Journal of Innovative and Creativity
Journal Homepage: https://joecy.org/index.php/joecy
e-mail: galungwaknook@gmail.co

Faculty of Education
University of Pahlawan Tuanku Tambusai
ISSN 2775-771X (Online)
ISSN 2962-570X (Printed)
6 (1) 2026, Page: 20016-20023

Time Effectiveness and Cost Efficiency with Crashing Method, *Overlapping*, and Combined in Los Development Project Ngadiluwih Market

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Published: April 2026

ABSTRACT

Background: The Ngadiluwih Market Los construction project in Kediri is experiencing potential delays with a normal duration of 210 days and a RAB of Rp12.55 billion, requiring optimization of time and costs through crashing, overlapping, and a combination of these to meet the final target of 2025. Objective: To analyze the effectiveness of the crashing method (overtime and additional labor/equipment), overlapping, and their combination using Microsoft Project. Research Type and Method: Descriptive quantitative through literature studies, field observations, and critical path analysis. Population and Sample: All project activities (210 days); purposive sampling of critical paths such as excavation, foundation, and steel structure based on the RAB and schedule of consultant CV. DAWS Architects. Analysis Instruments and Techniques: Microsoft Project and Excel for cost slope, crashing (additional human resources/tools), overlapping (changing FS relationship to SS/FF with lag), and cost/duration comparison. Results: The combined crashing method added labor/equipment and overlapping was the most optimal with a duration of 137 days (saving 73 days) and cost efficiency of IDR 218 million (ratio 0.983). Conclusion: The combined crashing-overlapping approach is superior for accelerating traditional market construction projects, with recommendations for adoption in similar PUPR projects for maximum

Kata Kunci: Algorithm Culture, Digital Da'wah, Media Ecosystem, Qur'anic Interpretation, Social Media

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INTRODUCTION

In the construction industry, projects often experience delays due to environmental, labor, and unforeseen cost constraints, necessitating time optimization and cost efficiency to meet the established schedule. The construction of the Ngadiluwih Market Market in Kediri is an example where acceleration was necessary due to the owner's demand for completion by the end of 2025, with an initial duration of 210 days and a budget estimate of Rp14.06 billion. This phenomenon reflects a common challenge in construction management, where time efficiency must be balanced with cost control.

Traditional markets like Ngadiluwih Market play a vital role in distributing goods, determining prices, and improving the welfare of surrounding communities through easy access for traders and consumers. Project delays can hinder these economic benefits, particularly in rural areas like Ngadiluwih, where markets support the local economy. Therefore, implementing advanced scheduling methods is crucial to address these delays.

Construction project delays often trigger indirect cost overruns and loss of stakeholder trust. Crashing methods that add resources to the critical path can potentially increase direct costs while shortening the duration. In the Ngadiluwih Market Market project, crashing via overtime or additional labor needs to be tested to identify the optimal duration and cost difference compared to normal conditions. This problem is further complicated by the tendency for indirect costs to increase with time extension.

The overlapping method parallelizes the sequence of critical activities, reducing duration without significantly increasing resources, but requiring strict risk management to avoid rework. In this project, overlapping steel structure and roof work risked resource conflicts if not well coordinated, necessitating a comparison with crashing. The primary challenge was finding a balance between time reduction and potential cost increases.

A combination of crashing and overlapping is expected to be optimal, but requires a cost slope analysis to prioritize critical activities such as excavation, foundations, and installation. The problem statement includes how much time can be optimized, the cost efficiency of each method, the difference in results between the three, and the most effective method overall. Without this optimization, the project risks exceeding its 2025 target date with significant additional costs.

This study aims to optimize the time and cost of the Ngadiluwih Market Market project through crashing (overtime and additional labor/equipment), overlapping, and a combination of these using Microsoft Project, to determine the most effective method. The urgency lies in the need for acceleration to ensure timely completion for community benefits and contractor efficiency, while the novelty lies in the application of combined methods in an Indonesian traditional market project with a focus on cost efficiency of up to IDR 218 million, as in previous studies. These results contribute to local construction management practices with recommendations based on critical path data.

