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Examination of Time Management Techniques Derived From Critical Path Method (CPM) Findings to Meet the Completion Goal For the Construction Project of the Central Kalimantan Public School

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A B S T R A C T

The Central Kalimantan Public School Construction Project involves building activities at several sites with varying conditions, such as peat soil, difficulties in transportation, severe weather, and limitations in material supply. These factors could affect the overall expenses and timelines of the project, highlighting the need to analyze their impact on how well the project performs. This research intends to examine the timeline for the Central Kalimantan Public School Construction Project and assess how well the schedule is monitored through the Critical Path Method (CPM). A case study was conducted using both descriptive and evaluative techniques. The information gathered included the original contract, any modifications, schedules, and reports on work progress. The CPM analysis was performed to pinpoint the critical path and the key activities that could affect the project's duration. The findings suggest that the conditions of the site have an effect on the project's timeline. The CPM analysis identified vital activities that need to be managed to achieve the project's completion goals. Using the CPM approach can help in controlling the schedule and in making informed decisions during the project's implementation

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INTRODUCTION

Infrastructure development is a strategic sector that plays a vital role in supporting economic growth, equitable development, and the improvement of public service quality. The success of a construction project is generally measured by its ability to meet three primary objectives: cost, schedule, and quality. These three aspects are interconnected and serve as key indicators for evaluating construction project performance. Consequently, effective cost and schedule management is crucial to ensuring project success.

The Public-School Construction Project in Central Kalimantan Province is a government initiative aimed at enhancing access to and the quality of educational services for the community. The project is being implemented across multiple locations in Central Kalimantan, each with distinct geographical characteristics. Under the initial contract, the construction value was set at IDR 985,900,000,000.00, with an execution period of 216 calendar days, spanning from November 17, 2025, to June 20, 2026.

During execution, the project encountered various challenges that impacted both costs and the project schedule. A primary obstacle was the prevalence of peat soil across a significant portion of the work sites. Peat soil is characterized by low load-bearing capacity, high water content, high compressibility, and a tendency for settlement over time, all of which necessitate specialized construction techniques. These conditions affected heavy equipment productivity, construction methods, and resource requirements, all of which exceeded initial estimates. Furthermore, the peat soil is susceptible to consolidation under construction loads, requiring measures such as soil improvement, additional fill material, staged compaction, and waiting periods to achieve the required soil stability. These specialized requirements led to increased work volumes, the use of additional materials, more intensive heavy equipment usage, and a larger workforce, ultimately resulting in higher project execution costs. In terms of scheduling, the peat soil consolidation process has the potential to extend the project duration, as certain construction activities cannot be performed concurrently; instead, the soil must reach a specific level of stability before subsequent work can proceed. Ongoing soil settlement during the construction phase may also necessitate remedial work, elevation adjustments, or other unplanned additional tasks. Without effective control measures, these conditions could disrupt the work sequence, reduce project resource productivity, and increase the risk of delays in project completion.

Beyond soil conditions, the project faces challenges regarding the mobilization of equipment and materials to the work site. Access to several project locations remains limited, with most routes having insufficient capacity to support the movement of heavy vehicles. Consequently, the distribution of construction materials and equipment cannot be optimized, leading to longer delivery times, higher transportation costs, and an increased risk of delays in supplying the resources required for the work.

Another factor influencing project execution is the occurrence of extreme weather conditions during the construction period. High rainfall intensity prevents certain tasks particularly earthworks, foundation work, substructure

construction, and activities involving heavy machiner from being carried out according to plan. Such conditions not only reduce work productivity but also threaten to disrupt the planned sequence of construction activities, thereby impacting the project's completion schedule.

Furthermore, the project encountered obstacles regarding the procurement of construction materials. Limited local availability of certain materials in Central Kalimantan necessitated sourcing some supplies from outside the region. This situation led to increased procurement and transportation costs, extended delivery times to the project site, and a heightened risk of work delays should supplies fail to meet demand. Material shortages also impacted work productivity and required schedule adjustments for several construction activities.

These various obstacles necessitated adjustments to the work execution, resulting in changes to project costs. Under the agreed contract addendum, the contract value rose from IDR 985,900,000,000.00 to IDR 1,035,519,567,108.00 an increase of IDR 49,619,567,108.00, or approximately 5.03% of the initial value. This cost increase reflects the financial consequences of site conditions encountered during project execution. Meanwhile, the completion target remains tied to the established contract schedule, necessitating efforts to control and accelerate work to ensure the deadline is met as planned.

