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COMPARATIVE STUDY OF CONVENTIONAL AND PRECAST METHODS FROM THE COST SIDE (CASE STUDY ON BATANG III INDUSTRIAL WORKER FLATS CONSTRUCTION PROJECT)

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ABSTRACT

The Batang III Industrial Workers Flats Construction Project is part of the construction of the Batang integrated industrial estate, where these flats will be a residence for workers in the Batang industrial area later. In the initial design of this project used the full precast upper structure method. This method requires a fairly high implementation cost, so changes were made to the precast / precast VE implementation method. The purpose of the study was to determine the cost efficiency between the upper structure method of full precast, VE precast column multi floor, conventional and choose the type of method that is more economical as an alternative option. This type of qualitative research uses the Value engineering (VE) method, the VE method is one of the well-known methods and has a considerable potential for success in controlling costs. This technique uses an approach by analyzing its function. The process carried out is to reduce cost reduction as far as possible while still paying attention to the desired quality and reliability. The results of this study showed that in the upper structural work of the Batang III industrial worker apartment project, it was found that the initial cost of the full precast method at a cost of Rp. 6,418,779,618, the conventional method amounted to Rp. 7,414,918,929, - and the VE precast method multi-floor column joint CCP, precast beam, combination of precast plate and conventional plate in the wet area amounted to Rp. 5,650,987,713, -with a cost difference of Rp. 767,791,904, - or 11.96%, it can be said that the VE precast method multi-floor joint CCP column, precast beam, combination of precast plate and conventional plate in wet areas is cheaper than the full precast method and full conventional method by considering quality results and implementation time.

Introduction

One method of implementing high-level building construction is to use a precast system. The problem is how much efficiency the use of conventional system technology compared to precast systems both in terms of time and cost. In one study, it shows that the precast system method is able to reduce the level of cost efficiency and implementation time compared to conventional system methods (ADIB, 2022). However, in the implementation of a project, problems are often found such as inefficient use of materials, unskilled human resources and inappropriate project implementation time so that it has the potential to be a waste of costs (Kusmiadji & Garside, 2023).

A method that can be used as a cost saving study is the value engineering (VE) method. Value engineering is a creative, organized approach and the target is to optimise the cost and performance of a facility or system (Nurrohman, 2020).

The objectives of this study, among others, Are to determine the method and design of the upper structure with cost savings and efficient implementation time by applying value engineering methods with a case study of the construction of Batang III Industrial Worker Flats. Identify the criteria of success in applying value engineering to determine the upper structure in the construction project of the Batang III Industrial Worker Flats.

Research Methods

Object and Subject of Study

The research was conducted on one of the construction projects of industrial workers' flats in Batang, Central Java. The building consists of 5 floors and one floor on the roof.

Research data

The data needed in this study, namely:

1. Data primer

The primary data in this study are:

a. Building location data
b. Price list of materials, wages and equipment

2. Data seconds

Data obtained outside the primary data is considered complementary data. These data are data from study literature and previous research studies.

Data processing and analysis techniques

Data processing and analysis will use value engineering methods by analysing alternative changes or dimensional replacements in the upper structure by reviewing the existing loads in the initial design and making alternative models of upper structure design, namely conventional upper structures and precast upper structures, with the following steps:

1. Information phase
2. Function analysis phase
3. Creative Level (creative phase)
4. Evaluation phase
5. Development phase
6. Recommendation phase

Results and Discussion

PreStudy Stage

The pre-study stage includes collecting information about the design of implementation methods and general data on construction work, where this study uses a case study of the Batang III Industrial Workers Flats Construction project.

The contract system for the Batang III Industrial Workers Flats Construction project is Unit Price, so the responsibility of the service provider or contractor is only in the construction process.

Study Phase (Value Job Plan)

The study stage of value engineering implementation consists of six stages: the information stage, function analysis stage, creative stage, evaluation stage, development stage and recommendation stage.

Information phase

This research applies the value engineering method to the Batang III Industrial Workers Flats Construction project. This apartment project is located in the Integrated Industrial Estate – Batang area. The construction of these flats includes reinforced concrete structures, roof structures, roof coverings, architecture, mechanical, electrical, plumbing, and landscape areas.