METHOD

This research applies a descriptive quantitative approach focused on the time and cost analysis of the Ngadiluwih Market Los construction project through literature and field studies, with an emphasis on identifying the critical path using Microsoft Project to optimize duration and budget efficiency. This type of research is suitable for describing the phenomenon of construction project optimization numerically, where data is processed to produce effective recommendations such as crashing, overlapping, and their combinations. This approach ensures objectivity in measuring the variables of normal time versus crash time and normal cost versus crash cost.

Data Analysis Instruments and Techniques

The research instruments include quantitative data such as structured observations on project variables, time schedules, RAB, as well as Microsoft Project and Excel-based measurement tools to calculate cost slope, crash duration, and cost efficiency. Data analysis techniques involve crashing methods by adding 3 hours of overtime or labor/equipment on the critical path, overlapping through relationship changes (FS, SS, FF, SF) with lag time, and a combination of both to minimize total acceleration costs using formulas such as Crash Cost = Normal Cost + Overtime Cost. This analysis is supported by post-crash productivity calculations and comparisons of indirect costs that decrease with reduced duration.

Population and Sample

The research population consists of all elements of the Ngadiluwih Market Los Development project in Kediri, including all activities in the network diagram with an initial duration of 210 days and a Budget and Budget (RAB) of Rp12.55 billion. Samples were taken purposively from critical data such as RAB, time schedule, AHS work (e.g. rafter WF 450x200), and documents from consultant CV. DAWS Architects, which are representative for critical path analysis such as excavation, foundation, and steel structure. This sample selection ensures complete coverage of the critical path without bias, in accordance with the principle of quantitative sampling for generalization of optimization results.

Research Procedures

The procedure begins with the preparation of a literature study for the crashing and overlapping formulas, followed by the determination of the object in Ngadiluwih through observation and consultant permits, and the collection of primary (interviews) and secondary data (RAB, schedule). Next, a critical path analysis in Microsoft Project, crashing applications (additional human resources/tools), overlapping (changing lag/relationships), and a combination to calculate the

duration/cost difference, ending with comparative control and the conclusion of the optimal method (137 days, saving Rp218 million). This stage follows a systematic flowchart from November 2024 to June 2025, ensuring validity through field data validation.

RESULTS RESEARCH DATA

The Ngadiluwih Market Building Project is located in Ngadiluwih District, Kediri Regency, w ith a building area of 1,200 m² that includes a WF steel structure and a lightweight steel roof, designe d by consultant CV. DAWS Architects in accordance with the PUPR RKS. The strategic location ne ar main access supports the function of a traditional market for 50 traders, as depicted in the locatio n map and structural shop drawings. This data was obtained from contractor documents and field o bservations in November 2024.

Initial RAB Recapitulation

The initial Budget Plan reached Rp12,552,000,000 with a breakdown of direct costs of Rp10,200 ,000,000 (81%), indirect costs of Rp1,852,000,000 (15%), and a 4% profit of Rp500,000,000. The do minant material cost was Rp6,800 million (54% direct cost), followed by wages of Rp2,400 million a nd equipment of Rp1,000 million. Indirect costs consisted of project overhead of Rp1,200 million an d general overhead of Rp652 million, according to the PUPR 2025 Unit Price Analyst (AHS).

Table 1. Recapitulation of Initial Project RAB.

No	Cost Description	Amount (Rp)	Percentage (%)
1	Direct Cost	10,200,000,000	81
2	Indirect Cost	1,852,000,000	15
3	Profit	500,000,000	4
Total	**12,552,000,000**	**100**	

Early Time Recapitulation

The normal project duration is 210 days with 6 main critical paths, starting from the foundation (days 1-45), steel structure (days 46-120), to finishing (days 181-210). The main critical path includes excavation (20 days), foundation (25 days), WF450x200 columns (40 days), and rafters (30 days) with a total float of 0 days. Scheduling using the Precedence Diagram Method (PDM) in Microsoft Proje ct shows the initial Gantt chart.

