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Comparative Analysis of Cost and Time for Beam, Slab, and Column Formwork Using Conventional and Aluminum Formwork Methods

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ABSTRACT

The development of the construction industry in Indonesia has accelerated urbanization and population growth, demanding the implementation of efficient construction methods, particularly in the development of high-rise buildings that optimize both cost and project duration. In reinforced concrete construction, formwork plays a significant role in determining the overall cost and time of the construction project. Therefore, this study analysis the comparison of cost and time for formwork work on columns, beams, and slabs in the BSI Tower project. Conventional formwork, typically made of wood, is still widely used due to its relatively low initial cost and flexibility. However, this method has several drawbacks, including material waste, low durability, high labour intensity, long processing time, inconsistent concrete surface quality, and a short service life, which lead to higher maintenance and replacement costs. In contrast, aluminum formwork is lightweight, precise, and reusable. This research employs a quantitative approach and utilizes Microsoft Project software. Cost analysis is conducted by multiplying the work volume by unit prices obtained from the 2024 Jakarta Standard Unit Price Analysis (AHSP) and project documentation, while time analysis is developed through Microsoft Project to estimate the duration of formwork installation and removal from floors 14 to 22. The results indicate that aluminum formwork is more efficient than conventional formwork in terms of both cost and time. The total cost of the aluminum formwork system was IDR 6,262,395,602, while the total cost of the conventional formwork system was IDR 6,509,110,236. This indicates that the aluminum formwork system is more economical, with a cost reduction of IDR 246,714,634, equivalent to approximately 3.79% compared to the conventional formwork system. Regarding time, aluminum formwork requires 63 days to complete, whereas conventional formwork takes 108 days, resulting in a time saving of 45 days. This research provides a data-driven framework to assist contractors in optimizing project scheduling and cost budgeting when transitioning from conventional formwork to aluminum formwork systems.

Keywords: conventional formwork; aluminum formwork; cost; time

1 Introduction

The construction industry in Indonesia is experiencing rapid growth in line with increasing urbanization and the need for efficient and sustainable high-rise building construction [1]. Selecting suitable formwork is pivotal in high-rise building construction, as it directly affects the overall cost, construction speed, and quality of the final structure [2]. Project are temporary activities limited by time, cost, and quality, requiring careful planning to meet objectives [3]. However, delays and cost overruns are common in construction projects [4]. Building should consistently perform effectively and dependably, ensuring the safety, health, comfort, and convenience of their occupants, while also aligning with the surrounding environment [5]. In the process of building reinforced concrete structures, formwork plays an important role as a temporary mold that determines the quality, cost, and time of project implementation [6]. Conventional wood-based formwork is still widely used due to its flexibility and low initial cost. But conventional formwork has disadvantages such as low durability, long processing time, and high maintenance and material replacement costs. As an alternative, Aluminum formwork is becoming widely used because it offers the advantage of being faster, lighter, durable, and can be used repeatedly with high precision, although it requires a

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greater initial investment [7]. This study adopts the BSI Tower building as a case study, as the project utilizes an aluminum formwork system in its construction. This case is considered unique because most building projects still predominantly employ conventional formwork systems. Therefore, the analysis of cost and time performance between conventional and Aluminum formwork systems in the BSI Tower Jakarta construction project plays a crucial role in determining the most effective and efficient formwork method. Furthermore, this study contributes to optimizing project scheduling and cost budgeting when transitioning from conventional to Aluminum formwork systems.

2 Data and Methods

2.1 Definition of Formwork

Formwork is a temporary tool used to support the weight during the casting and forming process of concrete [8]. Formwork gives necessary shape and dimensions to the structure [9]. The design of formwork must meet technical and economic aspects, as well as be strong, leak-proof, and easy to assemble and dismantle.

2.2 Definition of Conventional Formwork

Conventional formwork is a temporary mold system that functions to form concrete elements according to the shape and size that has been planned in the construction design. Traditional wooden formwork systems or also known as Conventional Formwork, are the oldest type of formwork in construction [10]. Formwork is easy to make, but it takes longer to build and has a shorter life cycle [11]. A primary drawback of the conventional method is material waste that cannot be reused for subsequent formwork operations. Formwork cost account for approximately 40% to 60% of the total cost of concrete works or around 10% of the overall building construction expenses [12]. Initial costs for conventional formwork systems are relatively low due to the accessibility and cost-effectiveness of materials such as timber and plywood compared to modern formwork technologies.

