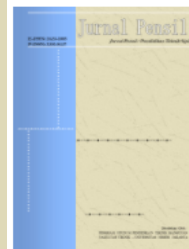


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COMPARATIVE ANALYSIS OF IN SITU AND PERI COLUMN FORMS AGAINST COST AND TIME (CASE STUDY: CINTA ALAM CULTURE PARK BUILDING)

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Abstract

Cost and time efficiency are key factors in the success of construction projects, particularly in repetitive column formwork works in multi-story buildings. This study compares the implementation of in situ column formwork and the PERI system in terms of construction costs and implementation time. The objective of this research is to determine the most efficient column formwork method that is suitable for the characteristics of construction projects in Indonesia. The study employs a quantitative approach using a comparative method based on work volume data, unit price analysis, and the duration of column formwork work in the Taman Budaya Cinta Alam Building project. The results show that the PERI formwork system is more efficient than the in situ method, both in terms of cost and implementation time. The PERI system provides cost savings of IDR 47,803,788.68 and shortens the work duration from 126 days to 28 days. Therefore, the use of the PERI formwork system is recommended for multi-story building projects, particularly for column works, to improve overall project efficiency.

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Keywords: Column Formwork, Construction Costs, In situ Method, PERI System, Implementation Time

Introduction

The construction field is one of the strategic sectors that plays an important role in developing infrastructure and boosting both national and international economic growth (Basuki, 2025; Arindi et al., 2025; Rohmawati & Zuhroh, 2019). When carrying out construction projects, time and cost efficiency are crucial factors that determine the success of a project (Vernandes Laia & Susetyo, 2024). However, this is a big challenge for construction companies in many countries (Budi, 2024; Arindi et al., 2025; Prasetyo, 2020). Formwork is one of the tasks that plays an important role in both aspects, especially in the column structures, which are numerous and repetitive in multi-story buildings (Shodiq et al., 2024; Kusuma & Susilorini, 2024).

To make strong concrete, formwork is used as a temporary mold (Maskur et al., 2023; Febriandy et al., 2026). With the development of construction technology, there are now several formwork implementation methods that are more flexible and efficient. Mistakes in formwork implementation can cause project delays, added costs, or damage to building structures (Restuningrat, 2024; Rossaty et al., 2023; Lirawati, 2021). There are two main methods for column formwork implementation: the in situ method and the PERI system. The in situ method uses plywood and hollow iron as the main materials, which are assembled directly on the project site (Guspari et al., 2022; Muhammad et al., 2026). While the PERI method uses modular components made of steel, which can be manufactured off-site and quickly installed on-site (Putra & Soedjadi, 2021; Salsabila et al., 2025; Nugraha & Chairulloh, 2018).

Many studies have discussed the advantages of both methods. Study (Arif & Irawan, 2021; Fikri et al., 2026) had formwork made in parallel outside the project. However, this study also shows that the PERI method requires higher initial costs because it needs special equipment, transportation, and more experienced labor. Although the in situ method tends to be more flexible and economical, studies (August et al., 2026; Maskur et al., 2023; Caesario & Priyanto, 2023) show that this method takes longer to install, especially on projects and structures of the same large scale.

Although various studies have discussed the efficiency of conventional formwork methods and modular systems, most of them are still conceptual or conducted on structural work other than columns, as in studies (Harmaezza et al., 2026; Mafriyal et. al., 2022; Rohim et al., 2025). Empirical studies that directly compare cost and time efficiency between in situ column formwork methods and the PERI system based on project data in Indonesia are still limited. Additionally, the characteristics of column work in multi-story buildings that are repetitive have not been widely analyzed specifically in the context of choosing the most efficient execution method.

There aren't many studies comparing costs and time on construction projects in Indonesia, even though a few studies have looked at both methods. Also, repeating project characteristics, like multi-story buildings or large-scale infrastructure, which are becoming more common in the national construction industry, haven't been discussed by a lot of researchers.