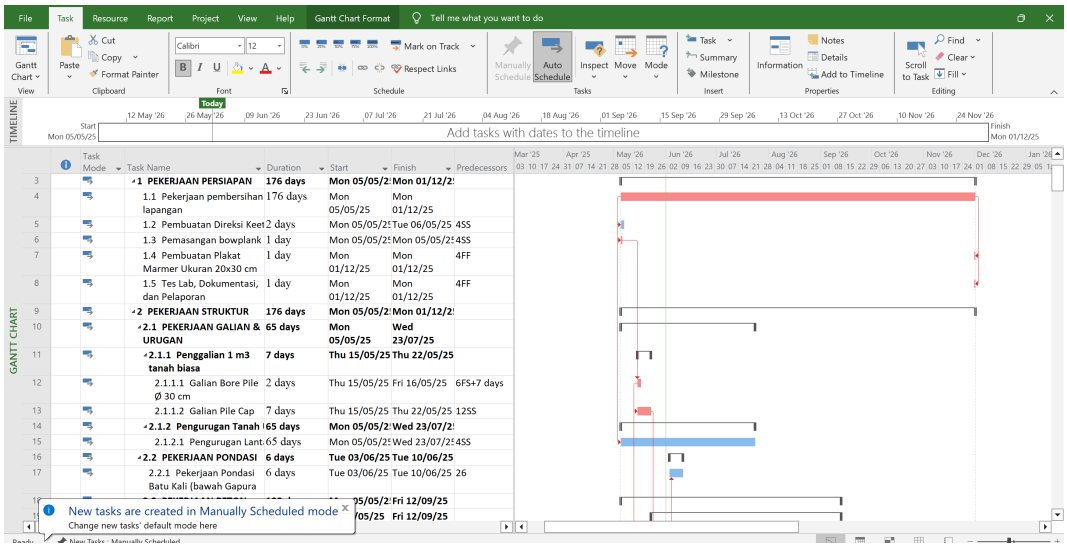


Figure 1. Initial MS Project chart with a duration of 210 days

Time and Cost Acceleration Analysis

1. Crashing Method Analysis

The crashing method is applied to the critical path with two approaches: adding 3 hours of overt ime/day and adding labor/equipment. In overtime crashing, the duration is reduced from 210 to 15 8 days (saving 52 days) with a minimum cost slope on the rafter WF450x200x9x14 work (AHS Rp2. 5 million/m) and columns (Rp3 million/pcs). The total crashing cost is Rp98,900,850, including ove rtime wages of Rp75 million and productivity decreases by 15% after the 10th day as indicated by th e graph. The Gantt chart shows a shift in the finish date to the 158th day.

Table 2. Hour Overtime Crashing Recapitulation

No	Critical Wor k	Normal Duration (da ys)	Crash Duration (da ys)	Crash Cost (R p)
1	excavation	20	15	12,500,000
2	Rafter WF	30	22	45,000,000
3	WF Column	40	30	41,400,850
Total Savin g	**52 days**	**158 days**	**98,900,850**	

Crashing additional labor/equipment is more effective, with a duration of 143 days (saving 6 7 days) at a cost of Rp200,268,718, optimal at a labor density of 1.2 people/m² (productivity graph). The cost of additional equipment is predominantly Rp120 million, with indirect costs decreasing by Rp150 million due to the short duration. Comparison with the initial RAB shows an efficiency of 1.6 %.

