Identifying Critical Tasks In The Kadiri University 4 Floor Building Construction Project Using The Critical Path Method

Mahardi Kamalika Khusna Ali[1*], Hanie Teki Tjendani[2], Budi Witjaksana[3]

[1,2,3] Department of Civil Engineering, Faculty of Engineering, University of 17 August 1945, Surabaya, East Java, 60118, Indonesia
[*]Corresponding Author:
Email: mahardikamalika125@gmail.com

Abstract.

This study aims to identify critical tasks in the construction of a 4-floor building at Kadiri University using the Critical Path Method (CPM). The project is planned to be completed within 43 weeks, from October 2023 to August 2024, with a budget of IDR 20,551,534,000. Data collection involved direct site visits for primary data and secondary data from project documentation, including the Cost Budget Plan (RAB) and project schedule. Using Microsoft Project software, a project network was mapped, and CPM analysis was performed to identify the critical path. The analysis revealed that several tasks, such as site cleaning, demolition, temporary project fencing, heavy equipment work, geotechnical work, and various structural works from the 1st to the 5th floors, are on the critical path. These tasks have zero slack time, indicating that any delays will directly impact the overall project timeline. Identifying the critical path is crucial for project managers to prioritize resources and efforts on these tasks to ensure the project stays on schedule. This study underscores the significance of CPM in project management for timely completion and effective resource allocation, providing valuable insights for managing similar construction projects.

Keywords: *Critical Path Method (CPM), Project Management, Construction Project, Kadiri University and Critical Tasks.*

I. INTRODUCTION

Lecture buildings are an important foundation for academic and social development in the campus environment. Apart from being a place for the teaching and learning process, the lecture building is also a center for interaction between students and lecturers, a place where seminars, discussions and various other academic and non-academic activities take place. With adequate facilities, lecture buildings can support learning to be more effective. Apart from that, the existence of representative lecture buildings is also a reflection of the quality of an educational institution, able to attract the interest of prospective students and support the prestige of the university on a local and global scale. Therefore, the construction of lecture buildings is an important long-term investment for educational progress and intellectual development in society [1].Kadiri University, as the oldest private university in the Kediri Residency, is currently in the process of building a four-story lecture building which is an important milestone in improving educational infrastructure. With awareness of the importance of adequate facilities for academic progress and student learning experiences, the construction of this building is a manifestation of the university's commitment to providing a learning environment that is modern, comfortable and in line with the needs of the times. It is hoped that with this lecture building, the university can increase its capacity in holding various academic activities, increase accessibility for students, and provide facilities that support the development of academic and social potential for the entire campus community [2].

The Kadiri University 4-story lecture building construction project is planned to be completed over 43 weeks, starting in October 2023 to August 2024, with a budget of IDR 20,551,534,000. Based on the latest report in week 25, the project is planned to achieve progress of 53.59%. However, the realization shows that the project progress is only 47.95%, indicating a delay with a deviation of 5.64%. This delay requires immediate action to avoid further losses and correct the lag and accelerate project progress.One of the factors causing delays is the crucial building structure casting process. Delays in this process can cause significant delays in the overall project schedule [3]. Apart from that, unexpected rainfall with high intensity

is also a factor that often disrupts the smooth running of construction projects. Therefore, an effective project management strategy is needed to complete the project on time as planned.To overcome this problem, the Critical Path Method (CPM) can be used to identify the most critical jobs. CPM allows determining the critical path which is a series of tasks that must be completed on time for the project to be completed on schedule [4]. With proper identification of the critical path, the project manager can take the necessary steps to speed up the completion of work on that path and ensure the project does not experience further delays [5].Previous research regarding the application of the Critical Path Method (CPM) method in various construction projects shows significant results in optimizing project scheduling and reducing work duration.

For example, research by [6] on a subsidized housing construction project in Samarinda revealed that implementing CPM could reduce the project duration from 87 days to 78 days. [7] also found that increasing working hours was more cost-effective than increasing labor on the Stroke Center Building construction project. Research by [8] regarding road improvements in Tegal shows that accelerating the project using the Crashing method can reduce implementation time from 45 days to 39 days even though the costs are slightly higher. Research by [9] on the Kutisari 2 Elementary School construction project also shows that crashing can speed up the duration of the project with relatively small additional costs.Other studies demonstrate the effectiveness of CPM in identifying critical paths and controlling project costs and time. [10] applied CPM to a house improvement project in Surabaya and succeeded in reducing the duration from 102 days to 89 days. [11] used CPM to overcome delays in an office building construction project in Pasuruan by adding overtime. Research by [12] on the Pulomas LRT project shows that by implementing CPM and crashing techniques, the project duration can be cut from 90 days to 67 days.