The rise in execution costs and the various site-related obstacles highlight the challenges inherent in construction project management, particularly regarding cost and schedule control. This situation warrants analysis because project success depends not only on the ability to complete work according to technical specifications but also on the capacity to manage resources effectively, keeping costs under control while adhering to the execution schedule.

Previous studies have addressed the influence of site conditions, scope changes, and external factors on construction project performance. However, research specifically examining the impact of peat soil conditions, soil consolidation processes, limited access for mobilization, extreme weather, and material procurement constraints on the cost and schedule of educational facility construction projects in Central Kalimantan remains relatively limited. Therefore, this study aims to contribute to the field of construction management particularly regarding cost and schedule control for projects located in regions with challenging geographical and environmental characteristics.

Based on this context, it is necessary to conduct a study analyzing the costs and execution schedules of school construction projects in Central Kalimantan. This research is expected to provide insights into the factors influencing cost increases and schedule performance, while also serving as a basis for project owners, supervisory consultants, and contractors to enhance the effectiveness of planning, execution, and control for similar construction projects in the future.

THEORETICAL REVIEW

In 2012, Budi Witjaksana and S.P. Reresi conducted research on project cost analysis using the Earned Value Method within the performance process, discussing how integrated cost and schedule control can be used to evaluate project performance and detect deviations at an early stage.

In 2020, Nurfianti and Budi Witjaksana conducted research on the time and cost analysis of the Solia Boutique Hotel Solo Laweyan construction project using the CPM method, discussing how CPM analysis can identify the critical path and activities that influence project duration.

In 2020, Saputra conducted research on time and cost control analysis for construction projects, discussing how CPM analysis is effectively used to develop work networks and determine the critical path.

In 2016, Juliana conducted research on cost and schedule control analysis in construction projects using the Earned Value Management method, discussing how integrated cost and schedule control analysis improves project performance evaluation.

METHODOLOGY

This study employs a case study approach utilizing quantitative descriptive analysis to examine the project duration of the Central Kalimantan Public School Construction Project. The case study approach was selected because the research focuses on a single construction project with unique characteristics specifically, work execution across multiple sites featuring peat soil conditions, limited access for mobilization, extreme weather, and material availability constraints all of which could potentially impact project costs and duration.

The research involved identifying various site conditions encountered during project execution and analyzing their impact on project costs. It also examined the influence of these site conditions on the project schedule by analyzing data regarding the execution schedule, work progress, and project implementation reports.

To evaluate the project's time performance, the study utilized the Critical Path Method (CPM) to identify the critical path, determine activities influencing the project completion duration, and analyze time control strategies applicable to achieving the project completion target. The CPM analysis was conducted based on the interdependencies between work activities as outlined in the project execution schedule.

The results of the schedule analysis are subsequently used to evaluate how factors such as peat soil conditions, soil consolidation processes, limited access for mobilization, extreme weather, and material availability impact project execution. This evaluation aims to provide insight into the factors influencing project schedule performance and serve as a basis for formulating more effective project control recommendations.

In general, the research stages include problem identification, project data collection, analysis of execution costs, schedule analysis using the Critical Path Method (CPM), evaluation of the impact of site conditions on the project schedule, and the formulation of conclusions and recommendations based on the

findings. Thus, this research is expected to contribute to the development of schedule management practices for construction projects sharing similar site characteristics with the Central Kalimantan People's School (Sekolah Rakyat) Construction Project.

The subject of this study is the Central Kalimantan Public School Construction Project, located in Palangka Raya City and the regencies of Katingan, East Kotawaringin, and Gunung Mas. This project was selected due to site conditions likely to impact costs and execution schedules such as peat soil, limited access for mobilization, extreme weather, and material availability.

The data utilized included initial contracts, contract addenda, schedules, and work progress reports. Analyses were conducted regarding project costs and execution timeframes, while schedule evaluation employed the Critical Path Method (CPM) to identify the critical path and support project schedule control. This study was conducted on the Central Kalimantan Province Public School construction project, which spans four locations: Palangka Raya City, Katingan Regency, East Kotawaringin Regency, and Gunung Mas Regency.