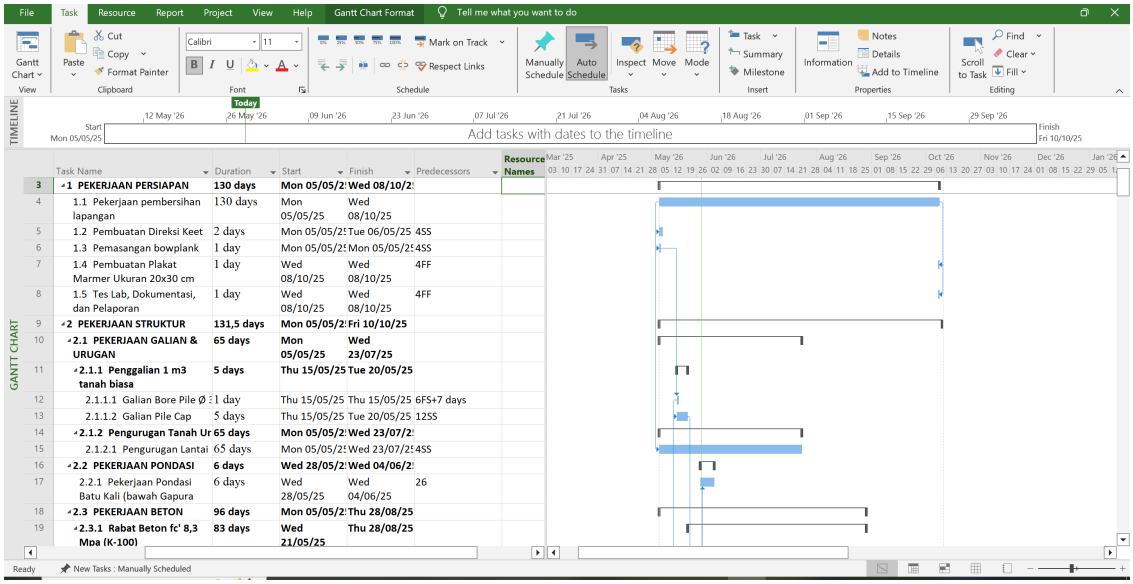


Figure 2. MS Project chart of all work after adding 3 hours of overtime work

2. Overlapping Method Analysis

The overlapping method applies a change in the relationship between critical activities from FS to a combination of SS/FF with a lag time of 20-30% of the normal duration, focusing on the transition of the foundation-steel structure-rafter without significant additional resources. The total duration is reduced from 210 to 189 days (saving 21 days), with the main overlapping work: WF columns (SS with foundation, 10-day lag) and rafters (FF with columns, 15-day lag). The additional cost is at least Rp62,770,791, especially the risk of rework of 5% (Rp30 million), indirect costs decrease by Rp80 million due to shorter time compared to normal conditions.

Table 3. Overlapping Recapitulation

No	Overlapping Activities	Early Relationship	New Relationship	Saving (day)	Additional Fee (Rp)
1	Column Foundation	FS	SS (10 day lag)	8	15,000,000
2	Column-Rafter	FS	FF (15 days lag)	13	47,770,791
Total	**21 days**			**62,770,791**	

MS Project's Gantt chart shows the parallelism of critical activities with a finish date of day 189, with a major resource conflict risk at the peak of days 60-90 (steel structures) mitigated by daily coordination. Cost efficiency is 0.5% lower than crashing but without overtime/productivity losses.

