

COST ANALYSIS OF THE CONSTRUCTION PROJECT FOR THE MALAKA REGENCY OFFICE BUILDING USING THE CRITICAL PATH METHOD (CPM)

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ABSTRACT

Efficient construction project management is crucial to ensure quality and timely completion within budget constraints, especially for large-scale infrastructure projects. This study examines the application of the Critical Path Method (CPM) in accelerating the construction schedule of the Malaka Regency Regent's Office. The project faced various challenges, including frequent delays caused by design changes, unpredictable weather conditions, labor shortages, and inadequate material or equipment supply. These challenges often disrupted the progress and efficiency of the project, necessitating an effective solution to mitigate potential time and cost overruns. To address these issues and align project progress with the original plan, CPM was utilized to identify critical paths, eliminate lag times, and optimize the overall project schedule. Using CPM analysis and Microsoft Project 2019 software, the project's original duration of 180 calendar days was successfully reduced to 100 calendar days. This acceleration was achieved by streamlining interdependencies between critical activities and optimizing work schedules without increasing project costs. The findings highlight the significant role of CPM in achieving time savings while maintaining the planned budget of IDR 94.59 billion. Moreover, this study demonstrates that proper scheduling, coupled with optimization techniques, can significantly enhance the efficiency and effectiveness of construction projects. These results underscore CPM's potential as a valuable tool for project managers to ensure timely completion without compromising quality or incurring additional costs. This research contributes to the growing body of knowledge in construction project management and offers practical insights for managing similar projects in the future.

Keywords: Construction Scheduling, Critical Path Method, Project Cost Management

INTRODUCTION

In the implementation of construction work, in addition to attention to quality, effective cost management is also an important aspect. A construction project as a temporary activity requires proper allocation and utilization of resources to achieve the target within the set budget (ASMI, 2019).

The increasing number of construction projects in various regions, including Malacca Regency, often faces challenges in cost management. Inadequate scheduling, the use of poorly conditioned equipment and the shortage of human resources (workers) can increase costs and extend the time in implementing the work of a project (ASMI, 2019).

Project management is a technique used to plan, perform, and control the activities of a project to meet project time and cost constraints. The technique is goal-oriented, where the goal may be the construction of a building, the opening of a new

office, or the control of research and development activities (Victor & Simanjuntak, 2021). Good project management is a key factor in ensuring the success of vital infrastructure projects (Wahananto, Witjaksana, Patriadi, 2024).

Construction work is highly dependent on several resources in its implementation consisting of materials, labor, costs, implementation methods and equipment. In the era of globalization, construction development is growing faster and accompanied by a variety of construction implementation methods that affect the cost and time of project completion (Lokajaya, 2019b). The Malacca Regency Regent's Office Construction Project faced similar challenges. Although the schedule has been prepared, in practice in the field, problems still often arise in the construction process, namely frequent delays in project completion. The causes of delays that often occur are due to design changes, weather factors, labor requirements, inadequate materials or equipment, planning errors or specifications (Klau, Sajiyo, Tjendani, 2024). In addition, the need to accelerate project completion can also lead to increased costs. This shows the importance of cost analysis to determine the financial implications of project acceleration.

This research focuses on analyzing the cost required to complete the Malaka Regency Regent Office Construction project and estimating the financial impact of the acceleration strategy using the Critical Path Method (CPM). Based on the background, the formulated problem is: how much will it cost to complete the project? Accordingly, the objective of this study is to analyze the implementation cost of the Malaka Regency Regent Office Construction project.

METHOD

Research Subject

The subject of this research is the construction project of the Malacca Regent's office - Jalan Sukabi Hanawa, Kamanasa Village, Kec. Malaka Tengah, Kab. Malacca.

Location and Time of Research

The research location is Jalan Sukabi Hanawa, Kamanasa Village, Kec. Malaka Tengah, Kab. Malaka, the effective research time is approximately 3 weeks.