Previous research on formwork techniques usually only focuses on the benefits of two types of formwork: traditional formwork and modular formwork. Their studies often also center on cost levels, production efficiency of these two types of formwork, or their advantages in practical applications. Very few people conduct research beyond this scope to make other comparisons: using real data collected from actual construction projects to directly compare the two types of column formwork—one being the standard formwork used for concrete casting on construction sites, and the other being special column formwork produced by PERI. Studies like this are always very few.

So, in this study, the goal is to analyze and compare the cost and time efficiency of column formwork work using the in situ method and the PERI system in a high-rise building project. These findings will bring some practical applications and contributions of the research in terms of being used as a technical guide in selecting an appropriate column formwork system.

Research Methods

In this study, a quantitative research methodology will be applied where two column formwork approaches will be compared in terms of cost and time. This research focuses on column formwork in construction projects. The research subjects will be in situ column formwork and PERI column formwork.

Duration of work for this project is calculated from the quantity of work related to column formwork that is derived from the working drawings and project documentation. This duration of work is calculated from dividing the quantity of work by productivity of the workers, which is obtained from Unit Price Analysis (AHSP), construction literature sources, and project documentation. Unit price in situ formwork consists of material and labor cost incurred on the construction site while unit price of PERI system is measured using formwork renting cost per square meter as per the rate of the research project. Implementation time analysis considers constant number of workers which is 10 workers per day for both formwork systems, so that work time comparison can be done objectively. Calculated values are then compared against project implementation schedule to ensure that the values comply with actual conditions and obtain objective work time comparison. Flow chart of this research phase is depicted in Figure 1.

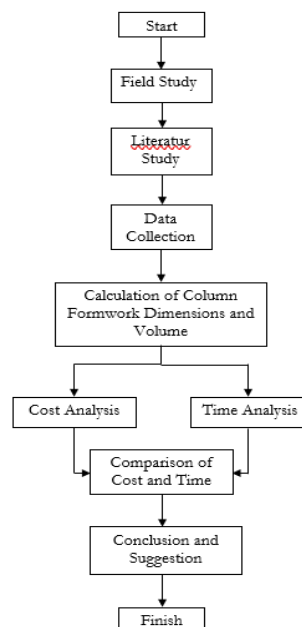


Figure 1. Research Flowchart

Research Results and Discussion

Comparative Analysis of Column Work Volume and Characteristics

Analysis of the column formwork volume is done in order to determine the extent of work, which is the foundation for cost calculation and construction duration. The volume of formwork is determined based on the size of the column and the floor height of each floor of the Taman Budaya Cinta Alam building. The calculation of the column formwork area is done based on the cross-section dimensions, column height, and number of columns. In general, the formwork surface area is calculated using the equation from (Putra & Rendi, 2026):

$$A = 2 \times (L + W) \times H \times N$$

Information:

A = total formwork (m²)

L = long (m)
W = wide (m)
H = concrete column height (m)
N = total column

The volume information is then used as the primary benchmark in comparing the efficiency between in-situ formwork for columns and PERI system.

Table 1. Column Formwork Volume

Area	Type	Total	Long	Wide	Width of The Upper Floor	Concrete Column Height	Total Formwork
			m	m	m	m	m ²
1st Floor	K1	2	0,6	0,6	0,1	4,42	20,736
	K2	5	0,6	0,6	0,1	4,42	51,84
	K3	8	0,5	0,5	0,1	4,42	69,12
	K4	14	0,5	0,5	0,1	4,42	120,96
	K5	1	0,6	0,6	0,1	4,42	10,368
	K6	6	0,5	0,5	0,1	4,42	51,84
	TOTAL	36					324,86
2nd Floor	K1	2	0,6	0,6	0,1	4,16	19,48
	K2	5	0,5	0,5	0,1	4,16	40,60
	K3	8	0,5	0,5	0,1	4,16	64,96
	K4	14	0,5	0,5	0,1	4,16	113,68
	K5	1	0,5	0,5	0,1	4,16	8,12
	K6	6	0,5	0,5	0,1	4,16	48,72
	TOTAL	36					295,56
3rd Floor	K1	2	0,5	0,5	0,1	4,16	16,24
	K2	5	0,5	0,5	0,1	4,16	40,60
	K3	8	0,5	0,5	0,1	4,16	64,96
	K4	14	0,5	0,5	0,1	4,16	113,68
	K5	1	0,5	0,5	0,1	4,16	8,12
	K6	6	0,5	0,5	0,1	4,16	48,72
	TOTAL	36					292,32

