Value Engineering Analysis on Building Structure Work

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Abstract. One way to reduce costs during the construction process is to optimize resources. Value engineering (VE) is a method used to analyze cost savings and product or project performance by maintaining appearance, quality, and maintainability. This study investigates the effectiveness of value engineering in the construction of apartment buildings to obtain cost savings from the initial budget planning. This research focuses on structural work such as slabs, beams, and columns. The Value Engineering method consists of five stages: information, creativity, analysis, development, and presentation. At the information stage, data is collected for cost planning, detailed construction designs, work plans, and terminology. According to the information gathered, the apartment construction contract cost a total of IDR 93,576,000,000, with structural work being one of the highest costs during building construction. The results of the analysis show that of the three alternatives offered, precast formwork, semi-system system, and full perilico system, the use of precast concrete experienced the most significant cost reduction, namely 19,21% of the total cost.

Keywords: Value Engineering, Structural Work, Project Management.

1. Introduction

The settlement for each project is different because each project implementation has unique characteristics or is different from other project implementations[1]. Factors that often occur that cause wasted costs include inefficient use of materials, inadequate human resources, and delays in completion, all of which result in wasted costs[1]. If this occurs, the project methods used can be re-evaluated to reduce costs without compromising project functionality.

Value Engineering (VE) is a cost optimization method that can reduce unnecessary costs without reducing the value or function of the project[2]. The author wants to carry out a value engineering analysis of apartment development projects to achieve more effective results. This research focuses on the application of Value Engineering in construction work processes such as walls, beams, floor slabs, and columns. The object of this research is an apartment building.

Construction of an apartment building with a project value of IDR. 87,328,000,000.00 consisting of fourteen floors, two basement floors, eleven floors for bedroom and service areas, and one rooftop floor. With 4–6% weekly delays in construction implementation, value engineering is required for cost efficiency without changing function or quality. The results of this study can be used as a reference when constructing buildings with the same features.

2. Methods

2.1. Value Engineering

Value Engineering is a systematic approach to obtain maximum results from any costs incurred [3]. The purpose of the Value Engineering analysis applied is to eliminate unnecessary costs and find alternatives to meet needs at the lowest cost without reducing the quality of construction [4]. The steps in implementing Value Engineering consist of two stages, namely [5]:

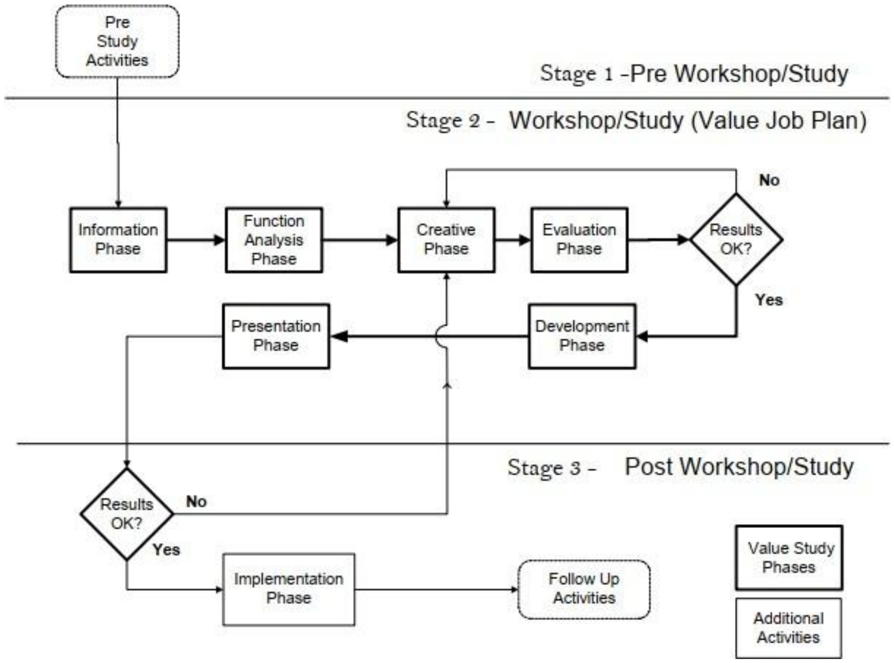

Figure 1 Value Engineering Process Flow

a. Informasi Phase

The information stage is the initial stage in value engineering analysis to determine conditions and constraints that may affect the project implementation process. Data needed such as: Detailed engineering design, budget plan (RAB) and technical specifications.

b. Creativity Phase

At the creativity stage, as many alternative recommendations as possible that fulfill the primary and secondary functions of the building are needed. In this study, brainstorming techniques were used to obtain alternative recommendations that are in accordance with the primary and secondary functions of the building.

c. Evaluation Phase

At the creativity stage, alternative recommendations are evaluated. In this study, the calculation of the budget plan (RAB) for each alternative recommendation is used to carry out an alternative analysis. Then, the results of the calculation of the RAB for each recommendation alternative are compared with the total cost value used for the initial design. The result is that the most cost-effective recommendation alternative is the most efficient.

d. Development Phase

At this stage, each solution idea will accept alternative recommendations made during the analysis phase. The purpose of the development stage is to further analyze and determine the selected alternative; This selected alternative will be paired with other alternative recommendations and paired comparisons will be carried out. There is a choice of the most efficient pair for value engineering.