Data

The data used in this research is secondary data obtained from the Malacca Regency Cipta Karya Office, in the form of RAB, Time Schedule and S-Curve data, while primary data is obtained from the results of direct unstructured interviews with the Project Manager of PT TURELOTO BATTU INDAH. For primary data, in addition to direct unstructured interviews, researchers also participated directly in the implementation of the scope of work of the construction of the new building of the Regent's Office of Malacca Regency.

The main data required for this research are Schedule and S curve of project implementation plan, Monthly Report, Direct Cost Calculation and Indirect Cost, employee salary data, operator labor wages and others / real data from contractors and not assumptions.

Data Analysis Technique

The analysis method used in this research is the Critical Path Method (CPM), using a single duration estimate approach or a single time estimate for each activity. The CPM method has been widely used on large projects, there are many work items, it is necessary to break down their interdependence to facilitate the control of Critical Trajectories as the main activities that cannot be late, it is necessary to control the implementation time so that the project is completed on time, at the right cost, at the right quality and in an orderly administration. CPM is widely known as a project control method with critical trajectory control.

RESULTS AND DISCUSSION

Recapitulation of Duration Requirements for Each Type of Work

The duration of each type of work is obtained from the S-curve of the construction of the Malaka Regent's Office building, there are 4 types of work groups, namely the main building work (Malaka Regent's Office), staff office building 1, staff office building 2, and complementary work. The total duration allocation according to the contract is 760 calendar days, which will be presented in tabulated form.

Table 1. Recapitulation of Total Price and Duration of Each Type of Work

| No | JOB Description | Amount of Price (RP) | Duration |
|--|---|-------------------------|-----------|
| I. Main Building (Malaka Regent Office) | | | |
| A. | Preparatory Work | 442.568.147,14 | 60 |
| B | Main Building Structure Works | 20.634.607.229,16 | 180 |
| C | Main Building Architectural Works | 21.413.688.182,02 | 50 |
| D | Mechanical, Electrical and Plumbing Works of Main Building | 7.822.587.485,01 | 50 |
| A. | Staff Building Structure Work 1 | 7.413.569.331,65 | 40 |
| B | Architectural Works of Staff Building 1 | 4.858.283.676,52 | 40 |
| C | Mechanical, Electrical and Plumbing Works of Staff Building 1 | 2.087.269.593,80 | 40 |
| A. | Staff Building Structure Work 2 | 7.185.493.295,30 | 40 |
| B | Architectural Works of Staff Building 2 | 4.792.790.169,38 | 40 |
| C | Mechanical, Electrical and Plumbing Works of Staff Building 2 | 1.619.278.904,24 | 50 |
| A. | Connecting Hallway Work | 9.400.112.511,19 | 40 |
| B | Landscape Work | 6.333.663.185,90 | 50 |
| C | Power House Work | 485.021.557,79 | 40 |
| D | Guard Post Building Work | 127.395.458,31 | 40 |
| SUB TOTAL | | 85.216.216.216,2 | 2 |
| 11% TAX | | 9.373.783.783,78 | |
| TOTAL | | 94.590.000.000,0 | 0 |

Creating Network Planning Curve Based on CPM Method Plan S-Curve

The S-curve of the plan from secondary data is not yet in the form of *Network Planning* so that it cannot provide information on the dependency between jobs and *the critical path* is not yet known. By using Microsoft Project 2019 software, scheduling in the form of *Network Planning* (in full in the attachment) with the following provisions:

- a. Scheduling using reference : Project Star Date
- b. Hours per day of project work : 8 hours
- c. Number of days per week : 7 days
- d. Hours per week : 56 hours
- e. Number of days per month : 30 days (calendar days)
- f. Determining predecessors :

