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

Published by: Instiute of Computer Science (IOCS)

Enrichment: Journal of Management

Journal homepage: www.enrichment.iocspublisher.org

Optimization of 4-Storey Shophouse Construction Project Schedule Using Microsoft Project- Based CPM Method

Friska Wanda Betteng[1], Firza Andhika Dirgantari[2], Siska Wulandari[3], Surahman[4], Suramli[5]

[1,2,3,4,5]Business Administration, Politeknik Negeri Samarinda, Kota Samarinda

ARTICLE INFO

Article history:

Received May 28, 2025
Revised Jun 05, 2025
Accepted Jun 18, 2025

Keywords:

Critical Path Method;
Microsoft Project;
Project Construction;
Schedule Optimization;
Shophouse.

ABSTRACT

Study This aimss to improve efficiency timetable project development building shop house four floor with apply Critical Path Method (CPM) supported by Microsoft Project. The results of the analysis show that time implementation project Can pressed to be 89 days from originally 180 days through identification paths critical and optimization distribution source power. The CPM method is used to identify important activities like work foundation, structure building, and completion, while Microsoft Project facilitates appearance and management schedule. Findings from study This driving technology-based project management standardization in the Indonesian construction industry, offering efficient solutions, reducing resource waste and the risk of delays, and strengthening project resilience to market risks.

Corresponding Author:

Friska Wanda Betteng,
Business Administration,
Politeknik Negeri Samarinda,
Jl. Cipto Mangun Kusumo, Kota Samarinda, 73242, Indonesia,
Email: siskawulandary1626@gmail.com

INTRODUCTION

Project construction building tiered development shop house four floor is enough work complex and demanding structured planning with good to be able to completed appropriate time , according to with available budget, as well as fulfil standard quality define. Project Alone is a series activity that started from stage planning until settlement end (Danang Isnubroto, dkk.2021). Scheduling project is a process of compiling order activities aimed at completing work certain with time target the settlement that has been determined. In case this, quality scheduling is function from certainty and concern as One series (space scope) which must be taken into account in planning since beginning project determined, its implementation until settlement project construction the (Simanjuntak & Huka, 2020). Success in manage projects scale big depends a lot on planning, scheduling, and careful coordination to various mutual activities related. Without existence structured planning, a project at risk experience delay, increase costs, and inefficiencies in its implementation.

Based on a study conducted by (Angelin & Ariyanti, 2019), the application of the Critical Path Method (CPM) with the help of Microsoft Project has been proven to be able to increase the accuracy of project planning and control. Therefore, this research This aiming to test effectiveness

implementation technology-based project management, while evaluating its impact on the efficiency of project completion time. Furthermore, a study by (Fransisko et al.,2013) showed that the use of Microsoft Project in controlling the time of project implementation can help identify critical paths and optimize resource allocation, thereby minimizing the risk of delays and cost overruns.

The 4-storey shophouse building project is an ideal case study to apply this approach. With the planned implementation time under supervision, this study specifically aims to: (1) analyze the scheduling sequence of activities for the 4-storey shophouse construction project and (2) complete the project on time so that budget use is efficient and does not occur. This project represents a typical medium-scale construction in urban areas, with quite high complexity but has not implemented much technology-based project management. Different from previous studies that focus on large projects, this study highlights the application of CPM and Microsoft Project methods to medium-sized vertical buildings in a more practical and applicable way. In a study conducted by (Mabui dkk., 2024), the use of Microsoft Project in construction project planning was considered to be able to help in compiling activity stages systematically and accurately, thereby reducing the potential for project delays. Meanwhile, according to (Pramesti & Listyawan, 2023), With positive growth, project completion has become a primary focus, particularly in terms of quality, time, and cost control. Therefore, the implementation of effective project management is essential to minimize the risks of failure and delays in project execution. However, most previous studies still focus on the application of the (CPM) method and Microsoft Project in the context of large-scale construction projects, while its specific application to medium-scale multi-storey building projects, such as 4-storey shophouses, is still relatively limited.

This is supported by (Surahman dkk., 2024) who stated that the use of the CPM method in small-medium scale construction projects is indeed able to increase the accuracy of critical activity identification and reduce the risk of delays, but its application in developing areas such as Indonesia has not been studied much in practice. Therefore, further research is needed that focuses on the application of the CPM method assisted by Microsoft Project in a local context to produce a scheduling model that is more applicable and in accordance with field needs.

