



Optimization of patane toraja construction implementation time using critical path method

Putri Sumbung¹, Adila Aisyah Putri², Surahman³

^{1,2,3} Business Administration, Samarinda State Polytechnic, Indonesia

ARTICLE INFO

Article history:

Received May 26, 2025

Revised Jun 02, 2025

Accepted Jun 17, 2025

Keywords:

Critical Path Method;

Project Management;

Patane;

Time.

ABSTRACT

One of the main challenges in the development of Patane is the lengthy implementation time due to a lack of structured and efficient time planning. This research focuses on streamlining the time needed to construct Patane, a traditional burial site of the Torajan people, by utilizing the Critical Path Method (CPM) in combination with Microsoft Project and QM for Windows software.

This study aims to optimize the duration of the Patane development project by using a systematic time management approach. A descriptive quantitative methodology was used to evaluate six interconnected phases of the project, ranging from initial preparation to the final touches. The findings indicated that every activity in the project is part of the critical path, with a total float of zero, leading to an overall project timeline of 84 days. This study underscores the importance of time management tools in culturally focused construction endeavors that encompass intricate social and spiritual aspects. Implementing CPM allows for more organized, effective, and precise project planning and execution, while respecting the cultural values of the Torajan community..

This is an open access article under the [CC BY-NC](https://creativecommons.org/licenses/by-nc/4.0/) license.



Corresponding Author:

Putri Sumbung,

Departement of Business Administration,

Samarinda State Polytechnic,

Cipto Mangun Kusumo Street, Sungai Keledang, Samarinda City, 75133, Indonesia

Email: putrisumbung@gmail.com

INTRODUCTION

In the modern construction world, project time management is one of the main pillars of successful project implementation. Delays in construction projects not only affect cost overruns, but also the reputation and quality of the final results (Sebastian & Jin, 2025). Therefore, methods such as the Critical Path Method (CPM) are very important in identifying activity paths that determine the total duration of the project (Muhammad et al., 2021; Saputra et al., 2024). The application of this method is increasingly popular as project complexity and the need for data-based decision-making increase.

The application of CPM is supported by advances in information technology, especially project management software such as Microsoft Project, which is able to visualize relationships between activities, calculate critical path durations, and monitor project progress dynamically and measurably (Haq, 2025). This makes CPM not only popular among professional project managers,

but also increasingly used in the civil engineering education and research sectors (Danniyanti, 2010; Sugiyarto et al., 2013; Surahman, Kusumah, et al., 2024).

However, currently there is still very little research exploring the application of CPM in culture based construction projects that have complex social and spiritual dimensions (Husna et al., 2022; Rembulan & Yuhao, 2023). Projects such as the construction of Patane a traditional Toraja tomb have unique characteristics that differ from conventional construction projects (Sarunan, 2023). In addition to technical aspects, the construction of Patane involves a series of traditional ceremonies whose timing has been determined by social norms and community beliefs (Markus, 2022; Milkia, 2023). Some of the most common obstacles in Patane construction include delays caused by the coordination of ceremonial schedules, the availability of traditional leaders, and the alignment of family members' presence, especially for those living outside the Toraja region (Resti et al., 2024). These delays are often compounded by logistical challenges and material availability in remote or culturally preserved areas.

For the Torajan diaspora community, such as those living in Bontang, East Kalimantan, there is a certain degree of flexibility in choosing the timing of rituals. However, many still adhere to traditional calendars and consult with elders or family in their hometowns to ensure that cultural protocols are maintained. Inaccuracy of time can disrupt the implementation of sacred traditional rituals. This shows that delays in projects like this are not just technical issues, but also have an impact on the cultural values of the community (Apriliani, 2024).

The urgency of time efficiency in culture-based projects such as Patane development can be quantitatively demonstrated by comparing the Time Cost Trade-Off (TCTO) analysis and delay sensitivity index between conventional and culture-based projects. For instance, while delay in a conventional project may lead to direct financial penalties, in culture-based projects it may additionally incur the intangible costs of cultural disruption, which can be quantified through multi-criteria analysis incorporating community engagement metrics and ritual-based time windows (Eyiah et al., 2025; Kadang et al., 2024). These comparisons indicate that culture-based projects are often less tolerant to delays due to fixed ceremonial schedules, making CPM application not only a managerial tool but a necessity.