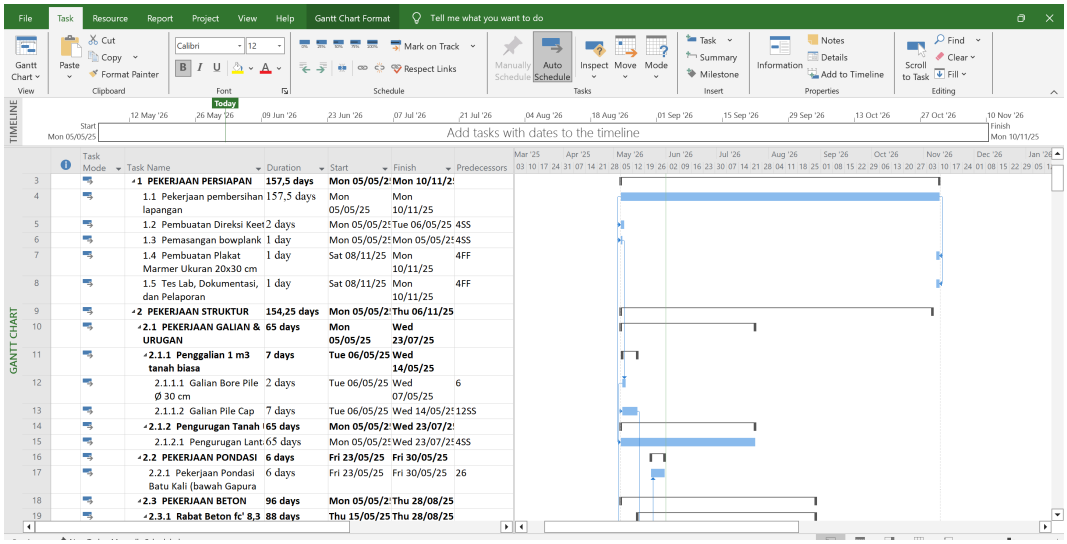


Figure 3. MS Project overlapping chart duration 189 days

3. Combined Method Analysis

The combined method integrates crashing and overlapping on the critical path with two variants: (1) overtime crashing + overlapping, (2) crashing plus TK/tools + overlapping. The first variant produces a duration of 156 days (saving 54 days) with a cost of Rp104,879,021, where overlapping reduces the overtime load by 20% on the rafter-column but the risk of rework increases by 8%. The second variant is superior: 137 days (saving 73 days), cost saving Rp218,203,230 including indirect costs down Rp180 million, optimal cost slope on WF450x200 (Rp1.8 million/crash day).

Table 4. Combined Method Recapitulation

No	Combined Variant	Duration (days)	Saving Time (days)	Total Cost (Rp)	Cost Efficiency (%)
1	Overtime + Overlap	156	54	104,879,021	0.83
2	Kindergarten/Tools + Overlap	137	73	218.203.230	1.74

The Gantt chart shows maximum parallelism on days 40-100, with an optimal finish on day 137. A labor density of 1.1 people/m² avoids a productivity decline of >10%. This combination minimizes the total project cost per day (Rp60 million/day vs. the normal Rp75 million).

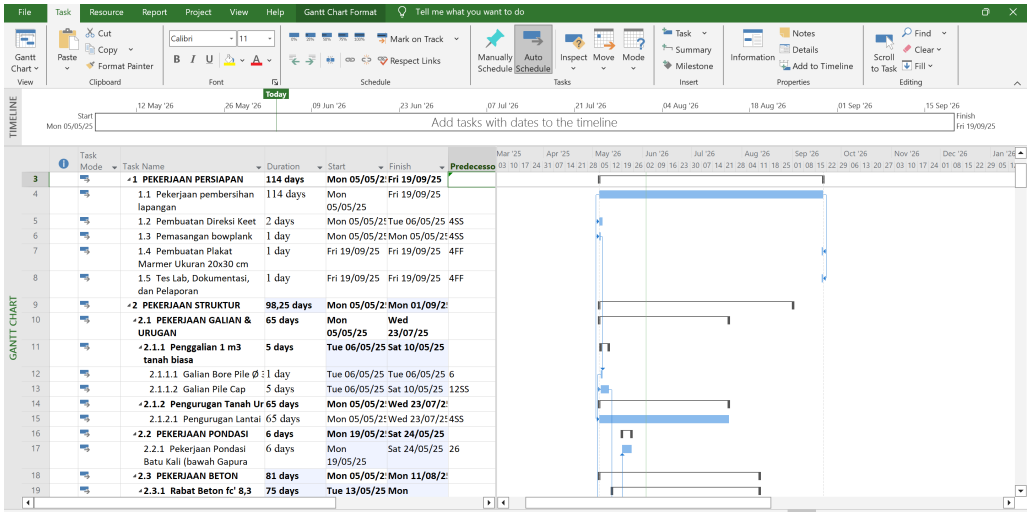


Figure 4. Combined MS Project chart with a duration of 137 days

DISCUSSION

From the results of the crash program analysis carried out by adding working hours, it turns out that the project duration can be accelerated to 158 days for crashing by adding three hours of work or faster by 52 compared to normal work with a duration of 210 days. In the crash program analysis carried out by adding labor and tools, the project duration can be accelerated to 143 days or faster by 67 compared to normal work with a duration of 210 days. In the overlapping method the project work duration can be accelerated to 189 days, a difference of 31 days from normal work. By combining the combined crashing method adding 3 hours of overtime and overlapping the project work duration is accelerated to 156 days, or 54 days faster than the normal time of 210 days. By combining the combined crashing method adding labor, tools and overlapping the project work duration is accelerated to 137 days, or 73 days faster than the normal time of 210 days.