For example, for column K1 on the 1st floor with 2 columns, dimensions 0.60 m × 0.60 m, and a height of 4.42 m, we get:

$$A = 2 \times (0.60 + 0.60) \times 4.32 \times 2$$

$$A = 20.736 \text{ m}^2.$$

The same calculation is applied to all column types, resulting in a total formwork area for the 1st floor of 324.864 m², the 2nd floor of 295.568 m², and the 3rd floor of 292.320 m². Thus, the total column formwork volume analyzed is 912.752 m².

According to the data provided in Table 1, there are huge volumes of work for column formwork on each floor, and there is a clearly repetitive pattern. It is due to this reason that choosing the technique of formwork will be one of the key factors affecting the cost and efficiency of the construction project. The repetitive volume of formwork from floors 1 through 3 suggests that column formwork will technically be better performed by the modular formwork system compared to the traditional one.

The application of the PERI technique using standard panels is quite easy to implement on column elements with similar dimensions (Wicaksono, 2025; Muafo & Yusuf, 2024). Conversely, the in situ technique involves continuous activities in terms of cutting, assembling, and disassembling the formwork (Firmansyah et al., 2024; Lin, 2021). This makes the in situ technique usually inefficient in projects with column features that repeat themselves.

Furthermore, the rate of errors in the process of performing the activity is also influenced by the high level of workloads (Cesilia, 2024). Considering that the assembly work is conducted on site and that the work is highly reliant on the skills of the workforce, the in situ process involves a greater degree of errors in terms of installing the formworks (Limenta, 2018). In contrast, the PERI technique has a more accurate construction design and results in neater columns.

Cost Analysis

Cost calculation analysis was done for the comparison of the total cost of column formwork work with the in situ system and PERI system. This cost calculation will be made according to the volume of column formwork work and the unit prices for the Taman Budaya Cinta Alam Building. The elements of the cost that will be calculated are the cost of material, labor, and cost of formwork system per floor level because this cost calculation can be used as a benchmark to compare the cost efficiency of column formwork systems.

Table 2. Total Cost of In-situ Column Formwork Calculation

No	Description	Cost (Rp)
1	Formwork costs for first floor columns	81.986.983,49
2	Formwork costs for 2nd floor columns	74.593.456,76
3	Formwork costs for 3rd floor columns	73.773.748,44
TOTAL COST (Rp)		230.354.188,68

Table 3. Total Cost for PERI Column Formwork Calculation

No	Description	Volume (m ²)	Unit Price	Total Price
1	Column Formwork Set Floor 1	324,864	Rp. 200.000,00	Rp. 64.972.800,00
2	Column Formwork Set 2nd Floor	295,568	Rp. 200.000,00	Rp. 59.113.600,00
3	Column Formwork Set 3rd Floor	292,32	Rp. 200.000,00	Rp. 58.464.000,00
TOTAL PRICE			Rp. 600.000,00	Rp. 182.550.400,00

In the in situ method, the total cost is the sum of the costs of materials and labor needed for the construction, installation, and dismantling of the formwork at the project site. Based on Table 2, the work cost for the 1st floor is Rp 81,986,983.49, the 2nd floor is Rp74,593,456.76, and the 3rd floor is Rp73,773,748.44. So:

$$\begin{aligned} \text{C.in situ} &= \text{Rp}81.986.983,49 + \text{Rp}74.593.456,76 + \text{Rp}73.773.748,44 \\ &= \text{Rp}230.354.188,68. \end{aligned}$$

