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ANALYSIS OF THE CALCULATION OF BUILDING CONSTRUCTION FOR A LABORATORY AND LECTURE HALL AT THE NATIONAL DEVELOPMENT UNIVERSITY "VETERAN" IN EAST JAVA USING ALUMINUM FORMWORK BASED ON COST AND TIME

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ABSTRACT

In this final project, the object of the planned construction management is the Laboratory and Auditorium Development Project of Universitas Pembangunan Nasional "Veteran" Jawa Timur which is located at Jl. Raya Rungkut Madya Gunung Anyar, Surabaya, Jawa Timur. This building has 9 floors and a steel frame roof. The lower structure uses piles and the upper structure uses reinforced concrete. In the preparation of this Applied Final Project, it discusses the comparison between the calculation of time and implementation costs in the Laboratory and Auditorium Building Construction Project at Universitas Pembangunan Nasional "Veteran" Jawa Timur using the existing conventional formwork method (wood) with the Aluminum Formwork method. From this calculation, it is found which method is the most effective to use in terms of time and cost. Time is calculated based on the implementation method used and analysis of production capacity, productivity, and calculation of work duration. The cost is calculated based on analysis in the field through surveys either directly or through equipment and obtained from several pieces of kinds of literature. So that using the right method can be produced time and cost effective. For scheduling each work item, it is done by making bar charts and S curves using the Microsoft Project software application. It is hoped that these calculations can be used as input to the Microsoft Project software application to assist in obtaining the duration and cost of each work item and the selected implementation method.

Keywords: Implementation Cost, Implementation Method, Scheduling, S-Curve

Introduction

A project can be implemented if good planning has been carried out beforehand. This planning includes planning the required implementation costs in detail, the duration of work implementation, as well as selecting implementation methods in the field (Rochmanhadi, 1992). The implementation method is the method used in a job so that it can be implemented in the project (Sastraatmadja, 1994). The choice of method influences the appropriate methods and tools to be used in the field so that work can be carried out effectively and efficiently. The use of the aluminum formwork method (Alumunium Formwok) is considered to have advantages compared to conventional formwork methods, because the installation and dismantling process is fast and can be used many times. So it can reduce time and costs in the implementation of high-rise buildings (Widiasanti & Lenggogeni, 2013).

In this thesis, the planned construction management object is the construction project for the Joint Laboratory and Lecture Building at the East Java "Veteran" National Development University, which is located on Jl. Rungkut Madya Gunung Anyar, Surabaya. This project has 9 floors and a steel frame roof built with a length of 46 m, a width of 34 m and a height of 38 m and a total building area of ±8,528 m². The construction project for the Joint Laboratory and Lecture Building at the National Development University "Veteran" East Java consists of two main structural works, namely the lower structure and the upper structure. The lower structure in this project uses a pile foundation, while the upper structure uses reinforced concrete. This project uses in-situ casting methods to build the main structure. Apart from that, the implementation duration is limited according to the contract, so good planning of construction implementation methods and effective calculation of implementation time and costs are needed so that the project can be completed on time (Husen, 1994; Wilopo, 2009). So this thesis will discuss the calculation of construction time and costs for the construction of the Joint Laboratory and Lecture Building at the National Development University "Veteran" East Java using aluminum formwork which will focus on carrying out structural work in this building including pile caps, sloofs, columns, beams, floor plates, stairs and steel frame roof.

Calculating the implementation time for building construction uses the Predence Diagram Method (PDM) which is analyzed with the help of

Microsoft Project software. To calculate implementation costs, an Implementation Budget Plan (RAP) is prepared and an S curve is obtained by calculating the weight of each job. From the results of these calculations, it can be seen which method is most effective to use in the construction of the construction project for the Joint Laboratory and Lecture Building at the East Java "Veteran" National Development University.

Research Methods

Data collection methods are the methods used to obtain data. The data required in preparing this thesis is divided into two, namely:

A. Primary Data

Data obtained directly includes:

1. Prices of materials and supplies.
2. Heavy equipment specifications.
3. Heavy equipment rental prices.

B. Secondary Data

Data derived from book references and the internet used to support the thesis compilation, including:

1. Working drawings.
2. RKS (Work Plan and Requirements).

The data that has been obtained is processed to achieve the initial objectives of this thesis. The data processing stages are as follows:

1. Grouping and arranging types of work.
2. Calculation of the volume of each work item.
3. Calculate the production capacity of each work item.
4. Calculating implementation time.
5. Calculate implementation costs.
6. The calculation results.