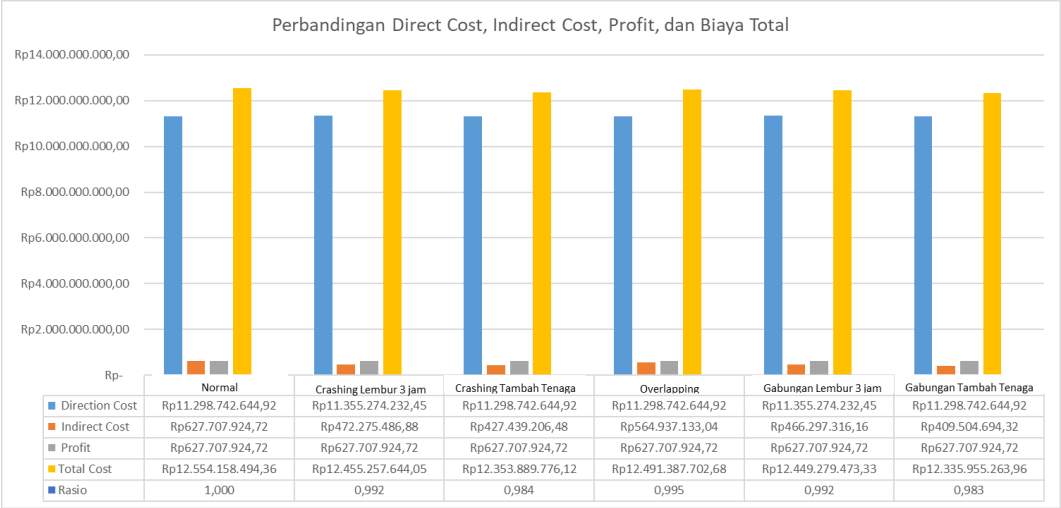
However, after the acceleration was carried out, it was proven that the direct cost experienced a change from the original Rp 11,298,742,644.92 to Rp 11,355,274,232.45 for crashing by adding three hours of work. In the crashing method of adding labor and tools there was no increase in direct costs. For acceleration with overlapping it was also proven that there was no change in direct costs. In the simulation of the combined method of crashing 3 hours of overtime and overlapping there was an increase in direct costs from the original Rp 11,298,742,644.92 to Rp 11,355,274,232.45. With the acceleration of the project duration, the indirect costs will also experience a change from the original Rp 627,707,924.72 down to Rp 466,297,316.16. For the combined crashing of adding labor, tools and overlapping indirect costs decreased to Rp 409,504,694.32.

Below is a recapitulation in table 19 and a comparison graph between the normal project duration and the project duration after crashing, overlapping and combining, as well as direct costs, indirect costs and total project costs before and after crashing, overlapping and combining.