In addition, research by [13] on the construction of the Protected Forest Park Gate in Langsa emphasized the importance of using CPM in estimating costs and project duration more efficiently.Although various studies have demonstrated the effectiveness of CPM methods in identifying critical paths and optimizing project duration, these studies generally focus on construction projects that differ in context and scale. This research still has limitations in its application to educational building construction projects, especially in university environments. This research aims to fill this gap by applying the CPM method to the Kadiri University 4-story building construction project. The novelty of this research lies in its specific focus on higher education projects and in-depth analysis of critical work that has the potential to accelerate project completion, provide practical contributions for project managers in academic settings and expand the application of CPM in more diverse contexts.It is hoped that this research can provide clear guidance for project managers in identifying the most critical work items as well as effective strategies to speed up the completion time for the Kadiri University 4-story building construction project. Apart from providing practical benefits, this research is also expected to contribute new knowledge in the field of construction management and civil engineering, especially in the context of using CPM to manage projects.

II. METHODS

The research location was carried out at Kadiri University, which is located in the western region of Kediri City, East Java, precisely on Jalan Selomangleng No. 01, Pojok Village, Mojoroto District. This research uses a descriptive method with a quantitative approach to identify critical work on the 4-story building construction project at Kadiri University using the Critical Path Method (CPM). This method involves several main stages, namely data collection, data processing, and critical path analysis.In data collection, primary data was obtained through direct visits to the project location to document project progress through photographs. Meanwhile, the secondary data obtained includes the Cost Budget Plan (RAB), project schedule, work volume, work unit weight, and project S curve. The data that has been collected is processed using Microsoft Project software.

The first step is to create a project network planning that maps all activities along with dependencies between activities. Next, a CPM analysis is carried out to identify activities that are on the critical path.The CPM method is used to determine the critical path of a project. The critical path consists of a series of activities that if delayed will delay the completion of the entire project [14]. Identification of the critical path is done by calculating the start and finish time of each activity and determining which activities do not have

time slack (slack). CPM analysis is carried out using forward pass calculations to determine the earliest start time (Earliest Start) and earliest finish time (Earliest Finish) of each activity. After that, a backward pass calculation is carried out to determine the latest start time (Latest Start) and the latest finish time (Latest Finish). From this calculation, slack time can be identified, namely the time allowance that shows how long an activity can be delayed without disrupting the overall project schedule. Activities that have zero slack time are on the critical path [15].

III. RESULT AND DISCUSSION

Based on critical path analysis using the Critical Path Method (CPM) on the Kadiri University 4-story building construction project, it was found that several jobs were on the critical path. Work on the critical path has no slack time, which means any delay in this work will have a direct impact on delays to the entire project. A list of jobs on the critical path along with their start time (Early Start), finish time (Early Finish), latest start time (Late Start), latest finish time (Late Finish), and slack time is shown in Table 1.

Table 1. Critical Path Analysis Results

Work Name	Early Start	Early Finish	Late Start	Late Finish	Slack
Site Cleaning Work	10/9/2023	10/20/2023	10/9/2023	10/20/2023	0
Demolition	10/9/2023	10/27/2023	10/9/2023	10/27/2023	0
Temporary Project Fence	10/23/2023	11/3/2023	10/23/2023	11/3/2023	0
Preparation of RK3K, Employment Insurance and Licensing	10/9/2023	10/20/2023	10/9/2023	10/20/2023	0
Provision of Job Protection Equipment	10/16/2023	11/3/2023	10/16/2023	11/3/2023	0
Provision of Personal Protective Equipment	10/9/2023	11/3/2023	10/9/2023	11/3/2023	0
Heavy Equipment Work	10/16/2023	11/17/2023	10/16/2023	11/17/2023	0
Geotechnical Work	11/27/2023	1/26/2024	11/27/2023	1/26/2024	0
Pilecap Foundation Work	12/11/2023	1/12/2024	12/11/2023	1/12/2024	0
Pile Foundation Work	11/6/2023	12/29/2023	11/6/2023	12/29/2023	0
1st Floor Structural Column Work	1/15/2024	2/9/2024	1/15/2024	2/9/2024	0
1st Floor Structural Beam Work	1/29/2024	2/16/2024	1/29/2024	2/16/2024	0
2nd Floor Structural Column Work	2/19/2024	3/15/2024	2/19/2024	3/15/2024	0
2nd Floor Structural Beam Work	2/26/2024	3/22/2024	2/26/2024	3/22/2024	0
3rd Floor Structural Column Work	3/11/2024	4/5/2024	3/11/2024	4/5/2024	0
3rd Floor Structural Beam Work	3/25/2024	4/19/2024	3/25/2024	4/19/2024	0
4th Floor Structural Column Work	4/22/2024	5/17/2024	4/22/2024	5/17/2024	0
4th Floor Structural Beam Work	5/13/2024	6/7/2024	5/13/2024	6/7/2024	0
5th Floor Structural Column Work	7/1/2024	7/5/2024	7/1/2024	7/5/2024	0
Floor Beam and Floor Plate Work on Floor 5	6/17/2024	7/5/2024	6/17/2024	7/5/2024	0
5th Floor Masonry and Plastering Work	7/15/2024	8/9/2024	7/15/2024	8/9/2024	0
5th Floor Floor and Wall Coating Work	7/29/2024	8/9/2024	7/29/2024	8/9/2024	0
5th Floor Painting Work	7/29/2024	8/9/2024	7/29/2024	8/9/2024	0
Roof Floor Clean Water Installation Work	7/29/2024	8/9/2024	7/29/2024	8/9/2024	0
Roof Floor Rainwater Installation Work	7/29/2024	8/9/2024	7/29/2024	8/9/2024	0