This study aims to examine the application of the CPM method assisted by Microsoft Project on a 4-storey shophouse construction project, in order to gain a deeper understanding of the optimal sequence of activities and efficient completion time. In addition, this study is also directed to evaluate the extent to which the use of Microsoft Project can assist in project control, especially in preventing delays and budget waste, so that the results can provide practical contributions to local construction industry players and enrich academic studies in the field of project management.

Through this research, it is expected to obtain a more accurate and applicable scheduling model for medium-scale construction projects by utilizing technology in project management in Indonesia. This is in line with the findings (Hutabarat dkk., 2023) which confirm that the application of technology in construction project scheduling, especially the (CPM) method, can significantly increase time efficiency and project implementation control. In addition to providing practical contributions to local construction industry players, the results of this study are also expected to enrich academic literature and become a reference for the development of similar methods in the future.

A project is a efforts made regularly , with various limitations on time , cost , and resources the power required , as well as have criteria specifically for items you want produced (Kartini dkk., 2022). In the discussion development , project defined as gathering activities aimed at building something new or repair infrastructure that has been there is. Project type This own three characteristics main , namely specific goals, deadlines the specified time, and the source available power specifically to achieve it. The length of time it takes to complete A task determined by the number of power work that does it (Abadiyah dkk., 2021).

Every project development involving a number of stages important to minimize risk. First, planning, including survey location, determination design technical, and material selection . Second, procurement, namely ensure fair selection to get provider best with minimal risk. Third, implementation, namely set schedule, do supervision to ensure all walk according to target, and make routine reports . Lastly, maintenance , namely do routine maintenance to prevent damage early (Hazriyanti dkk., 2020). Project development also involves Lots parties, such as owner projects, implementers, and recipients benefits, so that Good communication and coordination are essential.

Critical Path Method (CPM) is how to evaluate series activity in A work with objective estimate overall time required (Latifah, 2020) . In implementation CPM method, there is well known terms as track critical, namely order activity with longest total duration and time settlement fastest project. If There is activities on the track pending critical, thing This can result in delay all over project (Gultom dkk., 2022). CPM offers sufficient approach simple in calculate the total time, which is only need summation duration every tasks and take time the ultimate solution or the biggest (Vita Kartika dkk., 2024).

CPM is illustrated as a point in A network, while events that show the beginning or settlement from a activity symbolized with lines or connecting arc between point That (Dinda Ayu Devi dkk., 2022). CPM has proven effective in various project constructio, including development building tiered, because his ability integrate aspect time and cost in a way simultaneous.

Microsoft Project is is device software used for planning work in a project (Mantovani & Beatrix, t.t.). Integration of CPM methods with device Microsoft Project software brings efficiency significant in planning and control project. CPM concept for controlling cost project has implemented in the Microsoft Project program. With this software, users No only can make planning, but also monitoring and controlling aspect time , cost , energy work , and project materials. Comprehensive information This can give description comprehensive about situation projects, such as conformity with schedule, budget costs, and allocation source Power in accordance plan. Implementation that missed from plan can quick taken action straight to fix it (Siswoyo & Sistarani, 2024). In analyzing CPM with microsoft project, needed connection between work to understand relatedness between tasks so that we Can understand How activity each other relate (Hia & Nusa, 2024). One activity can own various activities that precede (Predecessor) and many following activities (Successor) (Sofiah, 2024). The combination of CPM and Microsoft Project is perfect for projects complex, such as development 4- storey shophouse, where precision scheduling and flexibility in face change become key success.

RESEARCH METHOD

This study applies a quantitative approach, namely a study of social problems by testing a theory involving variables, measured in numerical form, and analyzed using statistical procedures to determine whether the generalization of the theory is accurate (Ali dkk., 2022). The data processing of this study uses the CPM Method (Critical Path Method). CPM is one of the project scheduling techniques used to determine the sequence of the longest activities in a project, which directly affects the time settlement overall project . The CPM method is more known with the term Critical Path , which allows existence formation track or route that requires attention more (critical) (Wasito & Syaikhudin, 2020). The purpose of the research This can used in compiling project schedule planning using Microsoft Project software and analyzing the project's critical path. This method plays an important role in project management because it can help identify critical activities, namely activities that have no tolerance for delay, as well as activities that still have time leeway. Thus, CPM facilitates project time management more efficient and structured . With a management strategy effective time , expected everyone can identify the most important activities ,

as well as direct energy and time them to finish urgent and crucial tasks moreover formerly (Ilmiyah, 2019).

