Rp. 261.598,00
	=	Rp
	=	3.249.364.208,36
- Review Cost (15%)	=	15% x Construction Cost
	=	15% x Rp. 3.249.364.208,36
	=	Rp
	=	487.404.631,25

- LCC	=	Construction Cost + Review Cost
	=	Rp. 3.249.364.208,36 + Rp. 487.404.631,254
	=	Rp
	=	3.736.768.839,61

In the life cycle cost (LCC) calculation for concrete structural work from both the initial design and the selected alternative design, it was found that the selected alternative design is more cost-efficient in terms of life cycle cost compared to the initial design, amounting to Rp. 3,736,768,839.61.

**Recommendation Phase**

**Table 19. Recommendation for Beam Structural Work**

Project	:	Construction of Joint Public Lecture Building and Laboratory Faculty of Social and Political Sciences Phase 2 UPN "Veteran" East Java
Location	:	Jl. Rungkut Madya No.1, Gn. Anyar, Kec. Gn. Anyar, Surabaya, East Java, 60294
Work Item	:	Beam Structural Work
1. Initial Design	:	12mm plywood formwork, scaffolding using ringlock system
2. Initial Design Cost	:	Rp 3.365.508.298,80
3. Proposed Design	:	Beam scaffolding is made of bamboo with a diameter of 8–10 cm and a length of 4 m; the beam formwork uses 12 mm plywood
4. Proposed Design Cost	:	Rp 3.249.359.707,81
5. Savings	:	Rp 116.148.590,99
6. Savings Percentage	:	3,45%
7. Basis of Consideration	:	Based on the results of the cost-benefit analysis, zero-one matrix, and life cycle cost (LCC) calculation.

**4. CONCLUSION**

Based on the results of the above analysis, it can be concluded that:

- The analysis of work items suitable for value engineering can be identified through the information phase, which involves the cost model breakdown method, followed by the creation of a Pareto distribution diagram, and conducting a function analysis on the work item components. In this project, two sub-work items were identified as candidates for value engineering: beam structural work and slab work.
- The results of the life cycle cost calculation for the selected alternative using the LCC method are:
  - For the beam structural work, the amount is Rp3.736.768.839,614.
- From the analysis conducted, the following cost savings were obtained:
  - For the beam structure work, the saving amounted to Rp. 116.148.590,99 or 3,45% of the initial cost of the beam structure work.

**REFERENCE LIST**

- [1] Amelia, Hanifah. Sulistio, Hendrik. 2019. "analisis Value Engineering pada Proyek Perumahan Djajakusumah Residence" *Jurnal Matriks Teknik Sipil*.
- [2] Andriani, Rizki Mega, dkk. 2019. "Penerapan Value Engineering pada Struktur Bangunan Gedung Proyek Universitas Negeri Yogyakarta" *Jurnal Matriks Teknik Sipil*.
- [3] Ariadi. 2017. "Faktor Kunci Sukses Penerapan Value Engineering pada Bangunan Gedung di Indonesia". *Jurnal Rekayasa Sipil*, 6(2) : 77-85.
- [4] Blahri, Khaerul. 2018. "Penerapan Rekayasa Nilai (Value Engineering) Pekerjaan Arsitektural pada Pembangunan Proyek Transmart Carrefour Padang". *Jurnal Teknik ITS*.
- [5] Chandra, Suriانا, 2014 *Maximizing Construction project and Investment Budget Efficiency with Value Engineering*. Jakarta PT. Gramedia
- [6] Cahyadi, Hendra. 2018. "Penerapan Value Engineering pada Pembangunan Gedung Kampus LI Universitas Muhammadiyah Palangkaraya *Jurnal Keilmuan Teknik Sipil*", 1(2): 58-68.
- [7] Jaya, Nyoman Martha, dkk. 2019. "Penerapan Rekayasa Nilai pada Proyek Pembangunan Gedung Sekolah Sanur Independent School". *Jurnal Spektran*.
- [8] Kembuan, Angeline Shanty. 2016. "Penerapan Value Engineering pada Proyek Pembangunan Gereja GMI M Syaloom Karombasan". *Jurnal Sipil Statik*, 4(2): 95-103.
- [9] Nasrul dan Rozanya. 2017. "Penerapan Metode Value Engineering pada Proyek Pembangunan Asrama Putera Yayasan Tapuz Kota Pariaman". *Jurnal Teknik Sipil ITP*, 2(1): 29-38.
- [10] Priambudhi, Dimas. 2019. "Aplikasi Value Engineering Untuk Optimalisasi Pembiayaan pada Proyek Pembangunan Gedung Kuliah IL ULN Suska Riau". *Skripsi Universitas Islam Riau Pekanbaru*.
- [11] Ramadhan, R. P. 2020. "Analisis Faktor Penyebab Keterlambatan pada Pembangunan Proyek "SCE" Menggunakan Metode Analytical Hierarchy Process". *Business and Finance Journal*, volume 5, No.1.
- [12] Ramadhan, L. S. 2020. "Studi Value Engineering pada Proyek Pembangunan Pusat Laboratorium Forensik Kota Jayapura". *Skripsi Politeknik Negeri Malang*.
- [13] Rahma, Diyar, dkk. 2017. "Analisis Value Engineering dengan Metode Zero-One pada Proyek Pembangunan Gedung Laboratorium Komputer Kampus 3 Universitas Ahmad Dahlan Yogyakarta" *Jurnal Matriks Teknik Sipil*.
- [14] Rachmawan, Alvin Mufti. 2021. "Analisa Value Engineering pada Proyek Pembangunan Dormitory Airlangga Surabaya". *Jurnal Teknik Sipil*
- [15] Soares, Nicolau Martins. "Aplikasi Value Engineering Pekerjaan Struktur pada Proyek Pembangunan Mall Dinoyo City Malang".