Data Analysis Techniques

The data analysis techniques employed in this study are descriptive and evaluative in nature. The analysis aims to examine the costs and execution schedule of the Central Kalimantan Public School Construction Project and to identify the factors influencing them during the construction phase. These factors include peat soil conditions and the soil consolidation process, limited access for mobilization, extreme weather conditions, and the availability of construction materials.

Time analysis was conducted using schedule data, work progress reports, and project execution records to evaluate the project's schedule performance. This analysis aims to determine the degree of alignment between the planned schedule and actual work execution, as well as to identify factors affecting the achievement of project time targets.

Furthermore, the Critical Path Method (CPM) was applied to identify the critical path and interdependencies between work activities, and to determine which activities directly influence the project's completion duration. The CPM analysis serves as a basis for evaluating schedule control and formulating acceleration strategies where necessary.

The results of the time analysis were then comprehensively evaluated to understand the impact of site conditions on project execution and to identify schedule control measures that could be implemented to effectively and efficiently achieve the completion targets for the Central Kalimantan Public School Construction Project.

RESEARCH RESULTS AND DISCUSSION

Discussion of Critical Path Method (CPM) Results

CPM analysis results indicate that structural changes necessitated by discrepancies between the Detailed Engineering Design (DED) and actual peat soil conditions led to additional critical activities specifically soil improvement, *galam* timber matting, and geotextile installation as well as a modification of the ground floor system to a suspended slab. These activities lie on the critical path; consequently, any delay directly impacts the completion time of the entire project. These findings highlight that the alignment of the DED with actual site conditions is a crucial factor in meeting project schedule targets. This result aligns with research by Abdul Khohar, which identifies site condition compatibility as a dominant factor directly influencing project execution time.

Acceleration of Household Connection (SR) Implementation – Katingan

Based on the foundation design review documents, the Katingan project specifically requires adjustments to the substructure design and soil treatment works. This situation differs from standard substructure construction, as it impacts methods, work sequencing, the procurement of materials and piling equipment, productivity, and the opening of work access, while also necessitating special treatments, including:

Acceleration Timeline Regarding Household Connection (SR) Installation Constraints Katingan

Item	Causative Factor	Impact on Time
Site Readiness	Conditions on the ground are still forested, requiring additional time for land clearing operations.	25 days, based on calculations using 3 excavators with a capacity of 1,300 m² per unit.
Cone Penetration Test (CPT) Results	The results from 9 cone penetration test (CPT) points indicate the following: 1. cone resistance values remain low at depths of 3–5 m, 2. the average depth to hard stratum is 16–17 m, 3. the average thickness of the peat layer is 5 m; based on the CPT results, soil improvement is required—specifically, the installation of timber piles (*cerucuk*), *galam* timber matting, and geotextiles prior to placing the soil fill. The results from 6 borehole	

Item	Causative Factor	Impact on Time
	points indicate the following: brown, silty organic humus soil with an N-SPT value of 0 and very soft consistency at depths of 0.0–4.0 meters.	
Embankment Fill	In accordance with the initial design, the fill requirement—originally based on a cut-and-fill approach—was adjusted to utilize material sourced from outside the project, while accounting for peat soil settlement; the total fill volume required is 48,785 m^3.	68 days based on the calculation of total needs for daily quarry stockpile capacity can supply ±700m3/day,
Pack. Pile	Based on recommendations from experts and academics, the following are used: 1. For 2-story buildings: Recommended pile size: 12 m × 25 × 25 cm; number of piles based on structural calculations. 2. For 1-story buildings: Recommended pile size: 9 m × 25 × 25 cm; number of piles based on structural calculations.	25 days based on the design review on November 28, 2025, plus 14 days for the ordering and production processes.
Pack. Pile	Peatland conditions caused delays in the piling operations, as ground improvement and preparations for positioning the piling equipment were required.	The piling work took 157 days using 15 rigs, whereas the initial plan had scheduled it for 74 days using 4 rigs.
Regional road on extreme peat land at a height of 5m	The embankment work could not be carried out using a frontal approach, thereby requiring a longer duration. Subsequently, the specifications were adjusted from flexible pavement to rigid pavement, and later modified again to incorporate foam mortar.	Based on the initial plan, the flexible-rigid roadwork was scheduled for 24 days, whereas the execution schedule using foam mortar is set for 43 days.
Substructure Design for the Multipurpose Building, Canteen, and Church	The substructure is being modified into a suspended (stilt-like) configuration; additionally, for the central span, the installation of extra foundations along the respective building	The duration is 10 days, based on the number of starting points for the five buildings—increasing from 203 piles to 580

