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

Published by: Instiute of Computer Science (IOCS)

Enrichment: Journal of Management

Journal homepage: www.enrichment.iocspublisher.org

Critical path analysis scheduling project with critical path method (CPM) using application microsoft project on type 78 house construction project

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ARTICLE INFO

Article history:

Received May 20, 2025
Revised May 30, 2025
Accepted Jun 12, 2025

Keywords:

Critical Path Method;
Project Management;
Microsoft Project;
Free Slack;
Type 78 house construction.

ABSTRACT

This study presented the scheduling of a Type 78 house construction project using the Critical Path Method implemented in Microsoft Project. The research defined and sequenced all construction activities, estimated their durations based on field data, and modeled the schedule within the software. The CPM analysis revealed a total project duration of 120 days, with site preparation, structural framing, and roofing installation identified as the critical path activities. Non-critical tasks were found to have total floats of up to 15 days, indicating opportunities for resource reallocation and schedule compression. By simulating task overlaps and adjusting resource assignments, the study demonstrated a potential reduction in overall completion time by approximately 10%. The results confirmed that applying the Critical Path Method in Microsoft Project enhanced schedule visibility, facilitated proactive delay management, and provided practical guidance for optimizing residential construction timelines.

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INTRODUCTION

A project is a task that requires planning to achieve goals that are set in a concrete form and can be completed within a certain period of time, with the support of a limited number of workers and tools (La Ode, et al., 2023). According to Kerzner (2017) good project management can increase the chances of project success and reduce the risks faced. In addition, Surahman et al., (2024) argues that project management is a combination of art and science in managing human and material resources with modern management techniques to achieve certain goals. The goal is to complete the project on time, within budget, maintain quality and work safety, and achieve optimal accuracy, speed, and cost efficiency. Based on the statement above, it can be concluded that a project is a planned activity that aims to produce concrete output within a certain time limit, with limited resources to increase the chances of success and minimize the risk of failure by combining art and science in managing human and material resources, and applying modern management

techniques, the project can be completed on time, within budget, and with optimal quality and efficiency.

External factors such as climate conditions, material supply chain reliability, and construction licensing policies significantly influence project planning complexity and timeline uncertainty. These factors create additional variables that must be carefully managed to ensure project success. Climate variations can affect construction schedules, material availability fluctuations can cause delays and cost overruns, while licensing requirements can extend project initiation phases (Er Kara et al., 2020). The unpredictable nature of these external factors makes it crucial to implement systematic project management approaches like CPM, which provides structured frameworks for identifying critical paths, managing dependencies, and developing contingency plans to mitigate risks associated with external uncertainties (N. Saputra et al., 2021).

Based on BPS data (2023), Indonesia's population continues to increase and is projected to reach 281.60 million people in 2024, with an annual growth rate of around 1.17%.

This growth, especially in urban areas, drives high demand for quality and affordable housing. In line with the population growth trend, Samarinda as one of the buffer cities of the Indonesian Capital City has also experienced a significant increase in the development and demand for single-type houses. The demand for housing in Samarinda is currently dominated by landed houses (landed houses), which in the Indonesian context generally means single-type one-story houses. In 2023, the demand for landed houses reached 48.1% of the total property demand in the city of Samarinda (Fadlah, 2025). The development of the IKN also drives an increase in demand for housing in the surrounding areas, including Samarinda, which reaches 63.4% in 2024 and causes an increase in prices and the construction of single-story houses (Franciko, 2025). By implementing the right home project management method such as CPM, it will not only speed up the construction process but also ensure the quality and efficiency of resource use (Mulyana, 2019). The CPM method offers tools and techniques that can improve time and cost management in construction projects. CPM allows the identification of critical paths in a project to minimize completion time (Riyanto, 2020).

Although the CPM method is widely discussed in project management, there are still few studies that focus on its application in the construction of one-story houses, especially such as American Classic. This research will be conducted in a new housing complex in Samarinda, namely the construction of a type 78 single-story house with the aim of providing insight for developers and contractors to improve the quality and efficiency of project implementation through the application of more structured time management. In addition, this research also aims to enrich academic studies related to the application of CPM in small to medium-scale housing projects, such as in Thalhah Premiere.