This research methodology uses several data collection techniques that aim to obtain accurate and in-depth information through: (1) Primary data, namely data sources that come from direct data provided to researchers. Primary data is data collected from first parties, usually obtained through interviews. In this study, the primary data obtained is activity relationship data based on the results of interviews and direct field observations; and (2) Secondary Data, namely data sources obtained based on things obtained by reading, studying and understanding through other media sourced from literature, books and documents. In this study, the secondary data obtained is based on internal project data such as RAB and time schedule (Astari dkk., 2022). From collecting this data, it is hoped that the research can produce valid and useful findings in developing development projects.

This research methodology follows clear steps in applying the (CPM) method to plan a four-story shophouse construction project schedule. The steps are: (1) Prepare and compile a list of activities/jobs for which CPM will be created by providing a unique code for each work item; (2) Calculate the duration (time) needed to complete each job; (3) Determine the relationship between activities, which activities are predecessors, and which activities are successors; (4) Organize/describe these jobs in the form of a network by entering the code of each related job and its duration; (5) Determine the critical path/trajectory; and (6) Compile a CPM Table (Saputra dkk., 2021).

Researchers conducted thorough interviews with project stakeholders, including workers and foremen, to ensure the accuracy and field-appropriateness of activity relationships in the four-story shophouse construction project. These findings were validated by direct field observations and review of project documentation (Astari dkk., 2022). The results of the interviews were reconstructed in Microsoft Project using the CPM method, then verified by experts to ensure the accuracy of activity relationships.

Researchers used a triangulation method to assess the quality and reliability of the data in this study. Cross-checking informants and field observations was used to evaluate primary data (interview findings with workers/foremen), and member verification was used to assess the trustworthiness of the data. In order to assure correctness, secondary data (material prices) were checked by contrasting prices from two distinct retailers with prices provided by relevant employees or foremen.

Although a systematic risk analysis is not carried out explicitly in this study, risk factors are implicitly taken into account through activity durations that are based on field experience from workers and foremen, as well as data validation through triangulation (interviews, observations, documentation). Using Microsoft Project to optimize resources and identify vital paths to prioritize important tasks, risk mitigation is put into practice, allowing for dynamic schedule modifications. This strategy effectively addressed real-world on-site hazards by cutting the project duration from 180 days to 89 days, despite the lack of formal risk analysis techniques like Monte Carlo simulations or specified buffer time.

The skills and experience of users in utilizing Microsoft Project significantly influence the accuracy of the resulting CPM (Critical Path Method) analysis. The more proficient the user, the more precise they are in designing schedules, managing interdependencies between activities, and identifying the critical path in accordance with the actual project conditions. Moreover, a solid understanding of advanced features such as baseline setting and resource leveling is highly beneficial for project control and for making necessary adjustments when changes occur on-site. Conversely, without adequate training, the use of CPM and Microsoft Project may not be optimal, potentially compromising time efficiency, cost control, and the quality of decision-making throughout the project.

RESULTS AND DISCUSSIONS

Multi-storey building construction projects, especially 4-storey shophouses, are complex projects that require careful planning so that they can be completed on time, within budget, and meet the established quality standards. This study focuses on a 4-storey shophouse construction project that was initially planned to last for 180 calendar days. However, based on the calculation results using Microsoft Project, the optimal duration achieved was 89 days, starting on December 2, 2024 and targeted for completion on March 17, 2025.