2.3 Definition of Aluminum Formwork

Aluminum formwork is a temporary formwork Aluminum based. Aluminum formwork the modern approach to construction uses lightweight Aluminum alloy panels, offering advantages such as easy assembly, durability, and a smooth finish, but also requiring high initial costs, limited modification options, and uniform planning [13]. Aluminum formwork can be used 150-200 times so that the work becomes more efficient [14]. Aluminum formwork is faster to install and disassemble than conventional formwork because it has an all-in-one system that allows installation to be done more simply and with high productivity.

2.4 Multiplex

Conventional formwork involves the use of plywood sheets to create temporary structures for pouring concrete [15]. Plywood is a manufactured composed of multiple thin veneer layers. This lamination process produces a material with enhanced strength, dimensional stability, and flexibility, making it widely utilized in the construction industry. Unlike triplex, which consists of only three layers, plywood contains more than three layers, providing superior mechanical properties and durability. Typically, plywood formwork can be reused only 2 to 3 times before replacement is necessary, resulting in relatively higher operational.

2.5 Comparison of Conventional and Aluminum formwork

Table 1, shows the comparison between the use of conventional and Aluminum

Table 1. Comparison Conventional and Aluminum Formwork

Variable	Conventional	Aluminum
Speed	10-12 days	5-6 days
Quality	Less neat/ smooth	Neat and smooth concrete
Waste	A lot of wood waste	The main material does not produce waste
Use	2-3 times [16]	150-200 times [14]
Man Power	Skilled craftsmen [17]	No special skills required
Implementation	Transfer using Tower crane	Removal without Tower crane

2.6 Cost

Project costs play a crucial role in determining the success of construction projects and are typically divided into two main categories: direct and indirect costs. Effective cost planning and control are essential to ensure that construction projects remain within budget and on schedule. Research indicates that inadequate cost control frequently causes project delays, leading to increased costs and extended completion times. In the implementation in the field, many construction projects require enormous cost because there are costs resulting from inefficient planning and building design. The planning in question is the selection of materials which ultimately affects the quality and method of implementation. The construction costs can be optimized by back analysis based on building planning and design data [18].

2.7 Duration

The construction project duration denotes the total elapsed time necessary to complete all construction activities, spanning from the initial mobilization and site preparation phase through to final project handover. Planning and scheduling are crucial elements of project management as they govern the efficiency and performance of a project [19]. Effective time scheduling is critical to ensure that the project is completed within the established timeline.

2.8 Productivity

Productivity in construction operation is critical factor that directly influences the success or failure project. Type of formwork used in building projects affects the productivity [20]. Higher productivity is achieved when a larger volume of work is completed within a given timeframe. Generally, productivity can be quantified using the following formula:

$$\text{Productivity} = \frac{\text{Volume}}{\text{Duration}} \quad (1)$$

The volume of work is measured in units such as square meters (m^2) and time is measured in weekdays. This formula describes the efficiency of time use in completing a construction project.

2.9 Unit Price Analysis of Work Items

Unit Price Analysis is a method used to calculate the costs required in a construction project, including labor, materials, and equipment. The main goal of the Unit Price Analysis is to determine realistic and accurate prices for each work unit, so that it can help in the preparation of project budgets and provide a solid basis for bids and contracts.

2.10 Microsoft Project 2021

Microsoft Project 2021 is a project management software developed by Microsoft, designed to effectively plan, schedule, manage, and monitor projects. This tool is commonly utilized by project managers across various industries, including construction, technology, and business sectors.

2.11 Methods

This study uses a quantitative method because conclusions are drawn based on data [21]. More over Microsoft Project software It is used following the schedule of the implementation of columns, beams, and floor plates 14 to 22 using conventional formwork and Aluminum methods. To carry out the research process from beginning to end is shown in the form of a flow diagram in **Figure 1**. The following are the stages in the research flow chart:

1. Problem Identification

   In construction projects, formwork has an important role because it has a significant cost and time with the construction project. Therefore, an analysis is needed to determine the most efficient formwork method, both in terms of the duration of implementation and the costs incurred.

2. Literature Studies

   The literature study used in this study is sourced from books and journals that discuss comparative analysis. The use of conventional formwork and Aluminum method, especially related to costs and the implementation time in column, beam, and plate work.

3. Data Collection

   In this study, data were collected through field observations. Primary data included the implementation time of both conventional and Aluminum formwork systems, construction methods, and project documentation. Secondary data consisted of the Jakarta 2024 Unit Price Analysis, as well as relevant journals, textbooks, and project-related documents.

4. Data Processing

   Based on the structural drawings, the amount of conventional formwork and Aluminum was obtained for each floor. Then, the specifications of formwork materials, and the Jakarta 2024 Work Unit Price Analysis (AHSP) were used to compare the cost and time of the two methods.