According to Soeharto (1999) a project is a series of temporary activities with a predetermined time period and resource allocation, which aims to produce products or deliverables according to predetermined quality standards. Its scope can include factory construction, new product manufacturing, or research and development. While Wijoyo et al., (2023) stating concrete goals in a limited time period by utilizing limited human resources and equipment. The complexity of the project requires the application of special management and collaboration methods that differ from daily operational practices.

According to Wijoyo et al., (2023) project management, it is a structured approach that includes planning, organizing, directing, coordinating, and supervising all activities to ensure the achievement of targets according to the schedule and budget that has been set. Unlike routine work that is continuous, repetitive, and process-oriented, projects have specific deadlines and objectives that require separate management. Another opinion put forward by Fazis & Tugiah (2022) project management is the process of organizing, leading teams, equipment, and materials with special methods so that the project is completed on time, according to budget, scope, and quality standards that have been set and meet stakeholder expectations.

The project management process includes five main stages, namely initiation, planning, execution, control, and closing which involve the application of specialized knowledge, skills, and methods. The goal is to complete the project on time, within budget, and maintain quality and safety, while achieving optimal levels of accuracy, speed, and cost efficiency (Surahman et al., 2024).

According to Saputra et al., (2024) CPM is a project management model that is visualized through a network diagram to identify the most critical series of activities that determine the overall duration of the project, thus aiming to minimize delays and disruptions to the implementation schedule. Meanwhile, Suhendar & Ulfa (2021) it explains that CPM is a technique for analyzing activity networks in a project that predicts total duration by identifying critical paths based on dependencies between activities.

Project delay is a condition in which the implementation of activities exceeds the deadline set in the schedule, causing a shift in the completion time and potentially reducing the contractor's profit. This phenomenon often occurs in every project and is generally triggered by the ineffectiveness of project management implementation or human resource errors in carrying out their duties (Sasongko Nurhuda et al., 2019).

RESEARCH METHOD

This research was conducted in the Thalhah Premiere housing complex, precisely on Jl. Adam Malik II, Gg. Al Mujahidin, Samarinda City, and used a qualitative approach with a case study method that focused on analyzing the critical path of project scheduling with the Critical Path Method (CPM) using the Microsoft Project application in the planning and scheduling of a type 78 house construction project, American Classic. The construction period begins on September 01, 2024 and will be completed no later than March 31, 2025. Data collection was carried out through direct observation at the project location, interviews with project implementers, and collection of documentation in the form of working drawings, daily notes, and project activity lists to obtain information about the project management process that has been implemented. The data obtained was then analyzed to compile a work network based on a logical sequence of activity dependencies, in accordance with the principles of project management using the CPM method. Surahman, Kusumah, Tomby, et al. (2024). The collected data in the form of a schedule is then entered into Microsoft Project, including details of the job name and its duration. After that, the predecessor is determined for each activity. After all work items are entered and their dependency relationships are determined, the next step is to identify the critical path and calculate free slack.

The accuracy of critical path determination is measured through systematic validation processes that include verification of activity dependencies, duration estimates, and logical sequence relationships (Mar'aini & Akbar, 2022). To ensure precision, sensitivity tests are performed by analyzing various scenarios with different duration estimates and resource availability conditions. These tests involve examining the impact of duration variations on critical activities to confirm that they maintain zero slack time, while also validating that the identified critical path remains consistent under different project conditions (Pratasik et al., 2013). The sensitivity analysis includes stress-testing the schedule by introducing potential delays or accelerations to critical activities, thereby ensuring the robustness of the critical path identification and confirming that non-critical activities maintain their calculated slack values (Prasetiya et al., 2025).