PERI system costs are calculated based on the formwork work area and the rental price of the PERI system used on the project, which is Rp 200.000/m². The PERI cost calculation uses the following equation from (Rafik & Cahyani, 2017):

$$C. PERI = A \times R$$

Information:

C.PERI = total PERI cost (Rp)

A = volume (m²)

R = unit price PERI (Rp/m²)

The rental price of Rp200,000/m² is the price used as the basis for calculation in the research project according to AHSP Garut. In this study, the additional cost component outside the rental price is only taken into account if it is listed in the available project data, therefore:

$$\begin{aligned} \text{C.PERI} &= (324,864 \times \text{Rp}200.000) + (295,568 \times \text{Rp}200.000) + (292,320 \times \text{Rp}200.000) \\ &= \text{Rp}64.972.800 + \text{Rp}59.113.600 + \text{Rp}58.464.000 \\ &= \text{Rp}182.550.400 \end{aligned}$$

The cost comparison results represent the cost component available in the research data and is not intended as an estimate of the total cost of implementing the PERI system in other projects.

$$\begin{aligned} \text{Total cost difference} &= \text{Total in situ cost} - \text{Total PERI cost} \\ &= \text{Rp } 230,354,188.68 - \text{Rp } 182,550,400.00 \\ &= \text{Rp } 47,803,788.68 \end{aligned}$$

$$\begin{aligned} \text{Cost efficiency percentage} &= \text{Difference} / \text{In situ cost} \times 100\% \\ &= \text{Rp } 47,803,788.68 / \text{Rp } 230,354,188.68 \times 100\% \\ &= 20.75\% \end{aligned}$$

The calculation results show that the total cost of column formwork using the in situ method is Rp 230,354,188.68, while the PERI system method is Rp 182,550,400.00. The cost difference of Rp 47,803,788.68 or 20.75% indicates that the PERI system is more cost-efficient. This efficiency happens because the components of the PERI formwork system can be reused without significant functional deterioration, which helps reduce material costs.

This finding supports the research results (Rohim et al., 2025; Vansya et al., 2025; Rahadiano et al., 2022) which state that the PERI formwork system has an economic advantage in multi-story building projects with repetitive structural work. Unlike the in situ method that requires new material procurement and on-site assembly, the PERI system can optimize costs through panel standardization and cycle usage efficiency.

Time Analysis

A time analysis was carried out to compare how long it takes to do column formwork between the in situ method and the PERI system. The calculation is based on the volume of column formwork work on each floor, assuming the same number of workers, which is 10 people per day, for both methods. The calculation of execution time is done based on the work volume and work productivity using the equation ((Baco et al., 2024):

$$T = V / P$$

Information:

T = work duration (day)

V = work volume (m²)

P = work productivity (m²/hari)

This approach is used so that the time comparison can be fair and show the difference in efficiency between the two methods in affecting the project completion time.

Table 4. Time for In Situ Column Formwork Work

Area	Volume (m2)	Weight (%)	Duration (Days)
Lantai 1	324,864	2,241	42
Lantai 2	295,568	2,067	42
Lantai 3	292,32	3,373	42
TOTAL			126

Table 5. Time for In Situ Column Formwork Work

Area	Volume (m2)	Weight (%)	Duration (Days)
Lantai 1	324,864	2,241	10
Lantai 2	295,568	2,067	9
Lantai 3	292,32	3,373	9
TOTAL			28

Since this study uses the assumption of 10 workers per day for both methods, labor productivity can also be expressed using the following formula (Wiratama et al., 2024):

$$P.tk = V / (T \times N)$$

Information:

P.tk = labor productivity (m²/person day)

V = work volume (m²)

T = work duration (hari)

N = number of workers (orang)