5. Time Analysis of Conventional and Aluminum Formwork

   Formwork time analysis is comparing the duration of job completion to determine the most efficient method.

6. Cost Analysis of Conventional and Aluminum Formwork

   The cost calculation includes materials, wages, and tools based on the Jakarta 2024 Work Unit Price Analysis. Cost analysis was conducted for conventional and Aluminum formwork on columns, beams, and floor plates 14-22 of the BSI project *Tower* Jakarta.

7. Comparative Analysis

   After time and cost analysis, a comparison was made between conventional formwork and Aluminum for column, beam, and plate work.

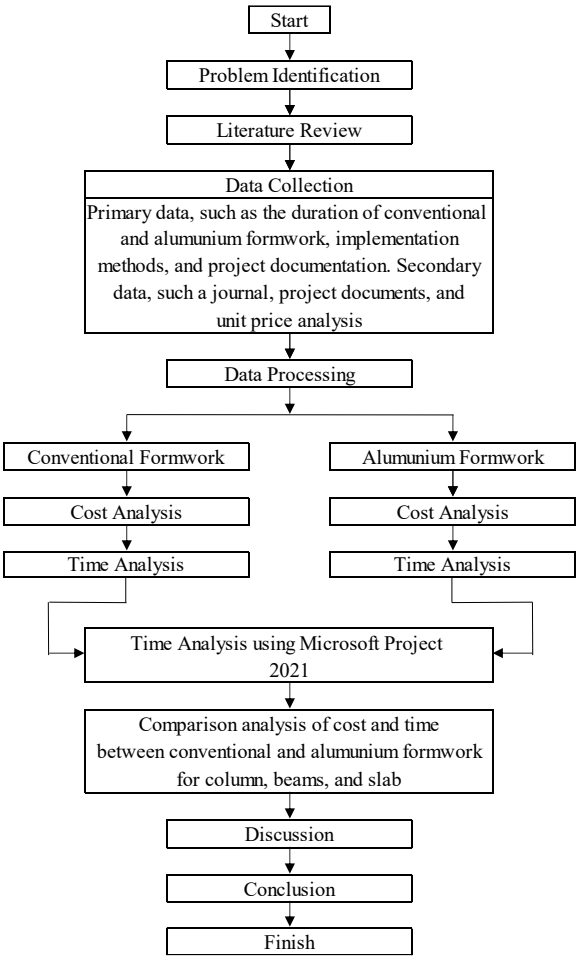


Figure 1. Research Flow Diagram

3 Results and Discussion

This study focuses on the analysis of columns, beams, and floor plates on the 14th-22nd floor by comparing the use of conventional formwork and Aluminum related to the time and cost of implementation in the BSI Tower Jakarta construction project. The cost of conventional formwork was determined for each structural component. The column formwork cost was IDR 520,587,942, the beam formwork cost was IDR 3,455,528,094, and the slab formwork cost was IDR 2,532,994,200, resulting in a total conventional formwork cost of IDR 6,509,110,236. In comparison, the Aluminum formwork system showed slightly different cost characteristics. The column formwork cost was IDR 541,925,798, the beam formwork cost was IDR 3,505,087,404, and the slab formwork cost was IDR 2,215,382,400, giving a total cost of IDR 6,262,395,602 for columns, beams, and slabs. In terms of construction duration, the conventional formwork method required 108 days to complete, whereas the Aluminum formwork system reduced the construction time to 63 days.

3.1 Column Formwork Volume

To calculate the volume of conventional formwork and Aluminum flooring, the first step is to identify the type and number of columns on each floor, then calculate the total volume as shown in **Table 2.**

Table 2. Volume of Conventional and Aluminum Column Formwork

Description	L	W	H	Quantity	Volume (m^2)
Formwork Volume for floor 14					
Column Formwork 1000 x 1000	1	1	4,1	14	229,6
Column Formwork 1600 x 1600	1,6	1,6	4,1	4	104,96
Formwork volume for floor 14					334,56
Formwork Volume for floor 15 - 22					
Column Formwork 1000 x 1000	1	1	4,1	112	1836,8
Column Formwork 1400 x 1400	1,4	1,4	4,1	32	734,72
Formwork volume for floor 15-22					2571,52

From **Table 1**, the total volume of conventional column formwork and Aluminum on the 14th – 22nd floor is 2571.52 m^2.

3.2 Beam Formwork Volume

To calculate the formwork volume of each floor, the first step is to identify the type of floor plate and the number present on each floor, then the total volume can be calculated as in **Table 3**.