This work unit price analysis is influenced by coefficient numbers which show the unit value of materials, the unit value of tools, and the unit value of labor wages or work units which can be used as a reference or guide for planning or controlling the costs of a job.

Prices for materials can be found on the market, which are then collected and recorded in a list called the unit price of materials, while labor wages are obtained at local locations which are then collected and recorded in a list called the unit price list for labor wages. The unit price in the calculation must be adjusted to field conditions, equipment condition (efficiency), implementation method and transportation distance.

The units used in determining unit price analysis for work items are units of money for each unit quantity of work items ($/m3, $/m2, $/m, and so on). This unit will be used as the basis for payment for work performers, therefore measuring work carried out for the purpose of payment must use the units used in unit price analysis of work items.

Work items used in preparing this thesis include:

1. Column Work
2. Beam Work
3. Floor Slab Work
4. Ladder Work
5. Shearwall work
6. Steel Truss Roof Work

Calculating the duration of work on the Joint Laboratory and Lecture Building Construction project at the East Java "Veteran" National Development University uses analysis of the number of workers, worker capacity and equipment efficiency using the Microsoft Project program so that Network Planning, Bar Charts and S Curves can be prepared.

Results and Discussion

Within this final project, the unit price of Aluminum formwork is calculated based on the area per m^2. The unit price is obtained from research conducted by Alham (2021). As for the selling price, it is derived from the study conducted by Yahya (2021).

The following is a summary of the purchasing prices for aluminum formwork.

Table 1. Summary Table of Duration and Job Prices

Aluminium Formwork			
Working	Volume	Cost	Total

Column	447,07	m²	Rp 2.499.544,81	Rp 1.117.460.207
Beam	796,40	m²	Rp 2.499.544,81	Rp 1.990.637.488
Floor Plate	797,94	m²	Rp 2.498.624,81	Rp 1.993.752.682
Ladder	30,40	m²	Rp 2.499.544,81	Rp 75.991.161
Shearwall	132,00	m²	Rp 2.499.544,81	Rp 329.939.915
Total Volume	2203,807	m²		

Aluminum formwork can be used approximately 150 - 200 times, allowing it to be resold after the project is completed. The resale price of aluminum formwork is found to be Rp1,478,898. Below is the calculation for the resale of aluminum formwork:

Formwork Volume = 2203.81 m²

Selling Price = Volume x Selling Price

Aluminum formwork = 2203.81 m² x Rp1,478,898 = Rp3,259,206,478

The time calculation used for this aluminum formwork is obtained from the research of Soedradjat (1984). Meanwhile, the cost calculation is obtained from the unit cost in the study by Alham (2021).

Construction execution time can be scheduled using the aid of a software program, namely Microsoft Project. With the aluminum formwork method, the total work duration is as follows:

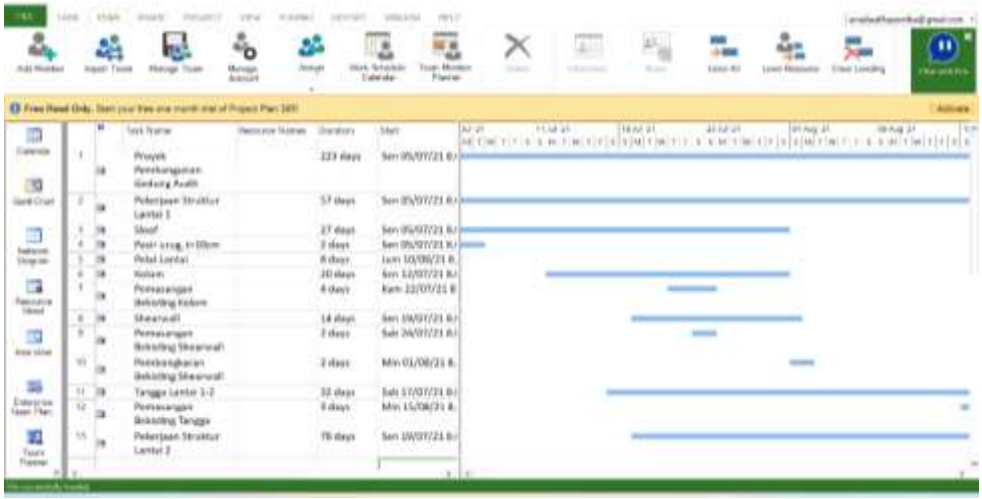

Figure 1. Scheduling Using Aluminum Formwork

From the above figure, it is found that the construction of the Laboratory and Joint Lecture Hall Building at the National Development University 'Veteran' in East Java using aluminum formwork requires 272 days, whereas conventional formwork requires 332 days, assuming a 7-hour workday starting from 08:00 to 16:00, with a 1-hour break, and Sundays off.

