Enrichment: Journal of Management, 15 (2) (2025)

Published by: Instiute of Computer Science (IOCS)

Enrichment: Journal of Management

Journal homepage: www.enrichment.iocspublisher.org

Time efficiency analysis of single floor shophouse construction project using the CPM (Critical Part Method)

Surahman[1], Yosafat Henry Radityatama[2], Ahmad Padillah[3], Satryawati[4]

[1,2,3,4]Bisnis Digital, Politeknik Negeri Samarinda, Indonesia

ARTICLE INFO

Article history:

Received May 28, 2025
Revised May 30, 2025
Accepted Jun 10, 2025

Keywords:

Construction Project;
Critical Path Method;
Single-Floor Shophouse;
Time Efficiency Analysis.

ABSTRACT

This study examines the efficiency of the implementation time of a single floor shophouse construction project in Samarinda City, through the application of the Critical Path Method (CPM). Secondary data in the form of a project implementation schedule was analyzed by preparing a work network diagram, calculating Earliest Event Time (EET) and Latest Event Time (LET), and identifying the critical path. The results of the analysis show that the duration of project implementation with normal time reaches 121 days, while with an accelerated scenario (quick time) can be cut to 87 days. The critical path consists of the sequence of activities A (preparation) → B (foundation) → C (structure) → D (wall) → E (roof) → G (harmonica door) → H (bathroom) → I (septic tank) → J (canopy) → K (electrical installation) → L (painting) → M (finishing), so that these activities become the main focus of control to avoid delays. Strategic recommendations include optimizing resource allocation, rescheduling non-critical activities, and implementing fast-track and overlapping work to shorten the implementation duration without compromising construction quality.

Corresponding Author:

Ahmad Padillah,
Bisnis Digital,
Politeknik Negeri Samarinda,
Jl. Cipto Mangunkusumo, Kampus Gunung Lipan, Samarinda, Kalimantan Timur, Indonesia.
Email: ahmadpadillah46@gmail.com

INTRODUCTION

Developments in information technology, particularly internet technology, enhance and support various professional domains by streamlining access, overcoming geographical barriers, and optimizing time management (Effendy & Nuqoba, 2017). Companies frequently undertake projects to advance business operations, necessitating tailored information systems to meet organizational objectives. Consequently, effective monitoring and management of system development projects are critical for aligning outcomes with corporate goals. Projects are defined as temporary initiatives that integrate resources including personnel, materials, equipment, and capital within a transient organizational framework to achieve specific targets. Control mechanisms are essential to ensure consistency between planned strategies and their execution (Megawati dan Gustina 2018).

Altatri's (2021) research highlights the cyclical trends in Indonesia's shophouse development: pre-economic crisis, these properties were prime investment assets, declined during the crisis, and rebounded rapidly post-crisis. According to the Siak District Investment and PTSP

Office, 367 shophouse units were added from 2017 to 2021, with 73 units in 2017 and 96 in 2018. Nationally, shophouse ownership credit grew by 11.10% in February 2024, with financing reaching IDR 28.2 trillion by June 2024, marking a 35.75% annual increase (Bank Indonesia 2024). Given that shophouse financing grew 35.75 % nationally by mid 2024, Samarinda likely experienced a comparable post pandemic demand surge—raising local project volumes by roughly one third. This compresses construction schedules and makes applying CPM essential to reduce baseline project durations by a similar percentage to avoid costly delays.