Based on this gap, this study aims to apply the CPM using Microsoft Project as a tool in managing the time of culture-based construction projects. This approach is expected to be able to present an efficient scheduling model that is in line with local values. Thus, construction practices based on traditional wisdom can be enriched methodologically and practically. This research focuses on the Patane construction project by the Torajan diaspora community living in Bontang, East Kalimantan.

According to Daulay et al. (2022) a project is a form of non routine business activity, has certain time, budget, and resource limitations, and is intended to produce output with special characteristics. To ensure that the project is implemented efficiently, on time, and in accordance with established quality standards, a structured and directed project organization is needed. Meanwhile Belferik et al. (2023) argue that a project is an activity or effort that is temporary in nature, with an implementation time that has been determined from the start. Although the time frame is limited, the results produced from the implementation of the project have the potential to have a significant and sustainable impact on the development of the company.

Based on the opinion put forward by Kartini et al. (2022) project management is a series of activities that include planning, scheduling, and organizing projects consisting of several activities or activities. Other experts such as Mar'aini & Akbar (2022) argue that project management is a systematic process that includes the use of various tools, resources, and certain methods to achieve the goals that have been formulated. Activities in project management include the stages of planning, organizing, implementing, and controlling in an integrated and structured manner.

According to Huda & Prasinta (2024) CPM is a network-based approach used to analyze the linear relationship between project time and cost. By identifying the costs of each activity, this method

allows for the acceleration of the completion of a number of activities from the normal duration that has been previously designed. Another opinion put forward by Saputra et al. (2024) CPM is a series of activities that function to identify the longest duration required to complete the entire project, so that it becomes the main reference in managing project time efficiently.

RESEARCH METHOD

This applied research uses a quantitative descriptive approach. Statistical analysis called quantitative descriptive is used to describe, summarize, and analyze quantitative data. Quantitative data is data that can be measured or calculated using numbers, such as age, weight, and height (Sudirman et al., 2023). This method was chosen because it is able to describe the activities of the Patane Toraja development project systematically and measurably, especially related to planning time using the CPM. CPM explains each activity, previous activity, activity time or normal time, and cost. This method is used to collect the data needed to create a work network (Astari et al., 2022; Utomo et al., 2020).

The quantitative descriptive method was chosen over other simulation or optimization methods because it allows for a straightforward, measurable, and systematic description of project activities, which is particularly suitable for cultural projects such as the Patane Toraja development. Cultural construction projects often involve unique, sequential, and context-specific tasks that are best captured through descriptive data collection and analysis rather than complex simulations or optimization models. Furthermore, the focus of this research is not to optimize cost or resources through mathematical modeling but to understand and illustrate the critical paths in project scheduling using real, observed data. This makes the quantitative descriptive method ideal, as it supports practical project documentation and planning, especially when using tools like the Critical Path Method (CPM) in Microsoft Project (Athira et al., 2021; Fernandes et al., 2024; Zunaidah et al., n.d.)

This research was conducted in Bontang, East Kalimantan, on the Patane Toraja development project. The project lasted for 90 days, starting from the preparation stage and ending at the finishing stage. Two methods were used to collect project data; direct interviews with project owners to find out about the stages of work being carried out; and project documentation, which includes a list of activities, work duration, and dependency relationships. The interviews produced structured data consisting of activity names, estimated durations, predecessor activities, and any constraints related to tradition or logistics. Although the six main stages preparation, foundation, pillars, walls, roof, and finishing are generally followed, the specific implementation of each stage can vary depending on regional customs, family traditions, and construction location.

To investigate the critical path of the project, each activity is analyzed based on its duration and the order of its dependency on other activities. External variables such as weather conditions, traditional prohibition days, and pre-scheduled ritual ceremonies were considered by adding buffer times to certain activities and adjusting sequence flexibility where required.