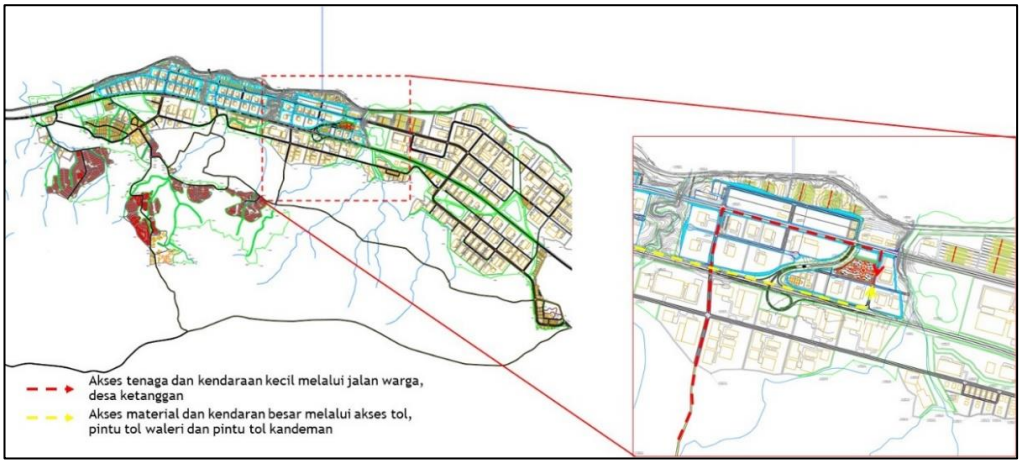

Figure 1 Project Site of Batang Industrial Worker Flats

Project information for Batang III Industrial Workers Flats is as follows:

Tabel 1. General Project Information

NO		DESCRIPTION
1	Project Name	Development of the Batang III Industrial Workers' Stack House
2	Project Location	Integrated Industrial Estate, Batang, Central Java
3	Source of Funds	State Budget for Fiscal Year 2021-2022
4	Employer	Ministry of Public Works and Public Housing
5	Building Users	Residential Facilities for Workers in Integrated Industrial Estate - Batang
6	Supervisory Consultant	PT. Mitraplan Design
7	Planning Consultant	PT. Concept Design Architect
8	Managing Contractor	PT. Brantas Abipraya (Persero)
9	Contract System	Harga Satuan / Unit Price
10	Contract Value	IDR 97,812,234,998.00 (including VAT)
11	Addendum Contract Value	IDR 107,593,000,000.00 (including VAT)
12	Implementation Time	June 30, 2021 to June 25, 2022
13	Building Area	19,728.45 m2
14	Number of Floors	5 Floors and 1 Floor Dak Roof
15	Upper structure method	Methods full precast

The initial design of implementing the reinforced concrete upper structure of this apartment building uses the total precast method (complete precast), which consists of

precast column components, precast beams and precast plates. Where the jointing of each component of precast concrete will be connected by the wet connection method (Abdurrahim, 2018), this method of implementation planning was chosen considering the relatively short time of carrying out work for 300 calendar days. However, the construction costs required were relatively high beyond the initial budget/cost set. The method and implementation design are evaluated to obtain the most efficient method and design. Research on the application of value engineering is only carried out for reinforced concrete upper structure work.