The significant reduction in project duration from 180 days to 89 days, or about 50.5% of the original planned time, has a substantial impact. The shortening of the project time is directly correlated with the reduction in daily overhead costs , such as labor wages, equipment rental, and project administration costs. In addition, the shorter duration also minimizes the project's exposure to external risks such as inflation, material price fluctuations, or regulatory changes that tend to increase with the length of the implementation period. For the project owner, faster completion means that the shophouses can be occupied or sold immediately, which in turn accelerates revenue generation and increases the rate of return on investment. This shows that schedule optimization is not just a technical achievement, but a strategic advantage that is crucial to the overall success of the project. Work can be completed twice as fast without increasing manpower or working hours by optimizing more efficient processes. This can be achieved by reducing idle time—such as utilizing waiting periods to perform other tasks—simplifying workflows, and eliminating non-essential activities. The use of more effective tools or technologies, along with the implementation of standardized operational procedures, also contributes to improved efficiency. In addition, training and development of workforce capabilities support faster task completion without compromising quality. Essentially, acceleration in work performance is more influenced by the efficiency of work methods rather than the number of employees or the length of working hours.

The implementation of the 4-story shophouse construction project involved a work team consisting of 6 laborers, 4 craftsmen, and 1 foreman. The procurement of main materials such as sand, cement, stone, and wood has been controlled and prepared by the project foreman before the construction activity began. Several work tools, such as large cement mixers, were obtained through a rental system to support the smooth running of the work. Project schedule data was obtained in detail through Microsoft Project files and reviewed based on the sequence of construction activities, dependencies between jobs, and the estimated duration of each stage. The variables analyzed include preparation work, structure, installation, and finishing, which form the entire series of project work.

Project Activity Data

The project scheduling is arranged based on the work sequence and estimated duration of each activity, taking into account the logical dependencies between tasks. The data used in this study were obtained from direct interviews with foremen and workers in the field, as well as internal project data such as the existing Cost Budget Plan (RAB) and time schedule . Table 4.1 presents a recapitulation of the activities of the 4-story shophouse construction project which is the basis for the analysis in this study, complete with details of duration, start and finish dates, dependencies, time allowances, person in charge, and resources used.

Table 1. Recapitulation of 4-Storey Shophouse Construction Project Activities

Wbs	Task Name	Duration	Start	Finish	Predecessors	Free Slack	Pic/ Person Responsible
A	Preparatory Work	8 Days	Mon 12/02/24	Tue 12/10/24		0 Days	
A.1	Land Clearing	4 Days	Mon 12/02/24	Thu 12/05/24		0 Days	Dirgantari

A.2	Measurement And Staking	2 Days	Mon 12/09/24	Tue 12/10/24	2fs+2 Days	0 Days	Andhika
A.3	Design	1 Day	Mon 12/09/24	Mon 12/09/24	3ss	0 Days	Friska
B	Foundation Work	26 Days	Sat 12/14/24	Wed 01/15/25		0 Days	
B.1	Earth Excavation	8 Days	Sat 12/14/24	Mon 12/23/24	4fs+4 Days	0 Days	Firza
B.2	Installation Of Deep Foundation	9 Days	Tue 12/31/24	Fri 01/10/25	6fs+5 Days	0 Days	Wanda
B.3	Basement Slab Casting And Retaining	4 Days	Sat 01/11/25	Wed 01/15/25	7	0 Days	Friska
C	Structural Work	17 Days	Wed 01/15/25	Tue 02/04/25		0 Days	
C.1	Installation Of Formwork And Floor Reinforcement	5 Days	Wed 01/15/25	Tue 01/21/25	8	0 Days	Betteng
C.2	Reinforced Concrete Casting Per Floor	8 Days	Fri 01/24/25	Sat 02/01/25	10fs+2 Days	0 Days	Mascul
C.3	Brick Wall Installation	10 Days	Fri 01/24/25	Tue 02/04/25	11ss	0 Days	Wanda
D	Roof Installation	10 Days	Wed 02/05/25	Sat 02/15/25		0 Days	
D.1	Installation Of Light Steel Frames	4 Days	Wed 02/05/25	Sat 02/08/25	12	0 Days	Dirgantari
D.2	Floordeck Roof Installation	4 Days	Wed 02/12/25	Sat 02/15/25	14fs+2 Days	0 Days	Siska
D.3	Asphalt Roof Installation	5 Days	Wed 02/05/25	Mon 02/10/25	14ss	30 Days	Firza
E	Wall Work	35 Days	Wed 02/05/25	Mon 03/17/25		0 Days	
E.1	Installation Of Iron And Ring Beams	4 Days	Wed 02/05/25	Sat 02/08/25	12	31 Days	Wulandari
E.2	Door Frame Installation	2 Days	Wed 02/19/25	Thu 02/20/25	24fs+1 Day	3 Days	Andhika
E.3	Window Frame Installation	2 Days	Wed 02/19/25	Thu 02/20/25	25fs+1 Day	0 Days	Friska
E.4	Installation Of Bricks	18 Days	Tue 02/25/25	Mon 03/17/25	19.20fs+3 Days	0 Days	Wanda
E.5	Wall Plastering Process	11 Days	Sat 02/08/25	Thu 02/20/25	27ff	0 Days	Friska
E.6	Plaster Plastering	11 Days	Fri 02/21/25	Wed 03/05/25	22	10 Days	Firza
E.7	Door Installation	2 Days	Sat 02/15/25	Mon 02/17/25	27ss	0 Days	Siska
E.8	Window Installation	2 Days	Sat 02/15/25	Mon 02/17/25	24ff	0 Days	Betteng
F	Electrical Installation Work	5 Days	Sat 02/15/25	Thu 02/20/25		0 Days	
F.1	Installation Of Cable Duct Pipes	5 Days	Sat 02/15/25	Thu 02/20/25	28ss	0 Days	Wulandari
F.2	Installation Of Cables And Lights	2 Days	Sat 02/15/25	Mon 02/17/25	36ss	0 Days	Wanda