Table 2. Summary Table of Duration and Job Prices

Floor	Alumunium		Conventional	
	Duration	Installation Costs	Duration	Installation Costs
1	70	Rp 3.296.092.576	73	Rp 2.010.442.207
2	79	Rp 6.220.427.743	88	Rp 2.664.783.655
3	92	Rp 2.769.637.412	101	Rp 3.215.242.031
4	62	Rp 1.641.314.449	72	Rp 2.163.381.628
5	62	Rp 1.641.314.449	72	Rp 2.159.511.628
6	62	Rp 1.641.314.449	70	Rp 1.997.030.365
7	62	Rp 1.641.314.449	72	Rp 2.159.511.628
8	63	Rp 1.649.804.449	73	Rp 2.168.001.628
9	73	Rp 2.007.230.118	80	Rp 2.498.111.777
Rooftop	51	Rp 1.238.711.590	55	Rp 1.496.450.948
Roof	26	Rp 860.286.431	26	Rp 860.286.431
Tower Crane Rental		Rp 1.858.125.000		Rp 2.188.125.000
Pipe support		Rp 348.174.515		
Total		Rp 26.813.747.633		Rp 25.580.878.923

Based on the table above, the cost using Aluminum Formwork amounts to Rp26,813,747,633. This price is then increased by an unforeseen cost of 10%

of the total value, which is Rp2,681,374,763. Additionally, the safety (K3) cost is taken at 1.5% according to the previous reference in a similar project, totaling Rp402,206,214. Hence, the total cost using Aluminum Formwork is Rp29,897,328,610. Considering the resale of Aluminum Formwork at Rp3,259,206,478, the total cost using Aluminum Formwork becomes Rp26,638,122,132. On the other hand, the cost obtained using conventional formwork is Rp25,580,878,923. This price is increased by an unforeseen cost of 10% of the total value, which is Rp2,558,087,892. Additionally, the safety (K3) cost is taken at 1.5% according to the previous reference in a similar project, totaling Rp383,713,184. Thus, the total cost using conventional formwork is Rp28,522,679,999.

The analysis results indicate the impact of using aluminum formwork, which are:

1. The use of aluminum formwork can reduce waste generated from wood usage.
2. The time required for implementation with aluminum formwork is faster compared to conventional formwork.
3. The cost involved in implementation with aluminum formwork is cheaper compared to conventional formwork.

Conclusion

Based on the results and analysis conducted for methods, costs, and time, it can be concluded that:

1. The time required to complete the structural work for floors 1-9 in the construction project of the Laboratory and Joint Lecture Hall Building at the National Development University "Veteran" in East Java using Microsoft Project is as follows:
   a. The work duration using aluminum formwork is completed in 272 days.
   b. The work duration using conventional formwork is completed in 332 days.

Therefore, the structural work with the fastest duration is achieved using aluminum formwork, with a difference of 60 days faster than using conventional formwork.

2. The implementation costs required to complete the structural work in the construction project of the Laboratory and Joint Lecture Hall Building at the National Development University "Veteran" in East Java are as follows:
   a. Total cost using aluminum formwork is Rp26,638,122,132.

b. Total cost using conventional formwork is Rp28,522,679,999.

Therefore, the structural work with the cheapest cost is achieved using aluminum formwork, with a difference of Rp1,884,557,867.

3. The impact of using aluminum formwork on time and implementation costs are as follows:
   a. The time required for implementation using aluminum formwork is faster compared to conventional formwork.
   b. The cost involved in implementation using aluminum formwork is cheaper compared to conventional formwork.
   c. Aside from the impact on time and cost, there are other effects of using aluminum formwork, such as:
   d. Aluminum formwork usage can reduce waste generated from wood usage.
   e. Aluminum formwork usage can mitigate social impacts, like traffic congestion due to heavy equipment movement and noise disturbance from construction activities. Particularly, considering the construction project is in an educational area.
4. Aluminum formwork excels in its implementation method due to its all-in-one system installation. This allows simultaneous formwork for columns, beams, and slabs, minimizing any backlog in work. The robust material allows for reuse, eliminating wood waste, and enabling recycling. This significantly supports green construction practices, promoting sustainability in both construction and the surrounding environment.
5. This formwork doesn't incur additional costs due to its durability for up to 25 uses and zero waste material. Therefore, aluminum formwork is suitable for constructing high-rise buildings with typical floors.
6. The aluminum formwork type requires the fastest installation time, approximately 6 days per floor. This is influenced by the ease of implementation, resulting in high productivity.

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