The calculation analysis in this study was carried out using Microsoft Project software. The Microsoft Project application functions to find out and identify critical paths and activities of work items, based on data obtained through interviews (Do'o et al., 2024). In this study, the CPM method was chosen because of its advantage in identifying tasks that most affect project completion time. By knowing the critical path, project managers can allocate resources, set priorities, and speed up work if necessary. This is expected to increase the overall effectiveness and efficiency in project implementation. QM for Windows was also used to perform cross-verification of network calculations generated in Microsoft Project. It helped confirm earliest and latest start times, floats, and overall project duration to ensure data accuracy and consistency.

RESULTS AND DISCUSSIONS

Activity Process Overview Project

Implementation development Toraja's Patane in progress for 90 days with involving three workers. All need material core building such as sand, cement and wood has prepared by the owner project before work started (Surahman, Saputri, et al., 2024). Meanwhile, some work tools are brought by the workers according to the needs in the field. The data in this study were obtained through face-to-face interviews with the project owner to gain a comprehensive understanding of the construction activities carried out (Perdana & Sari, 2022).

Table 1 contains related data activities carried out in project development patane toraja, started from stage preparation until stage settlement end (finishing).

Table 1. Order Activities in Patane Toraja Project

No	Job Name	Code	Preliminary Work	Duration (Days)
1	Preparation	A	-	4
2	Foundation work	B	A	12
3	Pole Work	C	B	12
4	Wall Work	D	B, C	30
5	Roofing Work	E	D	12
6	Finishing Work	F	E	14

Source: Processed Data (2025)

Based on Table 1, the results of the outer loadings test show that all indicators have values above

Completion Critical Path Method (CPM)

Calculation CPM used for planning and arranging timetable various activity in a project (Angelin & Ariyanti, 2019). Table 2 shows data regarding Early Start (ES), Early Finish (EF), Late Start (LS), Late Finish (LF) of each activity.

Table 2. Calculation CPM

No	Work	Duration	ES	EF	LS	LF
1	A	4	0	4	0	4
2	B	12	4	16	4	16
3	C	12	16	28	16	28
4	D	30	28	58	28	58
5	E	12	58	70	56	70
6	F	14	70	84	70	84

Source: Processed Data (2025)

Table 2 presents results calculation critical path which includes elements ES, EF, LS, and LF, which are related close with acceleration and also delay in settlement an activity. Stages next is create a network diagram work project development patane Toraja based on the list of activities that have been determined previously. This process started with make network activities and input duration of each job.

Network diagram Work For every stage construction the Then visualized as shown in Figure 1.

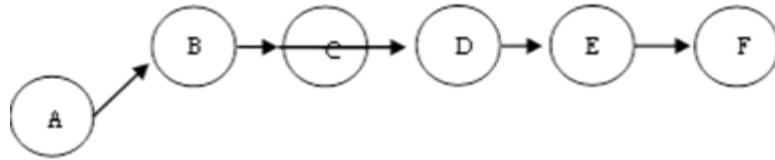


Figure 1. Network Diagram Work

After design and understand structure network work, Next steps make network Work with count track critical use method calculation proceed for get ES and EF values. After that, continued with calculation step back for get LS and LF values, can see in table 2.

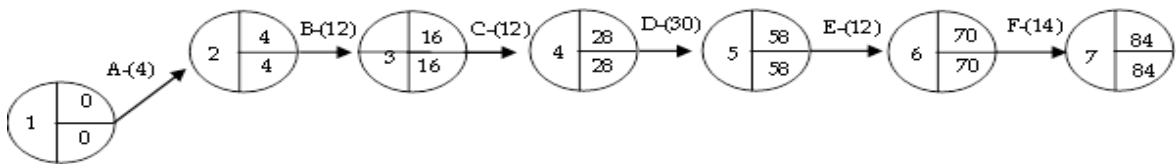


Figure 2. Forward and Backward Calculation Network

After determine track critical as well as to obtain results calculation forward and calculation step back, step furthermore is calculated total float with use formula following:

Total Float = LF - EF or LS - ES

Following is results Calculation of total float for each activity:

- TF(A) = 4 - 4 = 0 (critical)
- TF(B) = 16 - 16 = 0 (critical)
- TF(C) = 28 - 28 = 0 (critical)
- TF(D) = 58 - 58 = 0 (critical)
- TF(E) = 70 - 70 = 0 (critical)
- TF(F) = 84 - 84 = 0 (critical)

The total float values of zero in all activities indicate that each task is on the critical path, and therefore, any delay in one of these activities will directly delay the entire project. This condition shows that the project has no scheduling flexibility on its critical path. In other words, there is no buffer time to accommodate unforeseen delays without impacting the project's completion time. Calculation results forward and backward that has used for determine the total float, then arranged to form network track critical that can see in the picture following:

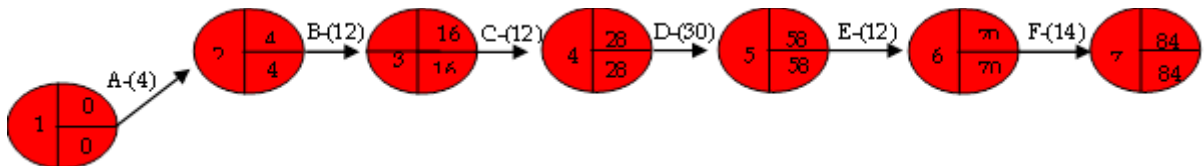


Figure 3. Critical Path

Based on Figure 3, can identified track critical in project development consisting of from activity A (preparation), B (foundation work), C (pole work), D (wall work), E (roof work), and F (finishing work). Total duration required for finish project based on results calculation track critical is 84 days, which is obtained from summation duration of each activity (4 + 12+ 12 + 30 + 12 +14).

To assess the accuracy of the CPM results, the estimated durations for each activity were compared with the actual implementation times recorded in the field during the 90-day project. Interviews and field observations indicated that while most activities closely matched the CPM estimates, some activities, such as wall work (D) and finishing work (F), experienced minor delays

due to unforeseen conditions (e.g., weather and material availability). However, these delays did not significantly affect the overall project duration, which was completed in approximately 90 days, slightly longer than the 84 days predicted by CPM. This suggests that while CPM provides a reliable baseline for project scheduling, allowances for float and contingency should be considered in real-world applications.

CPM Processing Using QM for Windows

Calculation with CPM method does not only can done manually, but also can completed with more efficient use help device soft like QM for Windows (Perdana & Sari, 2022).

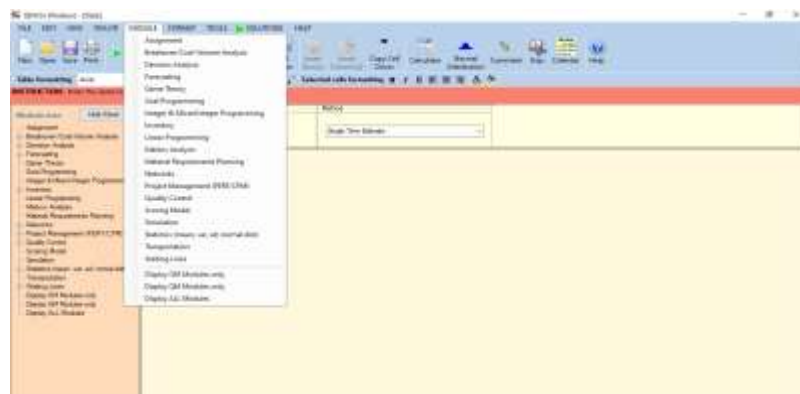


Figure 4. QM for Windows Module

Initial step in use application QM for Windows shown in Figure 4, namely with choose module special for calculation project. After module selected, stage furthermore is made or define project new, as shown in Figure 5.