Table 2. Details of Predecessors of each type of work

| Task Name | Duration | Start | Finish | Predecessors |
|---|-----------------|--------------------------|-------------------------|-----------------|
| CONSTRUCTION OF THE MALAKA REGENCY OFFICE | 1 day? | Monday, 12/09/22 | Monday, 12/09/22 | |
| MAIN BUILDING (MALAKA REGENCY OFFICE) | 230 days | Tuesday, 06/09/22 | Monday, 24/07/23 | |
| Preparation work | 60 days | Monday, 12/09/22 | Friday, 02/12/22 | |
| Structural work of the Main Building | 180 days | Tuesday, 06/09/22 | Monday, 15/05/23 | 3SS-4 days |
| Architectural work of the Main Building | 50 days | Monday, 05/12/22 | Friday, 10/02/23 | 3;4SS |
| Mechanical, Electrical, and Plumbing work of the Main Building | 50 days | Tuesday, 16/05/23 | Monday, 24/07/23 | 3;5 |
| STAFF OFFICE BUILDING 1 | 80 days | Tuesday, 25/07/23 | Monday, 13/11/23 | |
| Structural work of Staff Office Building 1 | 40 days | Tuesday, 25/07/23 | Monday, 18/09/24 | 3;4;6 |
| Architectural work of Staff Office Building 1 | 40 days | Tuesday, 19/09/23 | Monday, 13/11/23 | 3;4;6;8 |
| Mechanical, Electrical, and Plumbing work of | 40 days | Tuesday, 19/09/23 | Monday, 13/11/23 | 3;4;8;9SS-7days |

| | | | | |
|---|-----------------|--------------------------|-------------------------|---------------------------------|
| Staff Office Building 1 | | | | |
| STAFF OFFICE BUILDING 2 | 90 days | Tuesday, 14/11/23 | Monday, 18/03/24 | |
| Structural work of Staff Office Building 2 | 40 days | Tuesday, 14/11/23 | Monday, 08/01/24 | 8;9;10SS |
| Architectural work of Staff Office Building 2 | 40 days | Tuesday, 14/11/23 | Monday, 08/01/24 | 8;9;10;12SS |
| Mechanical, Electrical, and Plumbing work of Staff Office Building 2 | 50 days | Tuesday, 09/01/24 | Monday, 18/03/24 | 8;9;10;12;13SS |
| SUPPLEMENTARY WORKS | 376 days | Monday, 12/09/22 | Monday, 08/07/24 | |
| Connecting Corridor work | 40 days | Tuesday, 19/03/24 | Monday, 13/05/24 | 3;4;5;6;8;9;10;12;13;14 |
| Landscape work | 50 days | Monday, 12/09/22 | Friday, 18/11/22 | 3SS |
| Powerhouse work | 40 days | Tuesday, 14/05/24 | Monday, 08/07/24 | 3;4;5;6;8;9;10;12;13;14;16;17SS |
| Guard Post work | 40 days | Monday, 12/09/22 | Friday, 04/11/22 | 3SS |