Tabel 2 Project Cost Recap

No	Types of Jobs	Total Cost	Percentage (%)	Compulative (%)
1	Upper Structure Works	18.790.264.097,05	21,10	21,10
2	Sub Structure Work	13.202.111.806,36	14,82	35,92
3	Wall Work+Wall and Floor Cladding	10.161.540.667,51	11,41	47,33
4	Electrical Jobs	9.966.307.707,35	11,19	58,53
5	Work of Sills, Door Shutters and Shutters	5.204.854.075,46	5,84	64,37
6	Environmental Work	3.910.059.944,48	4,39	68,76
7	Non Standart Mechanical Electrical Jobs	3.168.049.446,00	3,56	72,32
8	8 Preparatory Work	3.149.233.790,72	3,54	75,85
9	Outward Looks Work	2.911.126.016,73	3,27	79,12
10	Standard Mechanical Work	2.786.790.616,01	3,13	82,25
11	Sanitair Installation Work	2.775.631.599,04	3,12	85,37
12	Ceiling Work	2.087.007.115,19	2,34	87,71
13	Landscaping Work	2.065.497.394,32	2,32	90,03
14	Utility Work	1.932.004.419,18	2,17	92,20
15	PVRoof 43 kWp Installation Work	1.877.521.168,28	2,11	94,31
16	Roof Structure and Roof Covering Works	1.775.215.777,82	1,99	96,30
17	Earthworks & Quarry	1.769.901.679,17	1,99	98,29
18	Stair Railling Works	801.064.288,04	0,90	99,19
19	Signage Works	721.034.227,53	0,81	100,00
TOTAL PRICE		**89.055.215.836,21**		

Table 2 shows that the upper structure work and the lower structure work have the most significant costs, with a percentage of 21.10% and 14.82%, respectively. Through Pareto analysis, the work to be done by value engineering (VE) is the work of the upper structure. However, value engineering (VE) will not be analysed for lower structure work because the specifications of the work must not be reduced and have been determined by the owner.

Function Analysis Phase

The function analysis stage has the meaning of description, study, and analysis, which will refer to the function of each scope of the problem studied, which will later be used as a reference to get creative ideas at the next stage (Diptera et al., 2018).

Creative Level (Creative Phase)

Considering the results of the analysis of the Pareto law, the value engineering (VE) in this study will focus on the work of reinforced concrete upper structures. This project's reinforced concrete upper structure work is devoted to the structural work of precast columns, beams, and precast floor plates (Sumarda et al., 2022).

At this stage, creative ideas are obtained by discussing them with several people involved in the field so that several alternatives can be researched. In column and beam structure work comparing conventional column and beam structure methods with precast column and beam structure methods, floor plate work comparing half slab plate structure methods with precast plate structure methods in dry areas combined with conventional structure methods in wet areas, and joint work comparing wet connection systems with Couple Coump Plate (CCP) connection systems (Wijaksono et al., 2018).

Researchers chose this alternative in the structural work of columns, beams and floor plates because these components are the main components in the building before the following work process. Researchers also assume that changing this system can reduce unnecessary costs in the implementation process and provide good cost savings for the company (MacIntyre et al., 2002).

Evaluation Phase

At this evaluation stage, the jobs that will be chosen by the criteria set are obtained. In the selection of alternative ideas, cost is not the main criterion since the work's advantages, disadvantages and characteristics are the basis of the selection of alternatives. The criteria for choosing alternative ideas are strength/quality, which is the primary function in material selection, cost, completion time, maintenance, ease of installation, number of labour, work equipment needed, waste material residue, technology/modernisation, and the level of natural damage from materials (Saragi & Zalukhu, 2022).

Table 1

Recapitulation of the comparison of the work of column structures and intermediate beams Early BBP, PRECAST KML VE and Conventional VE

No.	Types of Jobs	INITIAL RBP (Full Precast)	VE Precast Multi Floor Column	Conventional VE
	Structural Work			
1	STRUCTURAL WORK OF COLUMNS AND BEAMS	3.393.784.151,73	3.139.170.764,98	4.868.095.297,24
	TOTAL PRICE	**3.394.784.151,73**	**3.139.170.764,98**	**4.868.095.297,24**

The results of the researcher's evaluation of the cost of column and beam structure work from 2 alternative methods found that the alternative VE multi-floor column precast method is more efficient than the conventional VE method, where there is a cost savings of Rp.1,728,924,532.25 (35.52%). While from 3 alternative columns and beam structure

work, the complete precast method has the best cost efficiency among the other two alternative methods.