Table 3. Volume of Conventional and Aluminum Beam Formwork

Description	L	W	H	Quantity	Volume (m^2)
Beam formwork volume for floor 14-22					
Beam formwork 400 x 800	10	0,4	0,8	90	2880
Beam formwork 400 x 800	9	0,4	0,8	36	1036,8
Beam formwork 350 x 700	9	0,35	0,7	135	3705,75
Beam formwork 300 x 650	9	0,3	0,65	234	6212,7
Beam formwork 350 x 650	7,25	0,35	0,65	27	587,25
Beam formwork 300 x 600	7,25	0,3	0,6	54	1135,35
Beam formwork 500 x 800	11	0,5	0,8	36	1306,8
Beam formwork 300 x 650	10	0,3	0,65	45	1327,5
Beam formwork 300 x 750	11	0,3	0,75	18	603,9
Beam formwork volume for floor 14-22					18796,05

From **Table 3**, the total volume of conventional beam and Aluminum formwork on the 14th – 22nd floor is 18796.05 m^2.

3.3 Volume of Conventional and Aluminum Slab Formwork

To calculate the formwork volume of each floor, the first step is to identify the type of floor slab and the number present on each floor, then the total volume can be calculated as in **Table 4**.

Table 4. Volume of Conventional and Aluminum Plate Formwork

Description	L	W	Quantity	Volume (m^2)
Slab Formwork for floor 14-22				
Slab Formwork 3.3 x 9 m	9	3,3	180	5346 m^2
Slab Formwork 3.6 x 9 m	9	3,6	81	2624,4 m^2
Slab Formwork 3 x 9 m	9	3	81	2187 m^2
Slab Formwork 3.3 x 7.25 m	7.25	3,3	72	1722,6 m^2
Slab Formwork for floor 14-22				11880 m^2

From **Table 4**, the total volume of formwork for conventional slab and Aluminum floors 14 – 22 is 11880 m^2.

3.4 Conventional Formwork Unit Price

The unit price of conventional formwork used three times for column, beam, and plate work was obtained from the 2024 Jakarta Work Unit Price Analysis. From **Table 5**, it is found that the unit price of conventional formwork is IDR 179.137,51. From **Table 6**, it is obtained that the unit price of conventional beam formwork is IDR 183.843. From **Table 7**, it is obtained that the unit price of conventional slab formwork is IDR 213.215,00

Table 5. Conventional Formwork Column Unit Price

Description	Code	Unit	Coefficient	Unit Price (IDR)	Total Price (IDR)
Installation of 1 m^2 of formwork for columns (3 uses)					
Workforce					
Worker	L.01.	OH	0,6600	84.200,00	55.572,00
Carpenter	L.02.	OH	0,3300	100.900,00	33.297,00
Head Builder	L.03.	OH	0,0330	110.000,00	3.630,00
Command	L.04.	OH	0,0110	115.500,00	1.270,50
Total Labor Price					93.769,50
Material					
Nail 5 - 12 cm		kg	0,4000	19.100,00	7.640,00
Formwork Oil		Litre	0,2000	3.300,00	660,00
Class II wooden beams (Meranti batu)		m^3	0,00465	4.400.000,00	20.460,00
Plywood 12 mm thick		sheet	0,12705	145.000,00	18.422,25
Dolken Ø 8-10/400 cm		Trunk	0,6500	22.800,00	14.820,00
Total Material Price					62.002,25
Equipment					-
Total Tool Price					-
Total Labor Price, Materials and Equipment (A+B+C)					155.771,75
General cost and profit (10 - 15%) x D			15%		23.365,76
Unit Price of Work (D+E)					179.137,51

Table 6. Conventional Formwork Beam Unit Price

Description	Code	Unit	Coefficient	Unit Price (IDR)	Total Price (IDR)
Installation of 1 m^2 of formwork for beams (3 uses)					
Workforce					
Worker	L.01.	OH	0,6600	84.200,00	55.572,00
Carpenter	L.02.	OH	0,3300	100.900,00	33.297,00
Head Builder	L.03.	OH	0,0330	110.000,00	3.630,00
Command	L.04.	OH	0,0110	115.500,00	1.270,50
Total Labor Price					93.769,50
Material					
Nail 5 - 12 cm		kg	0,4000	19.100,00	7.640,00
Formwork Oil		Litre	0,2000	3.300,00	660,00
Class II wooden beams		m^3	0,00558	4.400,00	24.552,00