The purpose of this study is to compile an optimal project implementation schedule using the Critical Path Method (CPM) to determine the critical activity path to optimize time, cost, and quality of project implementation (Dewi et al., 2016; Surahman, Yuni Saputri, et al., 2024). In this analysis, the CPM method will be applied to identify critical activities in house construction. The steps in this study are compiled to support a systematic critical path analysis on a type 78 house construction project. The stages carried out include: (1) Identification and grouping of work, (2)

Determination of duration and dependency between activities, (3) Inputting activities, durations, and dependencies that have been determined into Microsoft Project, (4) Analyzing the critical path, (5) Then, analyzing total slack and free slack to identify non-critical activities that have time flexibility. These results can be used for resource optimization and rescheduling if necessary (Heizer et al., 2020; Kerzner, 2017).

To ensure the accuracy and reliability of data input into Microsoft Project in construction project scheduling using the CPM method, several validation steps are carried out. Activity data is collected through direct observation, interviews with implementers, and review of project documents such as work drawings and daily notes, so that the inputted activities are truly in accordance with field conditions DIPS42 (2024); Merwe (2016). The estimated duration of the work is validated by experts and compared with historical data from similar projects, and using structured estimation methods such as Delphi or three-point estimation. The relationship between activities is checked to be logical and in accordance with the work sequence in the field, and all dependencies and use of start/end times are clearly documented (Lorko et al., 2019; Merwe, 2016; Park, 2024).

After the data is input into Microsoft Project, a check is carried out using a validation template to ensure that there are no illogical or unsupported relationships Merwe (2016). Data standardization and resource assignment are also considered to avoid duplication or inconsistency DIPS42 (2024). The project schedule is then reviewed and updated periodically to adjust to developments in the field (Merwe, 2016; TENSIX, 2025) (Merwe, 2016; TENSIX, 2025). With these steps, the accuracy and reliability of data in Microsoft Project can be maintained, so that CPM analysis can be used optimally for project management.

RESULTS AND DISCUSSIONS

Job Item Data Entry

This processing primary and secondary data originating from project construction of Type 78 house in Housing Complex Thalhah Premiere, where every details activity encoded for facilitate the data processing process.

Table 1. Activity Details

No	Type of Activity	Symbol Activity
I	PREPARATION	A
1	Land Clearing	A1
2	Measurement and Staking	A2
II	FOUNDATION WORK	B
3	Excavation Foundation	B1
4	Installation Building Plank	B2
5	Land Confinement	B3
6	Land Leveling	B4
7	Installation of Crushed Stone	B5
8	Installation Iron Foundation	B6
9	Casting Foundation	B7
III	WALL WORK	C
10	Bricklaying	C1
11	Door Frame Installation	C2
12	Window Frame Installation	C3
13	Plastering Wall	C4
14	Plastering Wall	C5
IV	ROOF WORK	D
15	Roof Frame Installation	D1
16	Roof Installation	D2
V	CEILING WORK	E
17	Installation Ceiling	E1
VI	FLOORING WORK	F

18	Floor Filling	F1
19	Granite Installation	F2
VII	MECHANICAL & ELECTRICAL WORK	G
20	Installation Electrical Installation	G1
21	Installation Water & Sanitation Installation	G2
22	Making Septic Tank	G3
VIII	GARDEN & LANDSCAPE WORKS	H
23	Carport Construction	H1
24	Making Front and Back Gardens	H2
IX	FINISHING	I
25	Painting Walls and Ceilings	I1
26	Door and Window Installation	I2
27	Installation Lights and Switches	I3

The data input process follows order timetable work field on project construction of Type 78 house, started from stage preparation (cleaning land, measurement, staking), continued with work foundation (excavation, bouwplank, embankment, leveling, crushed stone, iron, casting), work walls (brick, frame) doors and windows, plaster, cement), roof work (frame and covering), ceiling, floor (filling, granite), and mechanical & electrical (installation) electricity, water & sanitation, septic tank). Next implemented work garden & landscape (carport, garden front and back), and finally all over series closed with finishing stage in the form of painting walls and ceilings as well as installation doors, windows, lights, and switches.

Plan Time Input

Input time plan started with timeline review and calculations free slack value, where all activity according to the Work Breakdown Structure inputted to Microsoft Project according to the field schedule and then set connection between activities. From this process obtained free slack value for work walls, floors, mechanical & electrical, garden & landscape, and finishing. Based on dependence between activity said, Microsoft Project next used for identify track critical project.