In residential construction, project management is vital for coordinating activities from initiation to completion (Julkarnaen dan Herlina, 2015). It involves applying knowledge, skills, and methodologies to fulfill project requirements. A project is further characterized as a time-bound endeavor to deliver unique outputs or services (Setiawan 2019). Moreover, aligning strategic site selection with clearly defined phases—from planning through execution to close-out—ensures that each stage is systematically organized for maximum efficiency and optimal results (Sayyid & Ali, 2021). Embedding a comprehensive risk management framework—covering risk identification, impact evaluation, and targeted mitigation—is indispensable for safeguarding project success (Huo, Xue, dan Jiao 2023). Finally, proactively identifying risk factors and integrating preventive measures into the planning system has been shown to markedly improve schedule performance in residential developments (Arief dan Latief 2021)

Project success largely hinges on meticulous planning and adherence to activity timelines, as overlapping or sequential tasks may lead to delays (Messah, 2013). Variables such as labor availability, material supply, equipment efficiency, site conditions, managerial competence, funding, and external factors like weather or economic instability also influence schedules (Widhiawati 2009). This study employs the Critical Path Method (CPM), a project analysis tool with fixed activity durations to optimize timelines and costs. CPM requires predictable task durations, enabling efficient phase completion (Haryani, 2024).

Despite the rising popularity of post-crisis shophouses, no prior research has applied CPM to assess time efficiency in single floor shophouse construction in Samarinda. Previous research has typically examined two-storey or multi-storey shophouses and residential projects, where factors like more complex structural designs, greater labor demands, and multi-phase resource planning come into play, such as (Brege dan and Nord, 2014; Ferdous dkk., 2019). In contrast, this study focuses exclusively on single storey rumah toko developments to highlight their inherently simpler load distribution, more straightforward workflow, and shorter activity sequences. By concentrating on a one-level structure, the analysis reveals how reduced structural complexity and a more linear task progression produce unique critical paths and risk profiles that differ significantly from those of taller, multi-level buildings. This study identifies critical paths and activities impacting project duration, aiming to pinpoint delay risks and propose strategies for shortening timelines without compromising quality (Mar'aini dan Akbar 2022).

Projects are a series of coordinated activities carried out within a certain time frame with the allocation of specific resources to achieve specific goals that have been set (Fazis, 2022). In addition, projects are also understood as non-routine activities carried out with certain time, budget, and resource constraints to produce products or outputs according to specific specifications (Lis dkk. 2024).

Project management is a discipline that integrates systematic planning, structured execution, and control mechanisms over limited resources including labor, time, and budget to achieve project objectives effectively, efficiently, and in accordance with the predetermined scope, schedule, and cost (Darsana et al., 2024). Furthermore, the project management process also includes supervision of technical specifications and monitoring of time and budget to ensure project completion is timely, cost-effective, and meets applicable standards (Alawiyah dkk. 2022).

CPM is a project scheduling method that focuses on identifying the critical path set of activities that determine the total duration of the project and although it does not model the linear relationship between time and cost, it is still able to recommend accelerated implementation to shorten the project duration (Sinurat dan Misdalena 2024). In the context of project planning and control, CPM models each activity as a structured network to estimate the minimum duration, arrange the sequence of activities, and optimally manage the completion time (Abdurrasyid dkk. 2019).

RESEARCH METHOD

Research Location

The research location is the place where the entire research process is carried out, including the stages of collecting, processing, and analyzing field data (Waruwu, 2024). This research was conducted on Jalan Adi Sucipto, Rawa Makmur Village, Palaran Subdistrict, Samarinda City. The selection of this location was based on the availability of adequate road infrastructure and optimal accessibility, thus facilitating smooth field data collection activities. The selection of this location was based on the availability of adequate road infrastructure and optimal accessibility, thus facilitating smooth field data collection activities. This project's scope, timeline, and engagement with local stakeholders can be contrasted with similar infrastructure initiatives in other regions to illustrate whether it exemplifies typical practices or presents unique features (Di Maddaloni and Davis, 2017). Such a comparison clarifies why this case was selected and underscores its relevance or distinctiveness within a broader context.

Literature Study Method

This literature review involved collecting and selecting articles, books, reports, and policies from libraries, Google Scholar, IEEE Xplore, and institutional repositories based on relevance, currency, methodology, and reputation, which were then critically analyzed and synthesized into a conceptual framework and research hypotheses (Purwanto 2022).