(Meranti batu)				
Plywood 12 mm thick	sheet	0,12705	145.000,00	18.422,25
Dolken Ø 8-10/400 cm	Trunk	0,6500	22.800,00	14.820,00
Total Material Price				66.094,25
Equipment				-
Total Tool Price				-
Total Labor Price, Materials and Equipment (A+B+C)				159.863,75
General cost and profit (10 - 15%) x D		15%		23.979,56
Unit Price of Work (D+E)				183.843,31

Table 7. Unit Price of Conventional Slab Formwork

Description	Code	Unit	Coefficient	Unit Price (IDR)	Total Price (IDR)
Installation of 1 m^2 of slab formwork (3 uses)					
Workforce					
Worker	L.01.	OH	0,6600	84.200,00	55.572,00
Carpenter	L.02.	OH	0,3300	100.900,00	33.297,00
Head Builder	L.03.	OH	0,0330	110.000,00	3.630,00
Command	L.04.	OH	0,0110	115.500,00	1.270,50
Total Labor Price					93.769,50
Material					
Nail 5 - 12 cm		kg	0,4000	19.100,00	7.640,00
Formwork Oil		Litre	0,2000	3.300,00	660,00
Class II wooden beams		m^3	0,00465	4.400,00	20.460,00
Plywood 12 mm thick		sheet	0,12700	145.000,00	18.415,00
Dolken Ø 8-10/400		Trunk	1,9500	22.800,00	44.460,00
Total Material Price					91.635,00
Equipment					-
Total Tool Price					-
Total Labor Price, Materials and Equipment (A+B+C)					185.404,50
General cost and profit (10 - 15%) x D			15%		18.540,45
Unit Price of Work (D+E)					213.215,00

3.5 Analysis of the Cost of Conventional Formwork

After obtaining the unit price for column, beam, and slab, the amount of cost needed for each work is calculated by multiplying the volume of each work by the price units as seen in **Table 8**. such as supporting journals [10] [12].

Table 8. Cost of Conventional Formwork

Description	Volume	Unit Price (IDR)	Total Price (IDR)
Floor Column Formwork 14-22	2906,08 m^2	179.137,51	520.587.942
Floor Beam Formwork 14-22	18796,05 m^2	183.843,31	3.455.528.094
Slab Formwork 14-22	11880 m^2	213.215,00	2.532.994.200
Total Conventional Formwork Floors 14-22			6.509.110.236

From **Table 8**, the total cost of beam and slab in the construction of BSI Tower using conventional formwork is IDR 6,509,110,236.

3.6 Aluminum Formwork Unit Price

The unit price of Aluminum formwork work for columns, beams, and plates is obtained From the BSI Tower Project documents as seen in **Table 9.** such as supporting journals [10].

Table 9. Aluminum Formwork Unit Price

Description	Unit	Unit Price (IDR)
Workforce		
Workers Install	m^2	53.000
Material		
Aluminium Formwork	m^2	97.000
Flat Ties/Wedges Ties	m^2	97.000
Tool		-
Total (labor + materials + tools)		150.000
Overhead Costs & Profits	12% x D	18.000
PPN 11%		18.480
Unit Price of Work		186.480

From **Table 9**, the cost of Aluminum formwork is Rp 186,480

3.7 Analysis of the Cost of Aluminum Formwork

After obtaining the unit price for the work of Aluminum formwork columns, beams, and slab, the amount of cost needed for each work is calculated by multiplying the volume of each work by the unit price. The results are presented in **Table 10.** such as supporting journals [12].

Table 10. Aluminum Formwork Work Cost

Description	Volume	Unit Price (IDR)	Total Price (IDR)
Column Formwork Floor 14-22	2906,08 m^2	186.480	541.925.798
Beam Formwork Floor 14-22	18796,05 m^2	186.480	3.505.087.404
Slab Formwork for floor 14-22	11880 m^2	186.480	2.215.382.400
Total Cost of Column, Beam, and Slab Formwork for floor 14-22			6.262.395.602

From **Table 10**, the total cost of columns, beams, and floor plates in the construction of BSI Tower using Aluminum formwork is Rp 6,262,395,602

3.8 Productivity

Productivity in construction work is a very important aspect and determines the success or failure of a construction project. Type of formwork used in building projects affects the productivity [20]. The greater the volume of work that can be completed in a given time, the higher the productivity level. Generally, productivity can be measured using the following formula:

$$\text{Productivity} = \frac{\text{Volume}}{\text{Duration}} \quad (1)$$

The volume of work is measured in units such as square meters (m^2) and time is measured on weekdays. This formula describes the efficiency of time use in completing construction projects.