Creating Network Planning

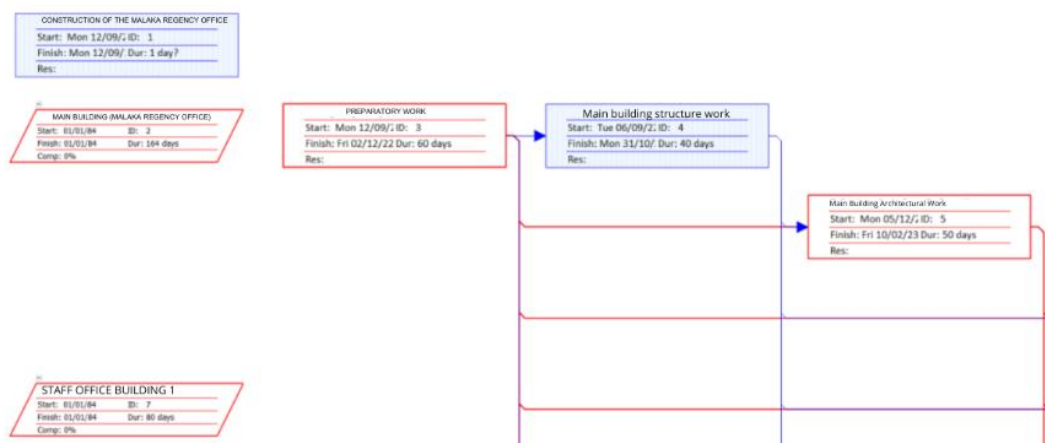


Figure 1. Network Diagram using Microsoft Project 2019

Creating Network Planning Based on S-Curve Plan

After Network Planning is made, the work and critical path can already be known. Using Microsoft Project 2019 software can present a complete *critical path*.

Table 3. Network Planning Critical Path Output

| Name | Start | Finish | % Complete | Remaining Work |
|--|--------------|--------------|------------|----------------|
| Preparation work | Mon 12/09/22 | Fri 02/12/22 | 0% | 0 hrs |
| Structural work of the Main Building | Tue 06/09/22 | Mon 15/05/23 | 0% | 0 hrs |
| Mechanical, Electrical, and Plumbing work of the Main Building | Tue 16/05/23 | Mon 24/07/23 | 0% | 0 hrs |
| Structural work of Staff Office Building 1 | Tue 25/07/23 | Mon 18/09/23 | 0% | 0 hrs |
| Architectural work of Staff Office Building 1 | Tue 19/09/23 | Mon 13/11/23 | 0% | 0 hrs |
| Structural work of Staff Office Building 2 | Tue 14/11/23 | Mon 08/01/24 | 0% | 0 hrs |
| Mechanical, Electrical, and Plumbing work of Staff Office Building 2 | Tue 09/01/24 | Mon 18/03/24 | 0% | 0 hrs |
| Connecting Corridor work | Tue 19/03/24 | Mon 13/05/24 | 0% | 0 hrs |
| Powerhouse work | Tue 14/05/24 | Mon 08/07/24 | 0% | 0 hrs |

From the results of the analysis using Microsoft Project 2019, it is found that the types of work that are on the critical trajectory are

Table 4. Details of predecessors of each type of work

| No. | Jobs | Duration |
|-----|-------------------------|----------|
| 1 | Main Building Structure | 180 Days |

Accelerating 180 Calendar Days to 100 Calendar Days

After knowing the work that is on the Critical Path, the work is accelerated from 180 calendar days (6 months) to 100 calendar days (3.1 months). By using Microsoft Project 2019 software, in accelerating the work as follows:

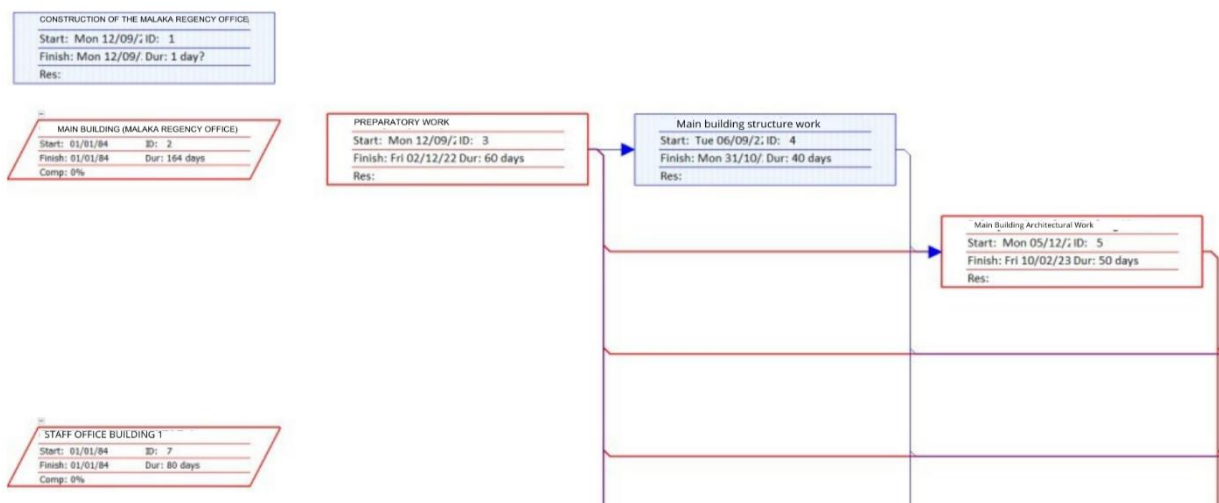


Figure 2. Network planning acceleration using Microsoft Project 2019

Details of Discussion on Accelerating 180 Calendar Days to 100 Calendar Days

Details of the acceleration of work from the plan for 180 calendar days (26 weeks) to 100 calendar days (14 weeks), the discussion steps carried out as follows (in full will be submitted in the attachment)

Table 5. Details of work predecessors

| Task Name | Duration | Start | Finish | Predecessors |
|---|----------|--------------|--------------|-------------------------|
| CONSTRUCTION OF THE MALAKA REGENCY OFFICE | 1 day? | Mon 12/09/22 | Mon 12/09/22 | |
| MAIN BUILDING (MALAKA REGENCY OFFICE) | 164 days | Tue 06/09/22 | Fri 21/04/23 | |
| Preparation work | 60 days | Mon 12/09/22 | Fri 02/12/22 | |
| Structural work of the Main Building | 100 days | Tue 06/09/22 | Mon 23/01/23 | 3SS - 4 days |
| Architectural work of the Main Building | 50 days | Mon 05/12/22 | Fri 10/02/23 | 3;4;5SS |
| Mechanical, Electrical, and Plumbing work of the Main Building | 50 days | Mon 13/02/23 | Fri 21/04/23 | 3;4;5 |
| Staff Office Building 1 | 80 days | Mon 24/04/23 | Fri 11/08/23 | |
| Structural work of Staff Office Building 1 | 40 days | Mon 24/04/23 | Fri 16/06/23 | 3;5;6 |
| Architectural work of Staff Office Building 1 | 40 days | Mon 19/06/23 | Fri 11/08/23 | 3;4;6;8 |
| Mechanical, Electrical, and Plumbing work of Staff Office Building 1 | 40 days | Mon 19/06/23 | Fri 11/08/23 | 3;4;8;9SS-7 days |
| Staff Office Building 2 | 90 days | Mon 14/08/23 | Fri 15/12/23 | |
| Structural work of Staff Office Building 2 | 40 days | Mon 14/08/23 | Fri 06/10/23 | 8;9;10SS |
| Architectural work of Staff Office Building 2 | 40 days | Mon 14/08/23 | Fri 06/10/23 | 8;9;10;12SS |
| Mechanical, Electrical, and Plumbing work of Staff Office Building 2 | 50 days | Mon 09/10/23 | Fri 15/12/23 | 8;9;10;12;13SS |
| SUPPLEMENTARY WORKS | 410 days | Mon 12/09/22 | Fri 05/04/24 | |
| Connecting Corridor work | 40 days | Mon 18/12/23 | Fri 09/02/24 | 3;4;5;6;8;9;10;12;13;14 |
| Landscape work | 50 days | Mon 12/09/22 | Fri 18/11/22 | 3SS |
| Powerhouse work | 40 days | Mon 12/09/22 | Fri 05/04/24 | 3;4;5;6;8;9;10;12;13 |
| Guard Post work | 40 days | Mon 12/09/22 | Fri 04/11/22 | 3SS |

Effect of acceleration on cost

From the results of the acceleration using CPM, the acceleration from 180 calendar days to 100 calendar days does not require additional costs, because

efficiency is carried out on working time without changing the direct costs of the project. So that the total cost of building the regent's office of Malacca district of Rp 94,590,000,000.00 is the same as the initial design without acceleration.