Item	Causative Factor	Impact on Time
	axes—incorporating pile caps and tie beams to distribute the loads from the area above—is proposed to ensure the structural integrity of the superstructure.	points—with a capacity of 40 points per day.
Structural Design Modifications for Peat Soil Conditions	To accommodate the characteristics of the peat soil, the building structure—originally a slab-on-ground design—was redesigned as a suspended (stilt) structure.	The duration is 10 days, based on the number of starting points for the five buildings—increasing from 203 piles to 580 points—with a capacity of 40 points per day.
Layout Modification (Re-layout)	Soil conditions in areas not covered by the initial site investigation turned out to consist of deep peat, causing several excavators to sink during operations; consequently, multiple layout revisions were required to optimize the execution of the work.	
Mating galam (cerucuk) and land ripening	Based on consultations with qualified experts and academics experienced in peatland management in Indonesia, *galam* timber mats are required for ground stabilization and to prevent heavy machinery from sinking at construction sites where piles have not yet been driven.	29 days, based on the time required for land preparation—involving *galam* piles, geotextiles, and fill material—in the Re-Layout building area prior to the commencement of piling work.
Addition of geotextile material	In addition to the vertical and horizontal application of *galam* timber piling, it is also necessary to lay down geotextile as a separator between the fill material and the peat; this prevents the fill from being directly absorbed by the highly porous peat soil.	29 days, based on the time required for land preparation—involving *galam* piles, geotextiles, and fill material—in the Re-Layout building area prior to the commencement of piling work.

Item	Causative Factor	Impact on Time
Change in pile depth	Based on discussions with the technical experts, it was agreed that the foundation would utilize the end-bearing pile type, which transfers structural loads directly to the hard soil stratum. For the Elementary School building, the Elementary School Boys' Dormitories (A and B), and the High School Girls' Dormitory, it is required to increase the pile depth based on the final set observed during pile driving analysis.	14 days—based on pile test results at the Boys' Elementary School 1 Dormitory, Boys' Elementary School 2 Dormitory, and Elementary School building—for the ordering and production process of piles with the new configuration.
Roofing Material Replacement (Transition to Tile Roofing)	In accordance with the President's directive issued during the 2026 National Coordination Meeting between the Central and Regional Governments—held on February 2, 2026, at the Sentul International Convention Center (SICC)—regarding the "roof tiling project movement" (part of the *Indonesia ASRI*—Safe, Healthy, Clean, and Beautiful—program) and its implementation in the *Sekolah Rakyat* (People's School) construction project, the *Sekolah Rakyat* construction team in Central Kalimantan Province has adjusted the roofing material specifications. Taking into account technical aspects and distribution feasibility, the project has shifted from the initial plan of using sand-coated metal roofing to lightweight UPVC tiles that resemble traditional clay tiles (Memorandum from the Director General of Strategic Infrastructure to the Minister of Public Works of the Republic of Indonesia regarding the	49 days, based on the time required for the ordering and production processes specifically 21 days at a capacity of 1,000 m² per day for a total volume of 21,652 m².

Item	Causative Factor	Impact on Time
	Application of Roofing Materials for *Sekolah Rakyat*, Number PR0303/B/Ds/2026/09, dated February 20, 2026).	

CONCLUSIONS AND RECOMMENDATIONS

Based on the analysis and discussion regarding the impact of substructure changes on the execution schedule of the Public-School Construction Project in Central Kalimantan Province, the following conclusions can be drawn:

1. Site conditions influenced the project execution schedule by potentially reducing work productivity, hindering resource mobilization, and necessitating adjustments to on-site execution methods. Nevertheless, through effective resource management and execution control, the project completion target was successfully maintained within the established contract duration.
2. Analysis using the Critical Path Method (CPM) demonstrated that identifying the critical path and controlling critical activities are crucial factors in maintaining the project's schedule performance. The application of CPM facilitated the identification of activities with a direct impact on the project completion duration, thereby serving as a basis for decision-making and time-control strategies during project execution.
3. Integrated time control is a vital factor in ensuring the successful execution of the project. Evaluating site conditions from the initial stage, managing resource mobilization effectively, and controlling critical activities via the CPM method can minimize the risk of delays in construction projects sharing similar characteristics.

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