Table 11. Recapitulation of Conventional Formwork Productivity

Floor	Productivity (Volume/Duration) (m^2)			Duration (Day)		
	Column	Beam	Slab	Column	Beam	Slab
14	66,9	298,3	188	5	7	7
15	66,9	298,3	188	5	7	7
16	66,9	298,3	188	5	7	7
17	66,9	298,3	188	5	7	7
18	66,9	298,3	188	5	7	7
19	66,9	298,3	188	5	7	7
20	66,9	298,3	188	5	7	7
21	66,9	298,3	188	5	7	7
22	66,9	298,3	188	5	7	7

Table 11. shows a recapitulation of the productivity of column, beam, and slab using conventional formwork methods.

1. Recapitulation of Work Productivity of Aluminum Columns, Beams, and Slab
   In **Table 12** there is a recapitulation of productivity and duration of work using Aluminum formwork.

Table 12. Aluminum Formwork Productivity Recapitulation

Floor	Productivity (Volume/Duration) (m^2)			Duration (Day)		
	Column	Beam	Slab	Column	Beam	Slab
14	111,5	522,1	330	3	4	4
15	111,5	522,1	330	3	4	4
16	111,5	522,1	330	3	4	4
17	111,5	522,1	330	3	4	4
18	111,5	522,1	330	3	4	4
19	111,5	522,1	330	3	4	4
20	111,5	522,1	330	3	4	4
21	111,5	522,1	330	3	4	4
22	111,5	522,1	330	3	4	4

2. Comparison of Conventional and Aluminum Formwork Productivity (m^2)
   Table 13 shows a comparison of the productivity of column, beam, and slab using conventional formwork and Aluminum methods.

Table 13. Recapitulation of Productivity of Conventional and Aluminum Formwork

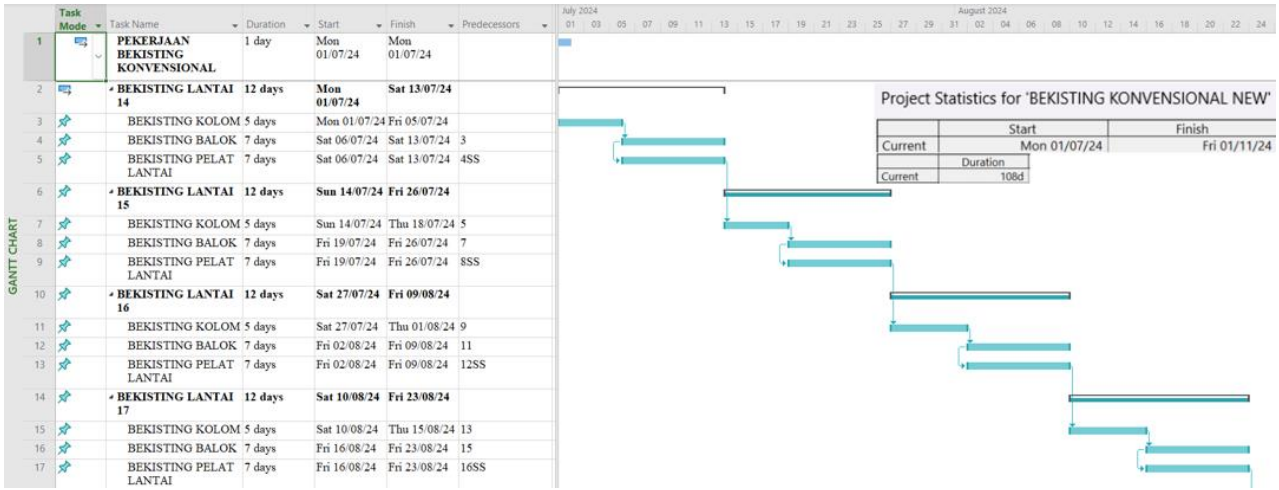
Comparison of Conventional and Aluminum Formwork Productivity (m^2)						
Floor	Conventional Formwork			Aluminum Formwork		
	Column	Beam	Slab	Column	Beam	Slab
14th Floor	66,9	298,3	188	111,5	522,1	330
15th Floor	66,9	298,3	188	111,5	522,1	330
16th Floor	66,9	298,3	188	111,5	522,1	330
17th Floor	66,9	298,3	188	111,5	522,1	330
18th Floor	66,9	298,3	188	111,5	522,1	330
19th Floor	66,9	298,3	188	111,5	522,1	330
20th Floor	66,9	298,3	188	111,5	522,1	330
21st Floor	66,9	298,3	188	111,5	522,1	330
22nd Floor	66,9	298,3	188	111,5	522,1	330
Average Column	64, 572 (m^2)			107, 627 (m^2)		
Average Beam and Slab	486,92 (m^2)			852,11 (m^2)		

Based on **Table 13**, the average productivity for completing column using conventional formwork is 64, 572 m^2/day. Beam and slab using conventional formwork is 486,92 m^2/day. Meanwhile, for column aluminum formwork is 107,627 m^2/day. Beam and slab using aluminum formwork is 852,11 m^2/day.