The analysis results displayed are only limited to work that is on the critical path. This is indicated by the slack time value of 0 days. There are 25 jobs that are on the critical path, starting with site cleaning work and ending with rainwater installation work. This means that there is no time allowance available for these works, and any delay will cause delays to the entire project. These jobs cover various stages of construction. The work on the critical path is on average dominated by structural work.Knowing the critical path is critical for project managers because it allows them to prioritize resources and effort on these activities to ensure the project stays on schedule. Implementation of the CPM method has proven effective in identifying the activities that have the most influence on the project schedule. By focusing efforts on these critical jobs, project managers can more effectively manage time and resources, and reduce the risk of project delays.

This is in line with the research objective to provide clear guidance for project managers in identifying and accelerating critical work, as well as managing additional costs arising from project acceleration.Overall, the results of this study confirm the importance of using the CPM method in

construction project management. With a clear understanding of the critical path and effective project acceleration strategies, project managers can be better prepared to meet challenges and ensure that projects are completed within the established schedule and budget. These findings are not only beneficial for the Kadiri University 4-story building construction project, but can also be applied to other construction projects, making significant contributions in the fields of construction management and civil engineering.

IV. CONCLUSION

Activities in the critical path category on the Kadiri University 4th floor building construction project include site cleaning work, demolition, temporary project fences, RK3K preparation, employment insurance and permits, provision of work protection equipment, provision of personal protective equipment, heavy equipment work, earthworks. , Pilecap Foundation Work, Pile Foundation Work, 1st Floor Structural Column Work, 1st Floor Structural Beam Work, 2nd Floor Structural Column Work, 2nd Floor Structural Beam Work, 3rd Floor Structural Column Work, 3rd Floor Structural Beam Work, 4th Floor Structural Column Work , 4th Floor Structural Beam Work, 5th Floor Structural Column Work, 5th Floor Floor Beam and Plate Plate Work, 5th Floor Masonry and Plastering Work, 5th Floor Floor and Wall Coating Work, 5th Floor Painting Work, Roof Floor Clean Water Installation Work, and Roof Floor Rainwater Installation Work. Identification of this critical path helps project managers make more informed decisions regarding resource management and time allocation. In order for projects to be completed on time, project managers can focus efforts on these critical jobs. So through critical path analysis, you can reduce the risk of project delays.

V. ACKNOWLEDGMENTS

The authors would like to express their sincere gratitude to the Department of Civil Engineering, Faculty of Engineering, University of 17 August 1945 Surabaya, for their invaluable support and resources provided during this research. Special thanks to the supervisors, Mrs. Hanie Teki Tjendani and Mr. Budi Witjaksana, who have guided and provided direction so that this research could be realized.

REFERENCES

[1] W. L. Hickman, “Campus Construction for Academic Survival: The Importance of the Curriculum in the College Building Program,” ***J. Higher Educ.,*** vol. 36, no. 6, pp. 322–330, 1965.

[2] R. Jurva, M. Matinmikko-Blue, V. Niemelä, and S. Nenonen, “Architecture and operational model for smart campus digital infrastructure,” *Wirel. Pers. Commun.*, vol. 113, no. 3, pp. 1437–1454, 2020.

[3] M. R. Prayoga, A. Purnomo, and A. Saefudin, “Analisis dan Optimasi Pengelolaan Waktu Pengecoran Struktur Beton pada Proyek Konstruksi: Studi Kasus Keterlambatan Pengecoran Kolom, Balok, dan Plat,**” *J. Pendidik. Tambusai,*** vol. 8, no. 1, pp. 350–358, 2024.