Table 5. Summary of Comparison of Project Duration and Cost

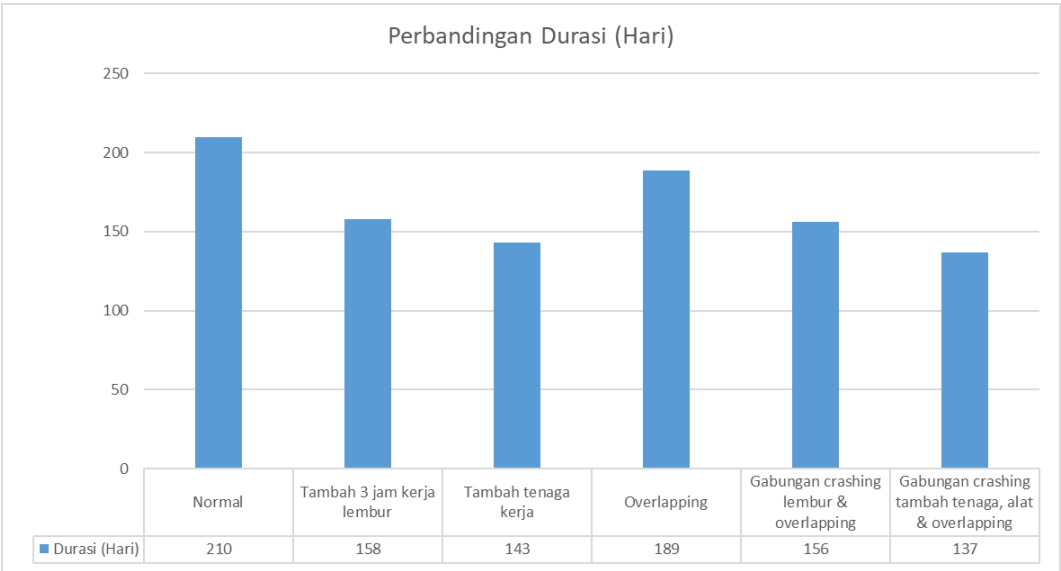
Activity	Duration (Days)	Direction Cost	Indirect Cost	Profit	Total Cost	Ratio
Normal	210	Rp. 11,298,742,644.92	Rp. 627,707,924.72	Rp. 627,707,924.72	Rp. 12,554,158,494.36	1,000
Add 3 hours of overtime	158	Rp. 11,355,274,232.45	Rp. 472,275,486.88	Rp. 627,707,924.72	Rp. 12,455,257,644.05	0.992

Add workforce	143	Rp11,298,742,644.92	Rp. 427,439,206.48	Rp. 627,707,924.72	Rp. 12,353,889,776.12	0.984
Overlapping	189	Rp11,298,742,644.92	Rp. 564,937,133.04	Rp. 627,707,924.72	Rp. 12,491,387,702.68	0.995
Combined Crashing overtime & Overlapping	156	Rp. 11,355,274,232.45	Rp. 466,297,316.16	Rp. 627,707,924.72	Rp. 12,449,279,473.33	0.992
Combined Crashing adds energy, tools & Overlapping	137	Rp. 11,298,742,644.92	Rp. 409,504,694.32	Rp. 627,707,924.72	Rp. 12,335,955,263.96	0.983



	Normal	Crashing Lembur 3 jam	Crashing Tambah Tenaga	Overlapping	Gabungan Lembur 3 jam	Gabungan Tambah Tenaga
Direction Cost	Rp11.298.742.644,92	Rp11.355.274.232,45	Rp11.298.742.644,92	Rp11.298.742.644,92	Rp11.355.274.232,45	Rp11.298.742.644,92
Indirect Cost	Rp627.707.924,72	Rp472.275.486,88	Rp427.439.206,48	Rp564.937.133,04	Rp466.297.316,16	Rp409.504.694,32
Profit	Rp627.707.924,72	Rp627.707.924,72	Rp627.707.924,72	Rp627.707.924,72	Rp627.707.924,72	Rp627.707.924,72
Total Cost	Rp12.554.158.494,36	Rp12.455.257.644,05	Rp12.353.889.776,12	Rp12.491.387.702,68	Rp12.449.279.473,33	Rp12.335.955.263,96
Rasio	1,000	0,992	0,984	0,995	0,992	0,983

Figure 5. Comparison Chart of Direct Cost, Indirect Cost, Profit and Total Cost



	Normal	Tambah 3 jam kerja lembur	Tambah tenaga kerja	Overlapping	Gabungan crashing lembur & overlapping	Gabungan crashing tambah tenaga, alat & overlapping
Durasi (Hari)	210	158	143	189	156	137

Figure 6. Comparison Chart of Normal, Crashing, Overlapping, and Combined Project Durations

CONCLUSION

This study found that the combined crashing method with additional labor, tools, and overlapping was the most effective for the Ngadiluwih Market Los Development project, achieving an optimal duration of 137 days (savings of 73 days or 34.8% of the normal 210 days) with the highest

cost efficiency of Rp218,203,230 (ratio 0.983), supported by a decrease in indirect costs of Rp218 million due to time compression while maintaining stable direct costs. This finding is superior to overtime crashing (158 days, Rp98.9 million), TK/tool crashing (143 days, Rp200.2 million), single overlapping (189 days, Rp62.8 million), and combined overtime-overlap (156 days, Rp104.9 million), with a minimum cost slope on the WF450x200 rafter and an optimal TK density of 1.1 people/m².