Based on Table 4, the formwork volume for the first floor is 324.864 m², completed in 42 days with 10 workers. The productivity of the work crew is:

$$P = 324,864 / 42 \\ = 7,735 \text{ m}^2/\text{day}.$$

Productivity per worker is:

$$P.tk = 324,864 / (42 \times 10) \\ = 0,774 \text{ m}^2/\text{person day}.$$

For the PERI method, the productivity of the working group on the 1st floor is:

$$P = 324,864 / 10 \\ = 32,486 \text{ m}^2/\text{day},$$

while productivity per worker is:

$$P.tk = 324,864 / (10 \times 10) \\ = 3,249 \text{ m}^2/\text{person day}.$$

On the 2nd floor, the productivity of the working group is 295,568/9 = 32,841 m²/day, while on the 3rd floor it is 292,320/9 = 32,480 m²/day. The difference in productivity shows that

the reduction in duration in the PERI system is not solely due to the number of workers, since the number of workers is assumed to be the same, but mainly stems from the difference in productivity assumed/used in the calculation of the two methods.

In terms of execution time, the in situ formwork method takes a total of 126 days, while the PERI system method only requires 28 days. This 97-day difference clearly highlights the significant advantage of the PERI system in speeding up column structure work. This can be attributed to the ease of installation of the panels using the modular panel system and the reduced work required for onsite fabrication.

The productivity used in the research was obtained from AHSP, construction literature, and available project documentation. To maintain a consistent basis for comparison, the number of workers was set at 10 people per day for both the in situ method and the PERI system. Using the same number of workers is meant to provide a uniform comparison basis, not to say that the productivity of both methods is the same. Thus, the difference in duration between the two methods reflects the difference in productivity used in the calculation of each method. The results of the calculation are then compared to the project implementation schedule to see how it fits with the working conditions available in the project documentation.

The standard formwork panels can be erected and stripped faster hence creating a shorter work cycle between floor to floor (Diga et al., 2024; Mulyadi Sugih Dharsono & Siti Hindun, 2024; Purwanto et al., 2022). This is consistent with the findings in the studies (Silitonga et al., 2024; Setiono et al., 2025; Khuluk & Purwanto, 2025) indicating that the modular construction technique will increase productivity and reduce the time taken for the structural works as opposed to the traditional techniques.

Technical and Managerial Implications of Choosing a Method

The selection of formwork technique will have far-reaching implications other than the time and cost aspects. Due to the high accuracy and rigidity of the formwork itself, the PERI formwork system will be able to enhance the output quality of the column construction. The wrong erection will minimize the usual reworks of the in-situ system.

Considering the economic aspect, the PERI system has the potential to reduce the cost and time, particularly in large projects (M. Wisridani Paradiang, 2025; Sassikirana & Gunasti, 2026). The reduction in time automatically reduces indirect cost and risk of delay in the project. As far as management is concerned, implementation of the PERI system demands effective planning, which includes proper scheduling and trained manpower (Syihabuddin et al., 2025). Even though it demands a high cost initially, as well as human resources in place, the PERI system is viewed as better than in situ.

Conclusion

This study aims to analyze the difference between in situ column formwork and PERI system based on the budget and time saving case in the construction of Cinta Alam Culture Park. This study used quantitative descriptive method by considering the volume of formwork, cost and work time based on the data retrieval of the project and a number of assumptions about the efficiency and productivity.

The result of the analysis is shown below. The total formwork volume is 912,752 m². The in situ system costs Rp230,354,188.68 with a duration of 126 days, while the PERI system costs Rp182,550,400.00 and lasts 29 days. Thus, for the presented case study, the use of the PERI system seems to be more cost-effective and less time-consuming.

This study is limited to a single project and the formwork of columns from the 1st to the 3rd floor, assuming a permanent workforce and PERI costs based on rental prices at the project. Indirect cost components and variability in execution conditions have not been fully examined.

Thus, study results should be evaluated considering specific features and conditions of each project.

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