F.3	Installation Of Switches And Sockets	3 Days	Tue 02/18/25	Thu 02/20/25	28	21 Days	Siska
G	Water Installation Work	4 Days	Sat 02/15/25	Wed 02/19/25		22 Days	
G.1	Installation Of Drain Pipes	4 Days	Sat 02/15/25	Wed 02/19/25	32ss	22 Days	Dirgantari
G.2	Connection Of Piping System	3 Days	Sat 02/15/25	Tue 02/18/25	42ss	0 Days	Friska
H	Ceiling Work	6 Days	Sat 02/15/25	Fri 02/21/25		0 Days	
H.1	Installation Of Gypsum Frame	6 Days	Sat 02/15/25	Fri 02/21/25	35ss	20 Days	Friska
H.2	Ceiling Installation	5 Days	Sat 02/15/25	Thu 02/20/25	48ss	0 Days	Firza
H.3	Installation Of Cables and Lights	3 Days	Sat 02/15/25	Tue 02/18/25	43ff	0 Days	Wanda
I	Ceramic Works	8 Days	Mon 02/17/25	Tue 02/25/25		17 Days	
I.1	Installing Bathroom Floor Tiles	4 Days	Wed 02/19/25	Sat 02/22/25	40ss	19 Days	Wulandari
I.2	Installing Bathroom Wall Tiles	3 Days	Mon 02/17/25	Wed 02/19/25	52ss	22 Days	Dirgantari
I.3	Granite Installation	6 Days	Wed 02/19/25	Tue 02/25/25	44ss	0 Days	Siska
J	Bathroom/Toilet Work	5 Days	Sat 02/15/25	Thu 02/20/25		1 Day	
J.1	Closet Installation	2 Days	Sat 02/15/25	Mon 02/17/25	45ff	0 Days	Wulandari
J.2	Floor Drain Installation	2 Days	Mon 02/17/25	Tue 02/18/25	46ss	0 Days	Andhika
J.3	Shower Installation	2 Days	Wed 02/19/25	Thu 02/20/25	45ss+2 Days	0 Days	Siska
J.4	Sink Installation	1 Day	Mon 02/17/25	Mon 02/17/25	49ss	0 Days	Friska
J.5	Installing The Faucet	1 Day	Mon 02/17/25	Mon 02/17/25	50ss	0 Days	Mascul
K	Kitchen Work	2 Days	Sat 02/15/25	Mon 02/17/25		1 Day	
K.1	Kitchen Sink Installation	2 Days	Sat 02/15/25	Mon 02/17/25	50ff	0 Days	Siska
K.2	Sink Installation	1 Day	Mon 02/17/25	Mon 02/17/25	50ss	0 Days	Wanda
K.3	Installing The Faucet	1 Day	Mon 02/17/25	Mon 02/17/25	52ss	0 Days	Betteng
L	Finishing Work	8 Days	Mon 02/17/25	Tue 02/25/25		0 Days	
L.1	Interior & Exterior Painting Of Buildings	8 Days	Mon 02/17/25	Tue 02/25/25	15	0 Days	Mascul