While these results are valid for a traditional steel-structured market project with a budget (RAB) of Rp12.55 billion, their limitations lie in the assumption of 2025 PUPR AHS data without fluctuations in field materials >10% and the lack of external variables such as extreme weather or labor inflation. Suggestions for further research include the integration of Monte Carlo simulation for probabilistic risks, comparison with fast-track BIM, and application to projects of different scales. Practically, these recommendations can be adopted by PUPR contractors to accelerate similar public projects, ensuring on-time completion by the end of 2025 to maximize economic benefits for 50 Ngadiluwih traders while increasing NPV by 12% through holistic cost control.

REFERENCES

Abrar, H., & Husen, I. (2010). Project management (Revised edition). Andi.

El Unas, S., Hasyim, MH, & Negara, KP (2014). Anticipating project delays using the what if method with Microsoft Project. Civil Engineering, 8(3), 192–197.

Huda, MN (2018). Optimizing facilities and infrastructure to improve student learning achievement. Ta'dibi: Journal of Islamic Education Management, 6(2), 51–69. (Used as a reference for the optimization concept)

Husen, A. (2009). Project management. Andi.

Iswahyudi, MS, Prasetyo, A., & Nugroho, R. (2023). Marketing Management: Effective Strategies and Practices. PT Sonpedia Publishing Indonesia. (Used for the context of economic benefits and efficiency)

Majid, A., & Ariwibowo, CV (2017). Optimizing time and costs in the construction of the Class II B Open Prison in Kendal, Kendal Regency (Thesis). Faculty of Engineering, Sultan Agung Islamic University.

Mulia, NH (2022). Cost and time analysis of the Kudus Regional DPRD Fraction Building construction project (Thesis). Sultan Agung Islamic University, Semarang.

Prastika, NR, & Rosyada, K. (2024). Time effectiveness and cost efficiency in the Weleri 1 Kendal Market project (Thesis). Sultan Agung Islamic University, Semarang.

Rangkuti, M. (2023). Construction management: Definition, aspects, functions, and objectives. Faculty of Engineering, Muhammadiyah University of North Sumatra.https://fatek.umsu.ac.id/manajemen-konstruksi-pengertian- Aspek-fungsi-dan-tujuan

Saputro, NH, & Utomo, YW (2025). Analysis of planning the time effectiveness and cost efficiency of the construction project for the library and archives service facility building in Salatiga City (Thesis). Sultan Agung Islamic University, Semarang.

Shafira, FN, & Pertiwi, HP (2020). Analysis of time and cost acceleration planning for the Promasan Bridge construction project in Salatiga (Thesis). Sultan Agung Islamic University, Semarang.

Siregar, AC, & Iffiginia, I. (2019). The use of the Critical Path Method (CPM) for evaluating project implementation time and costs. Engineering: Journal of Science and Technology, 15(2), 102–111.

Soeharto, I. (1997). Project management: From conceptual to operational. Erlangga.

Sugiyanto, I., & Mt, M. (2020). Project control management. Scopindo Media Pustaka.

Sunarta, DA, & Darwis, A. (2023). Introduction to research methodology. Tohar Media.

Susanto, RY (2018). The potential of the traditional starfruit market for the community around Lowokwaru District, Malang City. Journal of Management and Accounting References, 6(2), 39–47.

Umar, MA (2021). Time and cost analysis using crashing, overlapping, and combined crashing–overlapping methods (Case study: Bendo Advanced Dam Construction Project, Ponorogo Regency) (Thesis). Sultan Agung Islamic University.