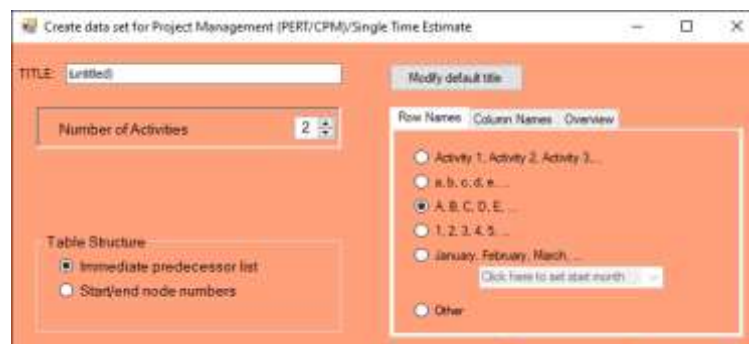


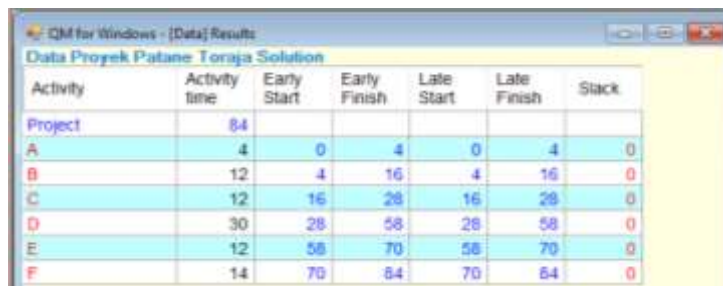
Figure 5. Creating a New Project

Activity	Activity type	Predecessor 1	Predecessor 2	Predecessor 3	Predecessor 4	Predecessor 5	Predecessor 6	Predecessor 7
A	4							
B	12	A						
C	12	B						
D	30	B	C					
E	12	D						
F	14	E						

Figure 6. CPM Method Data Input

Figure 6 shows stage activity data filling projects, which include type job, code or symbol activity, activity predecessors, as well as duration its implementation. After all data is entered, step furthermore is operated calculation automatic with select the solve menu on the menu bar. This

process will produce table calculation project. Figures 7 and 8 show the final output. from analysis track critical path obtained through application QM for Windows.



Activity	Activity time	Early Start	Early Finish	Late Start	Late Finish	Stack
Project	84					
A	4	0	4	0	4	0
B	12	4	16	4	16	0
C	12	16	28	16	28	0
D	30	28	58	28	58	0
E	12	58	70	58	70	0
F	14	70	84	70	84	0

Figure 7. CPM Method Calculation Results

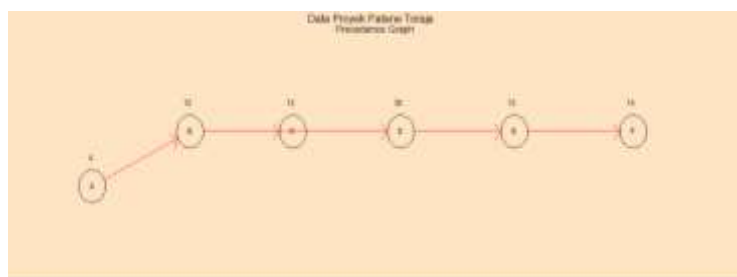


Figure 8. Network Diagram Calculation QM for Windows

Based on the results of data processing, the critical path in the Patane Toraja development project in Bontang covers nodes 1 to 6, which are consistent between manual CPM calculation and the QM for Windows application. Both methods confirmed that all activities lie on the critical path, each with zero total float. This means that rescheduling or delaying any task on this path will postpone the project completion date, reinforcing the need for strict time management and monitoring of each critical activity.

CONCLUSION

This study shows that the CPM method with the help of software such as Microsoft Project and QM for Windows can assist in managing time for construction projects based on culture, such as the development of Patane Toraja in Bontang. By identifying the critical path which includes six main tasks from preparation to project completion scheduling becomes more systematic, efficient, and accurately monitored. Calculation results show that all activities are included in the critical path, and the project proceeds for 84 days without any float time (total float = 0). This indicates that every activity plays an important role in the overall completion of the project. The CPM method has proven not only suitable for technical projects but also relevant and adaptive for culturally based projects with complex social and spiritual dimensions. To replicate these findings for other culture-based projects in Indonesia that include ritualistic activity structures, it is essential to first conduct a detailed mapping of traditional processes and local wisdom, and then integrate these with project management tools like CPM. This approach allows cultural milestones, rituals, and social customs to be included as formal activities within the project schedule. Therefore, combining project management technology with local wisdom can help similar projects succeed in the future. Based on these findings, it is recommended that future culturally-based construction projects implement the CPM method early in the planning phase to identify critical activities and potential delays. Additionally, collaboration with cultural stakeholders is essential to ensure that social and spiritual aspects are reflected in the project timeline, while still adhering to critical path constraints.

