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Optimization of Project Time for the Construction of 2-Door Rental Houses Type 55 using the Critical Path Method (CPM)

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Article Info

Abstract

The problem of delays in construction projects is still a crucial issue, especially in the small-scale housing sector which is generally managed manually and less structured. This study aims to optimize the implementation time of the 2-door rental house construction project type 55 by applying the Critical Path Method (CPM) method. The approach used is quantitative with the type of case study. Data is collected through observation and hands-on interviews, and analyzed using Microsoft Project software to map project activities, determine critical paths, and evaluate crashing scenarios. The results showed that the project that was originally scheduled for 176 days could be accelerated to 146 days with the identification of critical paths A-B-C-D-E-F-G-H-I-J. Time efficiency of 17.05% was achieved without sacrificing the quality of the work. These findings suggest that the CPM method is not only relevant for large-scale projects, but can also be effectively adapted to small-to-medium-scale projects such as the construction of rental houses. In addition to providing more accurate schedule control, the application of this method also improves managerial efficiency and accountability in the implementation of construction projects.

1. Introduction

Indonesia is a developing country with a large population and rapid population growth. This causes the demand for housing to be higher. Therefore, the planning and implementation of a home construction project is essential to meet these needs (Aprillia & A'yun, 2023) [5]. The need for housing in Indonesia continues to increase, causing a housing backlog, which is a gap between the number of houses that have been built and the number of houses needed by the population. In 2022, the housing backlog in Indonesia was recorded at 11 million units and in 2023 the backlog figure increased to 12.7 million units, an increase of 1.7 million units compared to the previous year. This increase is due to the growing demand for housing every year, around 600,000 to 800,000 units, due to the large number of new families who need a place to live (Subakti, 2024) [18].

Along with the times, construction projects have also made significant progress. The execution of construction work is highly dependent on resources, including materials, labor, costs, execution methods, and equipment. Various construction implementation methods can affect project completion time and cost (Yuwono *et al*., 2021) [20]. Therefore, planning management is needed so that the project can run according to the planned schedule and budget (Perdana & Rahman, 2019) [14].

Delays in completing projects are a common problem and can impact all aspects of implementation. On this basis, project management is needed which aims to manage the implementation of the project from the initial stage to the final stage by using the optimization method in project management that is widely used today, namely the *Critical Path Method* (CPM) (Chasan dkk., 2022) [8]. CPM is a method for planning and supervising projects is the most widely used system among all other systems that use the principle of network formation (Handayani *et al*., 2019) [11]. This method allows the identification of critical activities, such as the installation of foundations and roof structures, that directly affect the overall duration of the project. In addition, CPM allows the calculation of the trade-off between cost and time through a crashing scenario, where the acceleration of a one-day execution can be calculated with an additional certain cost, for example RpX per day.

In the CPM Method, there is a critical path, which is a path that has a series of activity components with the longest total implementation time. The critical path consists of a series of critical activities, starting from the first activity to the last activity of a project, the critical path is the trajectory that most determines the overall project completion time (Siregar & Iffiginia, 2019) [16]. Most studies on CPM tend to focus on large-scale construction projects, such as infrastructure or buildings, while their application for small-scale projects, especially the construction of rental houses, is still very limited (Ahmad *et al*., 2024) [1]. Departing from these limitations, this study was made to test and optimize the implementation of the construction project of a 2-door rental house type 55 with the application of the CPM method. This research aims to make a practical contribution in improving the efficiency of scheduling work that has been carried out manually, so as to optimize the construction process of 2-door rental houses type 55. This research is expected to make a practical contribution on how CPM can optimize the implementation of the construction project of a 2-door rental house type 55, and can be a reference for construction industry players in managing small-scale house construction projects more effectively and efficiently.

2. Literature Review
A. Basic Concepts of Operations Research in Construction
Operations research in construction is an analytical method for optimizing decision-making in projects. In a type 55 rental house project, operational research can be applied to minimize costs, time, and resources without sacrificing quality. For example, by using linear programming, contractors can efficiently allocate materials such as cement, bricks, and labor based on budget and deadlines. In addition, CPM helps identify critical tasks in construction so that there are no delays, such as the foundation process or roof installation.

The application of operations research also includes risk management and inventory. In a type 55 rental house project, inventory management helps ensure the availability of materials on time, avoiding excess stock or shortages that interfere with the progress of the project. Simulation techniques can be used to predict the impact of weather or supply disruptions on construction schedules. With this approach, contractors can make data-driven decisions, such as determining the optimal number of workers or choosing the lowest cost material suppliers, so that the project is completed efficiently and profitably.

B. The Role of Project Management in Construction
In the implementation of a project, the success of a project can also be measured in terms of cost and implementation time. Poor project performance is generally caused by a mismatch between the cost budget, the duration of implementation, and the quality of the work results compared to the initial planning (Erica & R. Yuniardi, 2022). A good project management framework should include planning, executing, controlling, and closing projects (Amsyal & Yusuf, 2025) [4]. Some of the factors that can cause delays in construction projects include ineffective management, errors in estimating project completion time, constraints related to materials, labor, equipment, funding, and less supportive environmental conditions. In a type 55 rental house construction project, the application of proper project management principles will help minimize the risk of delays and cost overruns.