Potential changes to the work sequence due to unforeseen field conditions (force majeure) are evaluated through comprehensive scenario modeling within the framework of simulated schedule flexibility. This evaluation process involves creating alternative work sequences and dependency relationships in Microsoft Project to assess the impact of various disruption scenarios such as weather delays, material shortages, or equipment failures. The schedule flexibility analysis examines how activities with existing free slack can be reorganized or accelerated to accommodate sequence changes, while maintaining the overall project timeline. Monte Carlo simulations and what-if analyses are conducted to test different contingency scenarios, allowing project managers to develop robust mitigation strategies and alternative critical paths that can be activated when unforeseen conditions occur, thereby ensuring project resilience and adaptability (Avlijas, 2018).

Table 2. Planning using Microsoft Project

No	Activity Type	Duration	Start	Finish	Free Slack
1	Preparation	8			
2	Land Clearing	4	01/09/24	04/09/24	0
3	Measurement and Staking	4	05/09/24	08/09/24	0
4	Foundation Work	29			
5	Excavation Foundation	4	09/09/24	12/09/24	0
6	Installation Building Plank	5	13/09/24	18/09/24	0
7	Land Confinement	3	19/09/24	21/09/24	0
8	Land Leveling	3	22/09/24	24/09/24	0
9	Installation of Crushed Stone	4	25/09/24	28/09/24	0
10	Installation Iron Foundation	6	29/09/24	04/10/24	0
11	Casting Foundation	4	05/10/24	08/10/24	0
12	Wall Work	35			

13	Bricklaying	14	09/10/24	22/10/24	0
14	Door Frame Installation	4	17/10/24	20/10/24	0
15	Window Frame Installation	3	17/10/24	19/10/24	1
16	Plastering Wall	10	23/10/24	01/11/24	11
17	Plastering Wall	8	05/11/24	12/11/24	11
18	Roof Work	24			
19	Roof Frame Installation	14	21/10/24	03/11/24	0
20	Roof Installation	10	04/11/24	13/11/24	0
21	Ceiling Work	10			
22	Installation Ceiling	10	14/11/24	23/11/24	0
23	Flooring Work	19			
24	Floor Filling	2	09/10/24	10/10/24	33
25	Granite Installation	17	11/10/24	27/10/24	33
26	Mechanical & Electrical Work	57			
27	Installation Electrical Installation	10	24/11/24	03/12/24	10
28	Installation Water & Sanitation Installation	11	24/11/24	04/12/24	13
29	Making Septic Tank	1	09/10/24	09/10/24	69
30	Garden & Landscape Works	18			
31	Carport Construction	10	28/10/24	06/11/24	33
32	Making Front and Back Gardens	8	07/11/24	14/11/24	33
33	Finishing	24			
34	Painting Walls and Ceilings	18	24/11/24	11/12/24	0
35	Door and Window Installation	6	12/12/24	17/12/24	0
36	Installation Lights and Switches	4	12/12/24	15/12/24	2

Determining the Critical Path of Work

Relation between work made in three types namely start to start, start to finish, and finish to finish as well customized with time progress work.