ACKNOWLEDGEMENTS

The author would like to express sincere gratitude to Samarinda State Polytechnic for the support and facilities provided throughout the implementation of this research. Special thanks are extended to the Departement of Business Administration for their valuable guidance, direction, and knowledge shared during the course of study and the preparation of this paper. The author also wishes to acknowledge the Center for Research and Community Service (P3M) of Samarinda State Polytechnic for the opportunity and support given in the realization of this academic work. It is hoped that this paper will contribute positively to the development of knowledge, particularly within the academic community of Samarinda State Polytechnic.

References

- Angelin, A., & Ariyanti, S. (2019). Analisis Penjadwalan Proyek New Product Development Menggunakan Metode Pert Dan Cpm. *Jurnal Ilmiah Teknik Industri*, 6(1), 63–70.
- Apriliani, A. D. (2024). Dinamika Pelaksanaan Ritual Ngaben Di Desa Adat Sampalan Tahun 2002-2022. *Jurnal Intelek Insan Cendikia*, 1(10), Article 10.
- Astari, N. M., Subagyo, A. M., & Kusnadi, K. (2022). Perencanaan Manajemen Proyek Dengan Metode CPM (Critical Path Method) Dan Pert (Program Evaluation And Review Technique). *Konstruksia*, 13(1), 164. <https://doi.org/10.24853/jk.13.1.164-180>
- Athira, N. R., Andris, D. A. M., & Khoiroh, S. M. (2021). Crashing Project Evaluation by Managing Allocation Resource and Cost using CPM-PERT and MS,Project in Nurul Hayat Mosque's Renovation. *Tibuana*, 4(02), 69–82. <https://doi.org/10.36456/tibuana.4.02.3770.69-82>
- Belferik, R., Andiyan, A., Zulkarnain, I., Munizu, M., Samosir, J. M., Afriyadi, H., Rusmiatmoko, D., Adhicandra, I., Syamil, A., Ichsan, M., & Prasetyo, A. (2023). *MANAJEMEN PROYEK: Teori & Penerapannya*. PT. Sonpedia Publishing Indonesia.
- Dannyanti, E. (2010). Optimalisasi pelaksanaan proyek dengan metode PERT dan CPM. *Semarang. Universitas Diponegoro*. [https://www.academia.edu/download/31412606/Optimalisasi_Pelaksanaan_Proyek_Dengan_Metode_Pert_Dan_Cpm-Jurnal\(1\).pdf](https://www.academia.edu/download/31412606/Optimalisasi_Pelaksanaan_Proyek_Dengan_Metode_Pert_Dan_Cpm-Jurnal(1).pdf)
- Daulay, M. T., Munarsih, E., Muafiqie, H., Alkadrie, S. A., Sukasmanto, Suarlin, J., & Suparman. (2022). *Konsep Dasar Manajemen Proyek di Era 4.0*. CV Rey Media Grafika.
- Do'o, R. R. R., Maulana, R., & Sari, S. N. (2024). Analisis Penjadwalan Waktu Kerja Proyek Menggunakan Metode CPM Pada Pembangunan Proyek Gedung DPRD Kabupaten Sleman, Yogyakarta. *STORAGE: Jurnal Ilmiah Teknik dan Ilmu Komputer*, 3(1), 55–62. <https://doi.org/10.55123/storage.v3i1.3139>
- Eyiah, A. K., Bondinuba, F. K., Adu-Gyamfi, L., & Liphadzi, M. (2025). Promoting Effective Management of Cultural Diversity in Multinational Construction Project Teams. *Buildings*, 15(5), Article 5. <https://doi.org/10.3390/buildings15050659>
- Haq, S. A. (2025). *Strategi Efektif Perencanaan dan Pengendalian Proyek Untuk Mencapai Target Tepat Waktu*. https://www.researchgate.net/profile/Mia-Global-Akademia/publication/388800308_Strategi_Efektif_Perencanaan_Dan_Pengendalian_Proyek_Untuk_Mencapai_Target_Tepat_Waktu_Sajira_Ahsanul_Haq/Links/67a6d075461fb56424cdc947/Strategi-Efektif-Perencanaan-Dan-Pengendalian-Proyek-Untuk-Mencapai-Target-Tepat-Waktu-Sajira-Ahsanul-Haq.Pdf
- Huda, I. F. N., & Prasinta, W. R. (2024). Perencanaan Manajemen Proyek dengan Metode Critical Path Method (CPM) dalam Pelaksanaan Program PKL di SMK Cendekia Batujajar. *EKONOMIKA45 : Jurnal Ilmiah Manajemen, Ekonomi Bisnis, Kewirausahaan*, 12(1), 539–550. <https://doi.org/10.30640/ekonomika45.v12i1.3617>
- Husna, R. A., Ilmiyah, N. F., & Resti, N. C. (2022). Implementasi CPM dan PERT dalam Memprediksi Durasi serta Biaya Pembangunan Musala Al-Ikhlas di Kotawaringin Barat. *Journal Focus Action of Research Mathematic (Factor M)*, 5(1), 97–109.
- Kadang, T., Hidayah, P. W., Simarmata, K., Putri, N. A., & Krisvinus, K. (2024). Analysis of Consultant Building Project Management Using the CPM (Critical Path Method). *Journal of Business Management and Economic Development*, 2(03), 1169–1179. <https://doi.org/10.59653/jbmed.v2i03.891>