CONCLUSION

Based on the analysis conducted, it can be concluded that the total cost of the Malacca Regent's Office construction project, amounting to Rp 94,590,000,000.00, remains unchanged despite the acceleration using the Critical Path Method (CPM), as there is no alteration in the project's direct costs. From these findings, several suggestions are proposed: future researchers are encouraged to explore alternative acceleration methods beyond CPM, incorporate elements of work implementation techniques rather than focusing solely on project duration, and consider utilizing different software tools aside from Microsoft Excel and Microsoft Project to enhance analysis and project simulation accuracy.

REFERENCES

- Asmi, N. (2019). "Analisis Pengendalian Biaya Dan Waktu Pada Perbaikan "Analisis Pengendalian Biaya Dan Waktu Pada Perbaikan Rekontruksi Jalan Metropolitan Makassar ". *Jurnal Teknik Sipil*, P.1-30.
- Fauzi, M. F. (3 September 2024). Analisa Penjadwalan Proyek Menggunakan Cpm Dan Pert Pada Proyek Pembangunan Gedung Koni Jakarta Pusat. *Jurnal Teknik Dan Teknologi Indonesia*, Vol. 2 .
- Hendriyani, I. (2023). Penerapan Metode Cpm Dan Pert Pada Penjadwalan Proyek Pemasangan Pipa Di Perumahan Graha Wiyata Asri Balikpapan. *Jurnal Transukma*, 236-242.
- Lokajaya, I. N. (2019). Analisis Pengendalian Waktu Dan Biaya Pada Proyek Peningkatan Jalan Dengan Metode Cpm Dan Pert. *Jurnal Teknik Industri*, Vol. 16 No. 2, Hal. 104-125.
- Marwan1, A. ((2024)). Optimasi Waktu Pelaksanaan Pada Manajemen Proyek Pembangunan Gedung Poltekkes Jurusan Farmasi Tahap 1 Dengan Metode Cpm Dan Pert . *Journal Of Industrial Engineering Tridinanti*, Volume 02, Nomor 01.
- Klau, M. J., Sajiyo, Tjendani, H. T. (2024). Time Acceleration Analysis Using The Time Cost Trade Off Method On The Wheat Silo And Pellet Silo Structure Repair Project Phase Iii In Surabaya. *International Journal On Advanced Technology, Engineering, And Information System(Ijateis)*, Volume 3, No. 3, Hal 385-395, 2024.
- Sutrisno. (April 2023). Implementasi Metode Cpm, Crashing Dan Pert Pada Penjadwalan Proyek Pembangunan Masjid Dan Asrama Yatim Piatu Barokah Amanah Mustaqbal. *Jurnal Serambi Engineering*, Volume Viii, No.2 Hal 5390 - 5400.

- Suwarno, E. (2024). Analisis Evaluasi Manajemen Waktu Dan Biaya Menggunakan Metode Cpm, Pert, Dan Tcto Pada Pelaksanaan Lapis Pondasi Atas (Lpa) Proyek Jls Lot 6 Tulungagung—Trenggalek. *Jurnal Inovasi Teknologi Dan Edukasi Teknik*, 10.17977/Um068.V4.I7.2024.
- Victor. (2021). Analisis Manajemen Biaya Proyek Pada Proyek Konstruksi Di Tangerang. *Prosiding Ceedrims*, 978-602-361- 385-4 .
- Wahananto, A., Witjaksana, B., Patriadi, A. (2024). Analisis Sistem Penyediaan Air Bersih Kampung Kasai Kecamatan Pulau Derawan Kabupaten Berau. *Jurnal Teknika (Jurnal Fakultas Teknik Universitas Islam Lamongan)*, Vol. 16, No. 2, Hal. 113-118.
- Yuwono, W. (Agustus 2021). Kajian Metode Pert-Cpm Dan Pemanfaatannya Dalam Manajemen Waktu Dan Biaya Pelaksanaan Proyek. *Journal Of Economic, Management, Accounting And Technology (Jematech)*, Vol. 4, No. 2 2622-8122.