Table 2
Recapitulation of comparison of floor plate structure work between Initial RBP, VE Precast + Conventional and VE Half Slab

No.	Types of Jobs	INITIAL RBP (Full Precast)	VE Precast + Conventional	VE Half Slab
	Structural Work			
1	LANYTAI PLATE STRUCTURE WORK	2.082.108.372,67	2.054.970.742,18	2.546.823.632,71
	TOTAL PRICE	**2.082.108.372,67**	**2.054.970.742,18**	**2.546.823.632,71**

The researcher also evaluated the floor plate structure work cost with two alternative methods. Table 4.4 shows that the alternative VE conventional combination precast method is more efficient than VE with the half slab method, with a cost savings of Rp—491,852,890.54 (19.31%). However, from the three alternative floor plate structural works in Table 4.4 above, the results of the complete precast method are much more cost-efficient than the alternative VE conventional combination precast method and the alternative VE half slab method.

Table 3
Comparative recapitulation of joint work between Initial RBP, VE precast CCP method and conventional VE

No.	Types of Jobs	INITIAL RBP (Full Precast)	VE Precast CCP method	Conventional VE
	Structural Work			
1	JOINT WORK	942.887.094,30	456.846.206,64	-
	TOTAL PRICE	**942.887.094,30**	**456.846.206,64**	**-**

Meanwhile, for joint work, an alternative method that is better in cost is the VE precast method, the CCP method compared to complete precast worth Rp.486,040,887.66 (51.55%) and for the conventional VE method, no additional costs are needed for the joint work.

Development Phase

In the course of structural work with the precast method, it has considerable repair/maintenance costs in the connection area between column, beam and floor plate components that are prone to leaks, especially in the toilet area and roof deck (wet area) (Saragi &; Zalukhu, 2022). So, in the view of researchers, this additional cost factor must be considered in determining the appropriate alternative job recommendations.

Table 4
Recapitulation of additional costs of repairing complete precast structure work

No.	Types of Jobs	Unit	Volume	Unit Price	Total Price
1	Bathroom and Laundry Room Floor Waterproofing	m2	2.625,32	247.866,17	125.664.025,39
2	Concrete Injection Work	point	5250,00	75.000,00	393.750.000,00
	TOTAL PRICE				**519.414.025,39**

Table 4 data is a calculation of additional costs that occur when structural work uses the complete precast method, where the additional cost of waterproofing and concrete injection items is repair work due to precast connections in wet areas that experience leaks (Saragi & Zalukhu, 2022).

Recommendation phase

After the analysis and calculation of the structure, the recommended alternative method is the complete precast structure method. The following compares existing costs after VE analysis (Lestari, 2019).

Table 5
Recapitulation of price comparison of structural work

No.	Types of Jobs	INITIAL RBP (Full Precast)	VE Precast CCP method	Conventional VE
	STRUCTURAL WORK			
1	STRUCTURAL WORK OF COLUMNS AND BEAMS	3.393.784.151,73	3.139.170.764,98	4.868.095.297,24
2	Occupation FLOOR PLATE STRUCTURE	2.082.108.372,67	2.054.970.742,18	2.546.823.632,71
3	JOINT WORK	942.887.094,30	456.846.206,64	
	TOTAL PRICE	**6.418.887.094,30**	**5.650.987.713,80**	**7.414.918.929,95**

From the overall evaluation results, it is recommended as the most potential alternative is a combination of multi-floor column structure work and precast beam method, dry area precast floor plate structure work and wet area conventional floor plate structure, joint Couple Coump Plate (CCP) system joint work at a cost of Rp.5,650,987,713.80 and work completion time of 300 days with consideration that cost is not the only criterion that Used. At the same time, the disadvantages are only in terms of initial costs, which are higher than that of other alternatives.

Conclusion

With the implementation of value engineering on the structural work method of the Batang industrial worker apartment project, a cost efficiency of 11.96% or Rp. 767,791,904.89 was obtained between the cost of work from the complete precast method (initial design), the conventional entire upper structure value engineering method and the multi-floor precast column method of precast beams, conventional plate combination precast plates in wet areas (Design Changes), where the cost of upper structure work using the value engineering method is cheaper compared to the conventional complete precast and total methods. With the analysis of value engineering on the upper structure work of the Batang industrial workers' flats, the conventional complete upper structure value engineering method and the precast beam multi-story precast column method, conventional plate combination precast plate in wet areas are choices in terms of quality, cost and time that are more economical that can be used in the project work.

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