- Kartini, I., Abdullah, A., Riauwati, J., Yoeliastuti, Y., Tannady, H., Khasanah, K., Batubara, H. C., Kamisi, H. L., Liana, W., & Purbaningsih, Y. (2022). *Manajemen Proyek*. Cendikia Mulia Mandiri.
- Mar'aini, M., & Akbar, Y. R. (2022). Penentuan jalur kritis untuk manajemen proyek (studi kasus pembangunan Jalan Selensen-Kota Baru-Bagan Jaya). *Jurnal Pustaka Manajemen (Pusat Akses Kajian Manajemen)*, 2(1), 6-13. <https://doi.org/10.55382/jurnalpustakamanajemen.v2i1.184>
- Markus, F. (2022). Kekebabatan Orang Toraja Kristen-Islam Berdasarkan Nilai Kultural Tongkonan Dan Falsafah Misa'Kada Dipotuo, Pantan Kada Dipomate. *ARUMBAAE: Jurnal Ilmiah Teologi Dan Studi Agama*, 4(2), 190-203.
- Milkia, M. (2023). *Teologi dan Ketorajaan: Identitas Ketorajaan dari Perspektif Generasi Z Diaspora di Gereja Toraja Jemaat Gideon Tanjung Redeb Klasis Kaltara Berau* [PhD Thesis, Institut Agama Kristen Negeri (IAKN) Toraja]. <http://digilib-iaknoraja.ac.id/id/eprint/748>
- Muhammad, A., Kurniawan, B., Mufidah, A. P., La Dai, L. D. M. B., & Pakarbudi, A. (2021). Analisa Jalur Kritis Pada Penjadwalan Proyek Pengembangan Sistem Informasi Menggunakan Teknik Critical Path Method (CPM)(Studi Kasus: PT. XYZ). *Prosiding Seminar Nasional Sains Dan Teknologi Terapan*, 9(1), 538-547. <http://ejurnal.itats.ac.id/sntekpan/article/view/2279>
- Perdana, M. A., & Sari, R. P. (2022). Optimalisasi Waktu Pelaksanaan Proyek Konstruksi Rumah Tinggal Menggunakan Metode CPM (Critical Path Method) dan PERT (Program Evaluation and Review Technique). *Jurnal Media Teknik dan Sistem Industri*, 6(2), 116. <https://doi.org/10.35194/jmtsi.v6i2.1944>
- Pernandes, P., Puri, P. A., & Nurhasanah, S. (2024). Implementation of CPM and PERT Method in Canteen Development Project CV Super Makmur. *West Science Business and Management*, 2(01), 179-193. <https://doi.org/10.58812/wsbm.v2i01.702>
- Rembulan, G. D., & Yuhao, S. (2023). Penerapan Metode CPM dan PERT Pada Proyek Konstruksi Gereja Kemah Tabernake PIK 2 Jakarta Utara. *Journal Of Industrial and Manufacture Engineering*, 7(2), 147-160.
- Resti, R., Burchanuddin, A., & Bahri, S. (2024). Relasi Kekebabatan Masyarakat Toraja Dalam Pelaksanaan Upacara Adat Rambu Solo' Kecamatan Rantetayo Kabupaten Tana Toraja. *Jurnal Sosiologi Kontemporer*, 4(2), Article 2. <https://doi.org/10.56326/jsk.v4i2.4864>