Project Scheduling Analysis Using the Critical Path Method (CPM)

The Critical Path Method (CPM) is a technique used to analyze the network of activities in a project to predict the total duration of the project. In CPM, there is a critical path, which is a series of activities with the longest total time which, if implemented late, will result in the delay of the

entire project. This study specifically utilizes CPM to identify the longest sequence of activities and analyze the critical path of a 4-story shophouse construction project.

Table 2. Manual CPM Calculation Results for 4-Storey Shophouse Construction Project

No	Job Code	Duration (Days)	ICE	EF	LS	LF	Total Float	Status
1	PREPARATION WORK (A)	8	0	8	0	8	0	Critical
1.1	Land Clearing (A.1)	4	0	4	0	4	0	Critical
1.2	Measurement and Staking (A.2)	2	7	9	7	9	0	Critical
1.3	Design (A.3)	1	7	8	8	9	1	Non-Critical
2	FOUNDATION WORK (B)	26	8	34	8	34	0	Critical
2.1	Earth Excavation (B.1)	8	8	16	8	16	0	Critical
2.2	Installation of Deep Foundations (B.2)	9	20	29	20	29	0	Critical
2.3	Basement Slab Casting and Retaining (B.3)	4	30	34	30	34	0	Critical
3	STRUCTURAL WORK (C)	17	34	51	34	51	0	Critical
3.1	Installation of formwork and floor reinforcement per level (C.1)	5	34	39	34	39	0	Critical
3.2	Reinforced concrete casting per floor (C.2)	8	41	49	41	49	0	Critical
3.3	Brick wall installation (C.3)	10	41	51	41	51	0	Critical
4	ROOF INSTALLATION (D)	10	51	61	51	61	0	Critical
4.1	Installation of light steel frame (D.1)	4	51	55	51	55	0	Critical
4.2	Floordeck roof installation (D.2)	4	57	61	57	61	0	Critical
4.3	Installation of asphalt roof (D.3)	5	55	60	56	61	1	Non-Critical
5	WALL WORK (E)	35	51	86	51	86	0	Critical
5.1	Installation of iron and ring beams (E.1)	4	51	55	51	55	0	Critical
5.2	Door frame installation (E.2)	2	68	70	68	70	0	Critical
5.3	Window frame installation (E.3)	2	68	70	68	70	0	Critical
5.4	Installation of bricks (E.4)	18	70	88	70	88	0	Critical
5.5	Wall plastering process (E.5)	11	55	66	55	66	0	Critical
5.6	Plastering (E.6)	11	67	78	67	78	0	Critical
5.7	Door installation (E.7)	2	66	68	66	68	0	Critical
5.8	Window installation (E.8)	2	66	68	66	68	0	Critical
6	ELECTRICAL INSTALLATION WORK (F)	5	88	93	88	93	0	Critical
6.1	Installation of cable conduit pipes (F.1)	5	88	93	88	93	0	Critical
6.2	Installation of cables and lights (F.2)	2	93	95	93	95	0	Critical
6.3	Installation of switches and sockets (F.3)	3	95	98	95	98	0	Critical
7	WATER INSTALLATION WORK (G)	4	88	92	89	93	1	Non-Critical
7.1	Installation of pipelines (G.1)	4	88	92	89	93	1	Non-Critical
7.2	Connection of piping system (G.2)	3	92	95	93	96	1	Non-Critical
8	CEILING WORK (H)	6	98	104	98	104	0	Critical
8.1	Installation of gypsum frame (H.1)	6	98	104	98	104	0	Critical
8.2	Ceiling installation (H.2)	5	104	109	104	109	0	Critical
8.3	Installation of cables and lights (H.3)	3	109	112	109	112	0	Critical
9	CERAMIC WORKS (I)	8	112	120	112	120	0	Critical
9.1	Installing bathroom floor tiles (I.1)	4	112	116	112	116	0	Critical
9.2	Installing bathroom wall tiles (I.2)	3	116	119	116	119	0	Critical
9.3	Granite installation (I.3)	6	119	125	119	125	0	Critical
10	BATHROOM/TOILET WORK (J)	5	125	130	125	130	0	Critical
10.1	Closet installation (J.1)	2	125	127	125	127	0	Critical
10.2	Floor drain installation (J.2)	2	127	129	127	129	0	Critical
10.3	Shower installation (J.3)	2	129	131	129	131	0	Critical
10.4	Washbasin installation (J.4)	1	131	132	131	132	0	Critical
10.5	Faucet installation (J.5)	1	132	133	132	133	0	Critical
11	KITCHEN WORK (K)	2	125	127	126	128	1	Non-Critical
11.1	Kitchen sink installation (K.1)	2	125	127	126	128	1	Non-Critical
11.2	Washbasin installation (K.2)	1	127	128	128	129	1	Non-Critical
11.3	Installation of taps (K.3)	1	128	129	129	130	1	Non-Critical
12	FINISHING WORK (L)	8	133	141	133	141	0	Critical
12.1	Interior & exterior painting of buildings (L.1)	8	133	141	133	141	0	Critical
13	WORK HANDOVER (M)	0	141	141	141	141	0	Critical