3.9 Analysis of Conventional Formwork Work Time

The time for conventional formwork work is performed using Microsoft Project to estimate the duration of completion of a construction project. The

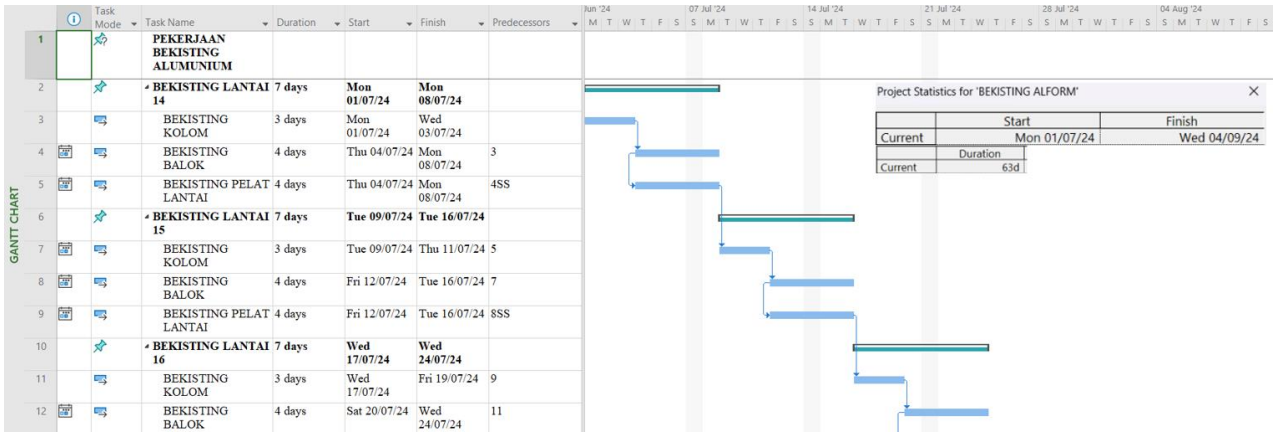
estimated time only covers the process of installing and dismantling the formwork on the 14th to 22nd floors for column, beam, and floor plate work. The duration of the work was obtained directly from the BSI Tower Jakarta project documents. The duration of the project is compiled using the Gantt Chart in the Microsoft Project as shown in **Figure 2.**



	Task Mode	Task Name	Duration	Start	Finish	Predecessors
1		**PEKERJAAN BEKISTING KONVENSIONAL**	1 day	Mon 01/07/24	Mon 01/07/24	
2		**BEKISTING LANTAI 14**	**12 days**	**Mon 01/07/24**	**Sat 13/07/24**	
3		BEKISTING KOLOM	5 days	Mon 01/07/24	Fri 05/07/24	
4		BEKISTING BALOK	7 days	Sat 06/07/24	Sat 13/07/24	3
5		BEKISTING PELAT LANTAI	7 days	Sat 06/07/24	Sat 13/07/24	4SS
6		**BEKISTING LANTAI 15**	**12 days**	**Sun 14/07/24**	**Fri 26/07/24**	
7		BEKISTING KOLOM	5 days	Sun 14/07/24	Thu 18/07/24	5
8		BEKISTING BALOK	7 days	Fri 19/07/24	Fri 26/07/24	7
9		BEKISTING PELAT LANTAI	7 days	Fri 19/07/24	Fri 26/07/24	8SS
10		**BEKISTING LANTAI 16**	**12 days**	**Sat 27/07/24**	**Fri 09/08/24**	
11		BEKISTING KOLOM	5 days	Sat 27/07/24	Thu 01/08/24	9
12		BEKISTING BALOK	7 days	Fri 02/08/24	Fri 09/08/24	11
13		BEKISTING PELAT LANTAI	7 days	Fri 02/08/24	Fri 09/08/24	12SS
14		**BEKISTING LANTAI 17**	**12 days**	**Sat 10/08/24**	**Fri 23/08/24**	
15		BEKISTING KOLOM	5 days	Sat 10/08/24	Thu 15/08/24	13
16		BEKISTING BALOK	7 days	Fri 16/08/24	Fri 23/08/24	15
17		BEKISTING PELAT LANTAI	7 days	Fri 16/08/24	Fri 23/08/24	16SS

Figure 2. Gantt Chart Conventional Formwork

From **Figure 2**, it can be seen that the conventional formwork Gantt Chart displays the list of conventional formwork work for each floor on the left, and the timeline of the conventional formwork project on the right side in the form of a horizontal bar chart showing the duration of each task, start and finish dates, and dependencies between tasks. It turned out that the duration of work on conventional columns, beams, and formwork plates was obtained within 108 days.