[4] A. F. Enisah, F. Hardiyanti, and A. N. Rachmat, “Analisis Jalur Kritis Pada Pekerjaan Konstruksi Pondasi Menggunakan Metode Critical Path Method (CPM),” in *Conference on Safety Engineering and Its Application*, 2023, vol. 7, no. 1, pp. 354–360.

[5] K. Abuhasel, “Sustainable Green City Development Project Analysis using the Critical Path Method (CPM) and the Crashing Project Method on Time and Cost Optimization,” *Eng. Technol. Appl. Sci. Res.*, vol. 13, no. 3, pp. 10973–10977, Jun. 2023, doi: 10.48084/etasr.5980.

[6] G. R. Rakasyiwi, B. Witjaksana, and H. T. Tjendani, “Project Scheduling Analysis Using the Critical Path Method – Case Study: Subsidized House Construction Project in Hill Mulya Housing, Samarinda City,” ***Int. J. Adv. Technol. Eng. Inf. Syst.,*** vol. 1, no. 4, pp. 73–88, 2022, doi: 10.55047/ijateis.v1i4.480.

[7] N. Sa’adah, E. Iqrammah, and T. Rijanto, “Evaluasi Proyek Pembangunan Gedung Stroke Center (Paviliun Flamboyan) Menggunakan Metode Critical Path Method (CPM) Dan Crashing,” *Publ. Ris. Orientasi Tek. Sipil*, vol. 3, no. 2, pp. 55–62, 2022, doi: 10.26740/proteksi.v3n2.p55-62.

[8] D. Irawan, A. L. Nurdin, A. Khamid, and Y. Feriska, “Model Analisis Pelaksanaan Proyek dengan Metode Critical Path Method (CPM) dan Metode Crashing (Study Kasus pada Pelaksanaan Pekerjaan Peningkatan Jalan Kebandingan – Gembongdadi , Kecamatan Kramat , Kabupaten Tegal) Project Implementation Analysis Mo,” ***Infratech Build. J.***, vol. 1, no. 2, pp. 96–102, 2020.

[9] M. B. Firdaus, H. T. Tjendani, and B. Witjaksana, "Acceleration Analysis Using the Crashing Method in the Sdn Kutisari 2 Development Project," ***Int. J. Adv. Technol. Eng. Inf. Syst.,*** vol. 2, no. 4, pp. 366–375, 2024.

[10] R. Firmansyah Abdulah and W. Handayani, "Analisis Keterlambatan Waktu Pengerjaan Proyek Perbaikan Rumah di Sommerset GF Citraland, Surabaya Menggunakan Metode CPM (Critical Path Method) pada CV Sinar Berkah Utama, Surabaya Jawa Timur," ***Al-Kharaj J. Ekon. Keuang. Bisnis Syariah,*** vol. 5, no. 3, pp. 931–942, 2022, doi: 10.47467/alkharaj.v5i3.1411.

[11] D. Purnomo, W. Oetomo, and R. Marleno, "Analysis Of Project Delay Using The Critical Path Method (CPM): A Case Study On The Construction Project Of The OPD Office Building In Pasuruan," vol. 3, no. 2, pp. 498–508, 2024.

[12] B. Setiawan and Ridwan Usman, "Optimalisasi Penjadwalan Proyek Dengan Menggunakan Metode CPM Di Proyek LRT Pulomas," ***JENIUS J. Terap. Tek. Ind.***, vol. 1, no. 2, pp. 77–87, 2020, doi: 10.37373/jenius.v1i2.52.

[13] T. N. Mulia, Safrizal, and Riny Candra, "Analisis Penjadwalan Proyek Menggunakan Critical Path Method (CPM) Studi Kasus pada Pembangunan Gapura Taman Hutan Lindung Kota Langsa," ***J. Penelit. Ekon. Akunt.,*** vol. 7, no. 1, pp. 82–90, 2023, doi: 10.33059/jensi.v7i1.7731.

[14] F. M. Azhari, A. I. Candra, D. A. Karisma, A. Yamin, and F. Rahmawaty, "Accelerate the Implementation Time of Kadiri University Clinic Constructions Projects Using Critical Path Method (CPM)," in *E3S Web of Conferences*, 2021, vol. 328, p. 10001.

[15] H.-H. Yang and Y.-L. Chen, "Finding the critical path in an activity network with time-switch constraints," ***Eur. J. Oper. Res.,*** vol. 120, no. 3, pp. 603–613, 2000.