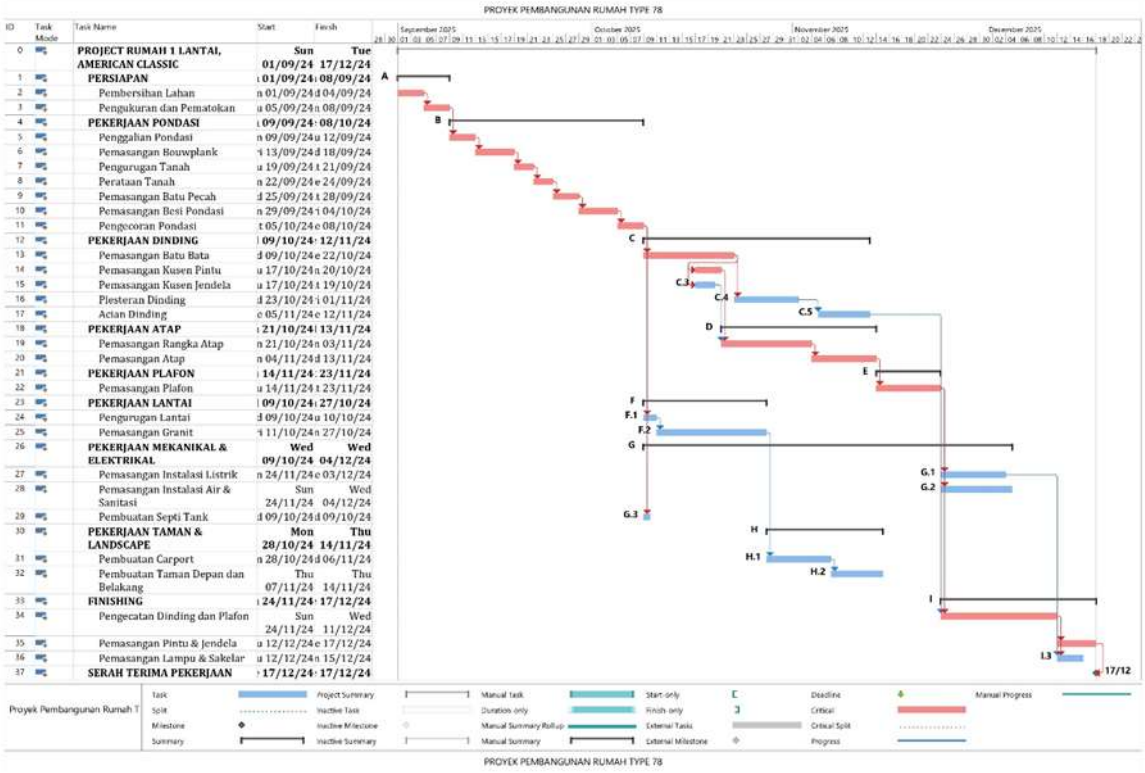

Figure 1. Critical Path with Microsoft Project

The input of the planned time is carried out according to the field schedule sequence, starting from the preparation stage, continuing with the foundation, walls, roof, ceiling, floor, mechanical & electrical, garden & landscape, and finishing. In order to avoid wasting time and labor during the implementation of these stages, slack analysis is used as a planning tool. Slack analysis helps optimize labor allocation by identifying non-critical activities (eg: floor filling, granite installation, septic tanks, and landscaping) that have time slack (slack up to 33 days). Labor from these activities can be temporarily diverted to critical activities (structure, walls, roof) to prevent delays.

CONCLUSION

Based on the results of data processing, it can be concluded that through the Critical Path Method (CPM) analysis, the work items that have a critical path or do not have float are A1-A2-B1-B2-B3-B4-B5-B6-B7-C1-C2-D1-D2-E1-I1-I2 including land clearing, measuring and staking, foundation excavation, bouwplank installation, land filling, land leveling, crushed stone installation, foundation iron installation, foundation casting, brick installation, door and window frame installation, roof frame installation, roof installation, ceiling installation, wall and ceiling painting, and door and window installation. By knowing this critical path, local developers can create a more realistic and efficient implementation schedule, anticipate potential delays, and choose the right implementation method and project layout planning. These findings can be used as a reference for a schedule model for similar housing construction projects in small to medium-scale urban areas, thereby increasing the effectiveness and efficiency of housing project implementation.

Based on the identified critical path results, concrete recommendations for the project management team include developing comprehensive Standard Operating Procedures (SOPs) that prioritize critical activities with zero float time, establishing mandatory daily monitoring protocols for critical path activities, implementing early warning systems for potential delays, creating resource allocation contingency plans that ensure priority access to materials and equipment for critical activities, and establishing clear escalation procedures when critical activities show signs of deviation from planned schedules. Additionally, the team should develop specific delay mitigation strategies such as maintaining buffer stocks of critical materials, pre-qualifying backup contractors for critical work packages, implementing parallel work execution where technically feasible, and establishing regular coordination meetings focused specifically on critical path progress to ensure proactive rather than reactive project management.

ACKNOWLEDGEMENTS

Appreciation to Samarinda State Polytechnic and the Department of Business Administration for their generous financial support of our project.

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