Secondary Data Collection

Secondary data is a collection of information previously collected for other purposes but then processed and analysed again to support research (Ellram & Tate, 2016). The main secondary data used was the project implementation schedule (time schedule) obtained directly from the organizers. This document was reviewed to ensure all important elements of the task list, duration, sequence, and interdependencies between tasks conformed to project management standards such as Gantt diagrams. Each activity was then broken down into structured work packages with unique identification codes for easy tracking. Validation of secondary data involves cross-checking reported activity durations against contract documents (Emanuelson and Egenvall, 2014; Mahadik and Topkar, 2023), detailed RAB schedules, and daily project reports to confirm consistency with agreed terms and actual work performed. Any discrepancies identified are then clarified with project stakeholders and reconciled to ensure the data's reliability before analysis. Finally, the data is validated through clarification with the project manager or relevant parties for accuracy and consistency before analysis (Odedairo, 2024).

Data Processing

Data processing of this research was carried out through a series of systematic stages to support work network planning and critical path identification. These stages include: (a) determining the code and duration of each job to facilitate the preparation of network planning; (b) creating network diagrams based on flow logic and inter-activity dependencies; (c) calculating Earliest Event Time (EET) to determine the earliest time an event occurs; (d) calculating Latest Event Time (LET) to determine the longest time the event occurs; and (e) determining critical paths, namely paths that pass through events with EET values equal to LET (Surahman, Angga Kusumah, and Tomby, 2024).

Table 1. Normal Time Activities According to RAB (Budget Estimate Plan)

No	Job Code	Code	Duration (Days) Normal
1	Preparation	A	5
2	Foundation Work	B	7
3	Structure Work	C	16
4	Wall Work	D	12
5	Roof Work	E	11
6	Floor Work + Ceramic Installation	F	18
7	Harmonica Door Work	G	4
8	Bathroom Work (2 Units)	H	16
9	Septictank Work	I	10
10	Canopy Work	J	6
11	Electrical Installation Work	K	7
12	Painting Work	L	12
13	Finishing	M	7

Source: Data Processed (2025)

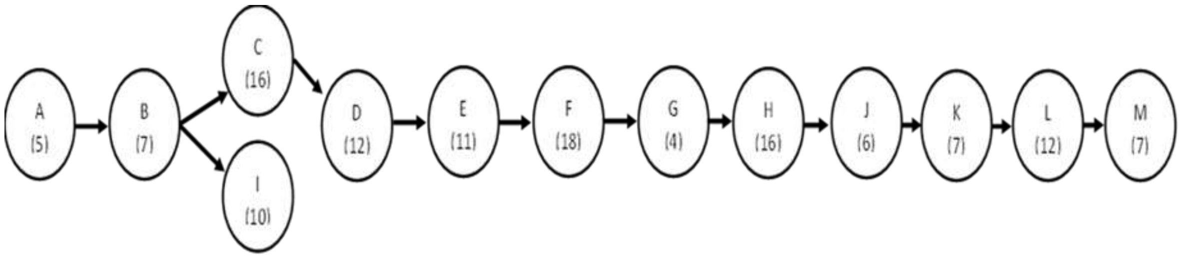

Figure 1. Analysis Using Critical Path Method (CPM)

RESULTS AND DISCUSSIONS

Process Overview of Project Activities

This study examines the implementation process of a shophouse construction project that was completed in a total of 121 days, run by a three-member team. Project management was controlled by Mr. Heri, while the provision of materials including sand, stone, cement and timber was fully handled by the project owner prior to the start of construction. The data collection method utilized in-depth interviews between the researcher and the project owner (Dinda Ayu Devi, Irawan, dan Cakrawala 2022). Variables identified include the sequence of main activities in the construction process, preliminary activities that facilitate subsequent activities, as well as the estimated minimum duration (fastest duration) and standard duration (normal duration) for each work step (Surahman et al., 2024).