- Saputra, I. H., Erina, Y., & Rodhi, N. N. (2024a). Analisis Pengendalian Waktu dan Biaya Proyek Konstruksi Dengan Metode CPM (Critical Path Method). *Innovative: Journal Of Social Science Research*, 4(6), 7797-7807. <https://doi.org/10.31004/innovative.v4i6.17179>
- Saputra, I. H., Erina, Y., & Rodhi, N. N. (2024b). Analisis Pengendalian Waktu dan Biaya Proyek Konstruksi Dengan Metode CPM (Critical Path Method). *Innovative: Journal Of Social Science Research*, 4(6), Article 6. <https://doi.org/10.31004/innovative.v4i6.17179>
- Sarunan, A. M. (2023). *Perancangan Kawasan Seni dan Budaya Toraja di Toraja Utara dengan Pendekatan Arsitektur Regionalisme: Acuan Perancangan* [PhD Thesis, Universitas Fajar]. <https://repository.unifa.ac.id/id/eprint/1474/>
- Sebastian, D., & Jin, O. F. (2025). Penyebab dan Tindakan Mitigasi Pembengkakan Biaya Pada Proyek Konstruksi. *Jurnal Media Teknik Sipil*, 23(1), 33-42.
- Sudirman, S., Kondolayuk, M. L., Sriwahyuningrum, A., Setiawan, J., Tandirerung, W. Y., Rahmi, S., Indrawati, F., Fitriya, N. L., Aziza, N., Wardhana, A., & Hasanah, T. (2023). *Metodologi Penelitian 1*. https://www.researchgate.net/publication/371988490_Metodologi_Penelitian_1_Deskriptif_Kuantitatif
- Sugiyarto, S., Qomariyah, S., & Hamzah, F. (2013). Analisis Network Planning Dengan CPM (Critical Path Method) Dalam Rangka Efisiensi Waktu Dan Biaya Proyek. *Matriks Teknik Sipil*, 1(4), Article 4. <https://doi.org/10.20961/mateksi.v1i4.37494>
- Surahman, S., Kusumah, A., Tiara, Tomby, R. S., & Nurmaulida. (2024). *Project management planning of the small house construction in samarinda using the critical path method (CPM)*. <https://doi.org/10.35335/enrichment.v14i3.1939>
- Surahman, S., Saputri, Y., Athoya, M. F., Rabbani, I. H., Rahmayanti, N. I., & Hidayati, D. (2024). House construction of time scheduling using criticalpath method (CPM) in selili district. *Enrichment : Journal of Management*, 14(2), Article 2. <https://doi.org/10.35335/enrichment.v14i2.1897>
- Utomo, G., Hendriyani, I., & Aida, S. N. (2020). Evaluasi Pelaksanaan Proyek Drainase Dengan Metode CPM Dan PERT: Drainage Project Implementation Evaluation With The CPM And PERT Method. *Media Ilmiah Teknik Sipil*, 9(1), 44-52. <https://doi.org/10.33084/mits.v9i1.1884>

Zunaidah, U., Kawuryan, R., Prasetyo, D. R., Aditya, R., & Salsabila, S. N. (n.d.). *Construction management analysis of time management in residential house construction of samarinda*. 2.