	Task Mode	Task Name	Duration	Start	Finish	Predecessors
1		**PEKERJAAN BEKISTING ALUMUNIUM**				
2		**BEKISTING LANTAI 14**	**7 days**	**Mon 01/07/24**	**Mon 08/07/24**	
3		BEKISTING KOLOM	3 days	Mon 01/07/24	Wed 03/07/24	
4		BEKISTING BALOK	4 days	Thu 04/07/24	Mon 08/07/24	3
5		BEKISTING PELAT LANTAI	4 days	Thu 04/07/24	Mon 08/07/24	4SS
6		**BEKISTING LANTAI 15**	**7 days**	**Tue 09/07/24**	**Tue 16/07/24**	
7		BEKISTING KOLOM	3 days	Tue 09/07/24	Thu 11/07/24	5
8		BEKISTING BALOK	4 days	Fri 12/07/24	Tue 16/07/24	7
9		BEKISTING PELAT LANTAI	4 days	Fri 12/07/24	Tue 16/07/24	8SS
10		**BEKISTING LANTAI 16**	**7 days**	**Wed 17/07/24**	**Wed 24/07/24**	
11		BEKISTING KOLOM	3 days	Wed 17/07/24	Fri 19/07/24	9
12		BEKISTING BALOK	4 days	Sat 20/07/24	Wed 24/07/24	11

Figure 3. Gantt Chart Aluminum Formwork

3.10 Aluminum Formwork Time Analysis

The time of Aluminum formwork work is compiled using the Microsoft Project to find out the duration required to complete the construction project. This calculation includes the process of installing Aluminum formwork on the 14-22nd floor which includes column, beam, and slab. The amount of work duration was obtained directly from the BSI Tower Jakarta project documents. **Figure 3** shows an Aluminum formwork Gantt Chart with a list of work for each floor on the left side and a project timeline on the right, in the form of a horizontal bar chart depicting the duration, start and finish dates, and dependencies between tasks. The results were obtained for the duration of the Aluminum formwork work within 63 days.

3.11 Comparative Analysis of Formwork Costs

Based on the results of the cost analysis that has been carried out, a cost comparison was obtained that showed that Aluminum formwork was cheaper than conventional formwork with a difference of IDR 246,714,634, as shown in **Table 14.**

Table 14. Comparative Analysis of Formwork Costs

No	Formwork Type	Total Cost (IDR)
1	Conventional Formwork	6.509.110.236
2	Aluminum Formwork	6.262.395.602
	Difference	246.714.634

3.12 Comparative Analysis of Formwork Work Time

Based on the results of the time analysis prepared using Microsoft Project, the duration for conventional formwork work is 108 days, while Aluminum formwork only needs 63 days, with a time difference of 45 days, as shown in **Table 15**. such as supporting journals [15].

Table 15. Formwork Work Time Comparison

Duration (Days)	
Conventional	**Aluminum**
108	63

4. Conclusion

Based on the results of the research that has been carried out regarding the comparison of cost and time with the use of columns, beams and plates formwork using conventional methods and aluminum formwork in the BSI *Tower* Jakarta construction project, the following conclusions are obtained:

1. Columns, beams, and slab that work using conventional formwork amounted to IDR 6,509,110,236. Meanwhile, columns, beams, and plates that use aluminum formwork are IDR 6,262,395,602. So, the work of columns, beams and slab using aluminum formwork is cheaper than conventional formwork, with a difference of IDR 246,714,634 or around 3.79%.
2. Column, beam, and slab work using conventional formwork can be completed with a duration of 108 days. Meanwhile, the work of columns, beams, and plates using aluminum formwork can be completed with a duration of 63 days. So, the duration of the implementation of columns, beams and slab using aluminum formwork is completed faster than conventional formwork, with a time difference of 45 days.
3. Aluminum formwork has been proven to be more cost-effective and time-saving. This is because the aluminum formwork system is modular, installation and disassembly is faster, can be used repeatedly, and the working duration is faster than using conventional formwork methods.

Future research is recommended to consider variations in the structural dimensions of columns, beams, and slabs to further evaluate cost and time efficiency, supported by 4D simulation tools such as Synchro.

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