Table 2. Project Activity Recapitulation

No	Job Code	Code	Duration (Days) Normal	Duration (Days) Quick Time	Prodeccessor
1	Preparation	A	5	4	-
2	Foundation Work	B	7	7	4
3	Structure Work	C	16	13	11
4	Wall Work	D	12	10	24
5	Roof Work	E	11	7	34
6	Floor Work + Ceramic Installation	F	18	13	41
7	Harmonica Door Work	G	4	3	54
8	Bathroom Work (2 Units)	H	16	12	57
9	Septictank Work	I	10	9	11
10	Canopy Work	J	6	4	69

11	Electrical Installation Work	K	7	7	24
12	Painting Work	L	12	9	73
13	Finishing	M	7	5	82

Source: Data Processed (2025)

Job Network with Normal Duration Using CPM

Based on the summary of project activities in Table 2, the researcher will explain the work network diagram with normal duration. The house construction process began on 14 April 2025 and is expected to be completed on 9 September 2025, with a total normal duration of 121 working days. Based on the information in Table 2, a normal duration work network diagram can be prepared as follows:

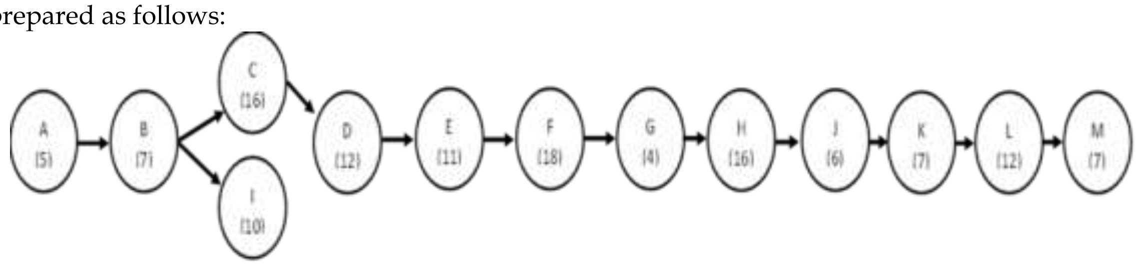

Figure 2. Schematic of Normal Time Plan

Description: Critical Path

Based on the illustration in Figure 2, an efficient duration schedule can be obtained by using the attached Gantt Chart.

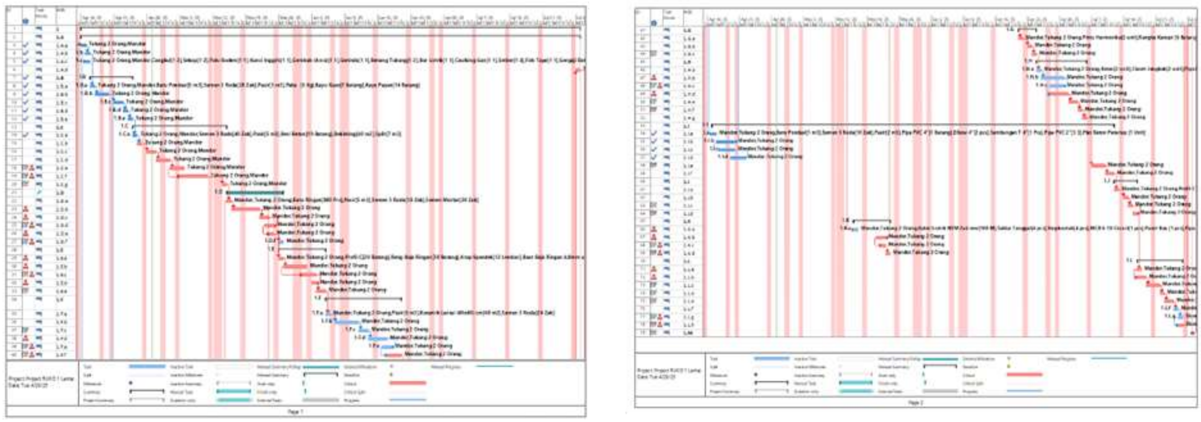

Figure 3. Gantt Chart Normal Network Time on Microsoft Project

Figure 2 presents the series of activities that must be passed in a house construction project, starting from the foundation excavation stage to the final completion of construction. Critical path analysis on the diagram shows that activities A, B, C, D, E, G, H, I, J, K, L, and M form a critical path that must be completed on time so that the project schedule is not disrupted.