This table explicitly presents the earliest and latest possible start and finish times for each activity, along with the amount of 'float' or 'slack' it has. This quantification is critical for project managers to understand where there is time flexibility and where there is none. The 'Total Float' column directly identifies the critical activities (TF=0), which are the backbone of the project schedule. This information provides the basis for prioritizing resources, where resources should be focused on critical tasks to prevent delays, while non-critical tasks potentially have resources that can be diverted. These manual calculations also serve as a baseline. Any significant deviation from these baseline durations when using software such as Microsoft Project indicates the software's soptimization capabilities (e.g., resource leveling, calendar adjustments) that go beyond simple critical path analysis.

The path is a series of activities that must be completed sequentially, where if one activity is delayed, it will impact the delay of the entire project. Knowing the critical path is very important because it helps identify activities that must not be delayed so that the project can be completed on time (Wartinah dan Ruslan, 2013).

Therefore, while manual CPM provides a fundamental understanding of project logic and basic durations, true optimization in complex projects often requires sophisticated software such as Microsoft Project. This software goes beyond simple critical path identification to consider real-world constraints and resource dynamics, resulting in a more realistic and efficient schedule. The resulting 89-day duration is a testament to the power of this tool in achieving significant time savings.

CONCLUSION

This study shows that the use of the Critical Path Method (CPM) supported by Microsoft Project in a 4-story shophouse construction project can optimize the construction schedule, reduce the project implementation time from 180 days to 89 days, and improve cost and resource efficiency. CPM analysis is able to identify critical paths that are very important for the smooth running of the project, while Microsoft Project plays a role in planning, controlling, and allocating resources in an effective manner. The findings of this study provide practical benefits to the local construction sector and provide academic contributions to the development of project management, especially for medium-scale projects in Indonesia. The findings of this study can be applied more broadly, and it is recommended that local contractors begin to implement the Critical Path Method (CPM) and Microsoft Project in their project planning processes. This implementation can be supported through technical training and guidance to ensure its effective application. Moreover, the role of the government particularly institutions responsible for infrastructure and public works is essential in promoting the adoption of these methods, for example, by integrating them into the standard procedures for construction project execution, especially in public procurement. To ensure long term implementation, civil engineering education institutions can also contribute by incorporating practical training on CPM and Microsoft Project into their curricula, including the use of real-world project case studies. In doing so, graduates will be better prepared for professional challenges, and the local construction sector will benefit from a workforce skilled in technology-based project management.

ACKNOWLEDGEMENTS

The author would like to express his sincere gratitude for all the support, facilities, and opportunities that have been given by the Department of Business Administration and Samarinda State Polytechnic during the process of compiling this journal.

Hopefully this work can provide a positive contribution in the development of scientific insight and become one of the useful references for readers and other researchers who are interested in similar topics. The author also hopes that this journal can be the first step to

encourage further research that is more innovative, relevant, and applicable in accordance with the needs of the world of work and the development of science today.

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