3. Results And Discussion

3.1 Information Phase

At the information stage, data collection is carried out related to the Apartment Building development project. Table 1 is a budget planning obtained from project data.

Table 1 Project Cost Recapitulation

NO	DESCRIPTION	TOTAL (IDR)
A	Preliminary Work	6,200,100,000
B.	Structure Work	
	Sub Structure Work - Foundation	5,313,697,733
	Upper Structure Work	28,092,426,000
	Other jobs	272,850,000
C.	Architectural Work	30.387.963.694
D.	Mechanical and Electrical Work	13,547,738,519
	Total	84,302,775,946
	Rounded up + 11% VAT	93,576,000,000

3.2 Creativity Phase

Next is the creativity stage to provide alternative recommendations for each work item.

a. Foot Slab

The original plan called for casting concrete using the cast in place method for the floor plates and using multiplex-style formwork. There are three other suggestions made. The bondek floor plate is the first suggestion made in place of formwork and bottom reinforcement. Precast concrete with the whole slab method, concrete with fabrication completed at the factory or outside the project, are recommended for the two floor plates. The third suggestion is the half-slab precast floor plate approach, which use precast concrete and has an additional cast in place for the plate's top.

b. Beam

Initial beam design employing traditional formwork, specifically multiplex with a 12 mm thickness. There are two different suggestions made, the first of which is to employ semi-system formwork. Phenol film is the material used, and hollow iron can be reused five times. The use of precast concrete with concrete sizes in accordance with the design is the second option.

c. Column

Initial designs for the column construction utilized standard formwork, namely multiplex with a 12 mm thickness. There are three different suggestions made, the first of which is to employ semi-system formwork. Phenol film is the material used, and hollow steel can be reused five times. The second option is full system formwork, which can be utilized 5–10 times and uses the peri lico column system. Utilizing assembled concrete is the third option.

3.3 Evaluation Phase

a. Foot Slab

Alternative implementation is carried out on Floors 1-10 and roof floors. Analysis of the floor slab work was carried out by calculating the RAB, after which a comparison was made of the initial design with each alternative recommendation.

Table 2 Results of Alternative Analysis Of Floor Slab Work

NO	Description	Amount (IDR)	Price Gap (IDR)	Markdown (%)
1	Initial Design	93.576.000.000	-	0
2	Floordeck Foot Slab	87.151.000.000	6.425.000.000	7,37
3	Precast Foot Slab	76.451.000.000	17.125.000.000	22,4
4	Precast Foot Slab with half-slab method	86.359.000.000	7.217.000.000	8,36

Based on these results, it is known that alternative 2 or floor slabs with the precast half slab method experienced the most significant cost reduction of 8.25% of the total cost.

b. *Beam*

On Floors 1 through 10 and the roof floors, alternative implementation is practiced. After performing an analysis of the beam work by computing the RAB, a comparison between the original design and each suggested alternative is made.

Table 3 Results of Alternative Analysis of Beam

NO	Description	Amount (IDR)	Price Gap (IDR)	Markdown (%)
1	Initial Design	93.576.000.000	-	0
2	Semi-system Formwork	89.222.000.000	4.354.000.000	4,88
3	Precast Beam	85.072.000.000	8.504.000.000	10,00

Based on these results it is known that second alternative or the use of precast concrete, has the most significant cost reduction of 5.41% of the total cost.

c. *Column*

On Floors 1 through 10 and the roof floors, alternative implementation is practiced. After performing an analysis of the beam work by calculating the budget planning, a comparison between the original design and each suggested alternative is made.

Table 4 Results of Alternative Analysis Of Column

No.	Description	Amount (IDR)	Price Gap (IDR)	Markdown (%)
1	Initial Design	93.576.000.000	-	0
2	Semi-system Formwork	88.573.000.000	5.003.000.000	5,65
3	Peri Lico Sistem Formwork	88.382.000.000	5.194.000.000	5,88
4	Precast Column	86.826.000.000	6.750.000.000	7,77

Based on these results it is known that third alternative or the use of precast concrete, has the most significant cost reduction of 5.41% of the total cost.

3.4 Development Phase

After knowing each of the most efficient recommendation alternatives, a pairwise comparison is performed for each recommendation alternative. then by implementing alternative precast concrete for slabs, beams and columns, the most efficient cost savings results are obtained. the result obtained is a cost savings of 19,21% of the total cost.

4. Conclusions

The application of value engineering is carried out on structural work with items of work supporting floor plates, beams and columns. Structural work is feasible for value engineering analysis based on Pareto's law. The alternatives given for each work item are the initial design floor slab work using conventional concrete, the selected design alternative uses precast as a substitute for conventional concrete. The selected alternative beam and column work is precast concrete as a substitute for conventional concrete and the use of conventional formwork. The results obtained decreased by 19,21% of the total cost.

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