By mapping out the sequential tasks on the critical path, project managers can schedule skilled workers (e.g., handymen) to rotate seamlessly between activities without idle time and pre-allocate key personnel to high-priority tasks. Likewise, logistics can be synchronized with task start dates—ensuring materials arrive just-in-time for each critical activity to prevent delays and minimize on-site storage.

By applying CPM to the project network modelling, the critical path becomes a key instrument in estimating the completion duration. Based on the accumulated duration of each activity, the total project implementation time is estimated at 121 days, which reflects the standard time required to complete the entire set of construction works.

Job Network with Quick Time Using CPM

In the implementation of the Job Network with Quick Time, the stages taken are basically the same as the Job Network with Normal Duration. This refers to the summary of project activity data listed in Table 2.

Table 3. Quick Time Activity

No	Job Code	Code	Duration (Days) Quick Time	Prodeccessor
1	Preparation	A	4	-
2	Foundation Work	B	7	4
3	Structure Work	C	13	11
4	Wall Work	D	10	24
5	Roof Work	E	7	34
6	Floor Work + Ceramic Installation	F	13	41
7	Harmonica Door Work	G	3	54
8	Bathroom Work (2 Units)	H	12	57
9	Septictank Work	I	9	11
10	Canopy Work	J	4	69
11	Electrical Installation Work	K	7	24
12	Painting Work	L	9	73
13	Finishing	M	5	82

Source: Data Processed (2025)

The shophouse construction process started on 14 April 2025 and was completed on 2 August 2025. This results in a fast-duration network diagram as shown in the following Figure.

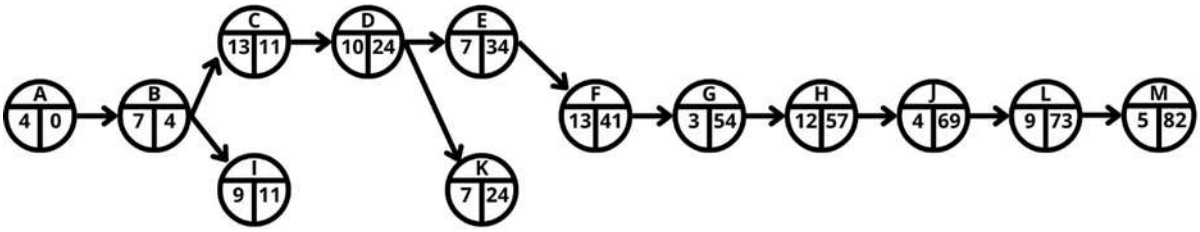

Figure 4. Quick Time Plan Schematic

Description: Critical Path

From Figure 4, the efficient time arrangement using the Gantt Chart can be seen as follows:

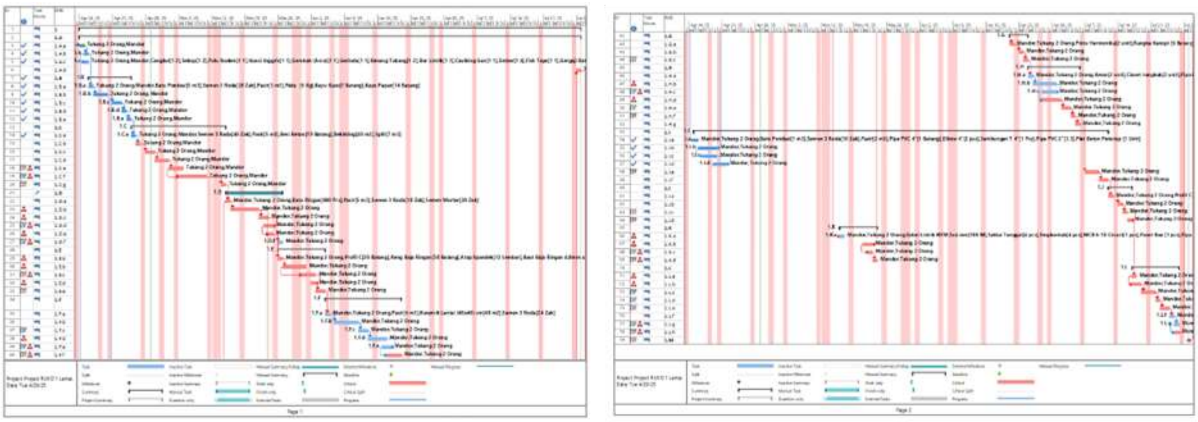

Figure 5. Quick Time Gantt Chart in Microsoft Project

Figure 4 illustrates the critical path identification process along with the calculation of the duration required for each activity in the housing project, in accordance with the approach in the Normal Time Network Diagram. The essential difference lies in the accumulated duration of the entire set of activities. In the Normal Time Network Diagram, the critical path is consistently defined as the sequence A → B → C → D → E → G → H → I → J → K → L → M.

Based on this sequence, the completion time of the shophouse construction project is estimated through CPM modelling. To determine the minimum duration, the duration of each activity on the network diagram was calculated in aggregate. The analysis results indicated that the shortest duration required to complete the shophouse construction project was 87 days. Accelerated schedules require additional work shifts and accelerated and augmented material procurement this confirmed previous stadies (Hurst, Sharpe, dan Yeager 2017; Thomas, 2000), increasing direct costs and supervision efforts as well as the risk of quality degradation due to tighter work windows. In addition, safety protocols should be intensified to mitigate the higher risks associated with overlapping tasks and tighter schedules.

CONCLUSION

This study aims to analyze the time efficiency of the construction of a single floor shophouse in Samarinda through the application of the Critical Path Method (CPM). The results showed that the project could be completed in 121 days under normal conditions, but by identifying the critical path-including Preparation Activities (A), Foundation Work (B), Structure Work (C), Wall Work (D), Roof Work (E), Harmonica Door Work (G), Bathroom Work (H), Septictank Work (I), Canopy Work (J), Electrical Installation Work (K), Painting Work (L), and Finishing (M)-the project duration could be shortened to 87 days through resource optimization on critical activities. This acceleration saves up to 28.1% of time, demonstrating the effectiveness of the CPM method in minimizing delays without compromising construction quality. This finding is in line with previous studies that highlight the ability of CPM in managing inter-activity dependencies and resource allocation. To improve project performance in the future, it is recommended that contractors focus on critical path monitoring, integrate monitoring tools such as S Curve, and consider risk analysis based on dynamic approaches such as PERT. Future research can explore the impact of acceleration on construction cost and quality in more depth to strengthen holistic project management strategies. These findings can form the basis of a standardized time-planning protocol by defining key phases and optimization guidelines to achieve consistent schedules, highlighting critical activities and resource allocation strategies. By integrating CPM-based monitoring tools and clear step-by-step procedures, contractors can apply this protocol across small-medium scale shophouse projects throughout Indonesia. By modeling baseline versus accelerated critical-path scenarios—including added labor, material, and inspection costs—contractors can assess whether a 28.1%-time reduction yields net project value and then choose from scenario-based strategies such as full acceleration with overtime and enhanced inspections, partial acceleration to balance costs and workmanship, or standard scheduling with contingency buffers.

ACKNOWLEDGEMENTS

Appreciation to the Business Administration Department and P3M of Samarinda State Polytechnic who have helped during the project, both by providing motivational and financial support.

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