C. Critical Path Method (CPM) as an Optimization Tool
CPM is able to predict the duration required to complete each activity while identifying critical tasks that require intensive supervision to ensure project completion on schedule (Alfianti, 2019) [2]. The CPM method is a great choice for project management to control project completion time more effectively and efficiently. To minimize the risk of delays and project cost overruns, work acceleration can be done through three control alternatives, namely additional labor, overtime work, or subcontractors (Wasito & Syaikhudin, 2020) [19]. In the context of the construction of type 55 rental houses, CPM will be used to determine the most efficient order of work and allocate resources optimally.

D. Integration of Operations Research and CPM in Construction
The integration between the principles of operations research and CPM provides a comprehensive approach to the optimization of construction projects. According to (Falah, 2025) [10] This combination allows for a more in-depth analysis of various project scenarios. For the 55 types 2-door rental house project, this integration will be focused on optimizing the stimulus between project time and cost.

With the help of operations research, the requirements for materials, labor, and equipment can be optimally calculated, while CPM is very useful for determining activities that are on a critical track, i.e. a series of tasks that directly affect the overall project completion time (Butarbutar *et al*., 2025) [7]. Through this integration, every stage of work from foundation to completion can be monitored and completed as per target, so that the project can run smoothly without significant delays and at a more controlled cost.

3. Research Methods
This research applies a quantitative approach to the type of case study research, since the main focus lies on the collection and analysis of numerical data related to the duration and financing of construction project activities (IMAN, 2024). The information is collected in the form of numbers, including the time of execution of each job, estimated costs, and the relationship between time efficiency and expenses. The data is then analyzed using the CPM method, which is designed to identify the most crucial activity paths in project optimization efforts. As stated by (Siroj *et al*., 2024) [17], a quantitative approach is very suitable for research that aims to test theories by measuring and analyzing the relationships between variables objectively.

The selection of the type of case study in this study is based on the need to explore in depth the implementation of the construction of type 55 rental houses that have specific and contextual characteristics. Through this approach, researchers can describe all stages of the project thoroughly, from planning, implementation, to final results. The case study also provides a more complete understanding of the application of the CPM method in small to medium-scale construction projects. In line with the view (Nurhayati *et al*., 2024) [13], case studies are effectively used to answer exploratory questions such as "how" and "why", especially when the object of the research takes place in a real-life situation that cannot be completely controlled by the researcher.

This research focuses on the construction of two units of type 55 rental houses, where each unit has a building area of 55 square meters. The two units are designed side by side in a single plot of land covering an area of 150 square meters (10 x 15 meters). Each unit is equipped with two bedrooms, one bathroom, living room, kitchen, and terrace, with an efficiently and functionally designed layout to meet the needs of residents of small families as well as individual tenants. The building is made up of 3.5 meters high with one floor, utilizing commonly used building materials such as reinforced concrete, red bricks, and light steel roof frames, which are known to be sturdy and economical.

The project stages broadly include several main types of work, namely initial or preparatory work, foundation construction, main structure of the building, architectural elements (including wall, floor, ceiling, and roof work), mechanical and electrical installation (MEP), and final completion and cleaning of the area. Each stage is detailed based on the order of implementation and estimated processing time, which is then used as the basis for analysis using CPM. Through this approach, the project is expected to be managed more efficiently both in terms of time and expenses, without neglecting the quality of the building and its function as a decent and comfortable rental residence.

The construction project of a 2-door rental house type 55 is carried out through a sequence of structured and integrated construction stages. The initial steps start from the preparation stage, which includes cleaning activities of the project area, the land measurement process, and the installation of bow planks as an initial reference for development. Then it was continued with foundation work, which included excavating the soil, installing river stones or foot plates, and sloof casting as the basis of the building structure. The next stage is structural work, which involves the construction of key elements such as columns, beams, and floor plates as per engineering specifications. After the structure is erected, the project enters the architectural work stage, which consists of the installation of brick, plaster and plaster, painting, installation of ceramic floors, gypsum ceilings, and light steel roof frames. Furthermore, MEP work was carried out, including the installation of electrical systems, lighting, as well as clean water systems and sewers. The final stage includes finishing and cleaning work, such as installing doors and windows, final painting, and cleaning of the entire building before the handover process. This entire series of work is analyzed using the CPM method to identify critical activity paths to optimize implementation time and budget use efficiently.

4. Results and Discussions

This research focuses on the analysis of the implementation of the Type 55 2-Door Rental House Construction project, which was completed within 176 days. This project was carried out by a team of 10 people with the project manager coordinated by Mr. Wartoni. The data collection technique was carried out through direct interviews with the project leader, to obtain detailed contextual and technical information.

The planning of this activity schedule uses the CPM method, with the Microsoft Project application. This method serves to determine the order of work execution, identify dependencies between activities, and calculate the estimated time to complete the work under normal conditions or in acceleration scenarios. The results of the scheduling are visualized in the form of *Gantt Chart* and network diagrams, which provide a systematic representation of critical paths so that project activities run according to the planned time targets.

Table 1: Project Activity Recapitulation

Yes	Work	Code	Duration (Day) Usual	Duration (Day) *Quick Time*	Predecessor
1	Preparation Stage	A	7	6	-
2	Foundation Stage	B	25	22	A
3	Development Stage	C	48	46	B
4	Roof and Covering Work	D	28	25	C
5	Interior Craftsmanship	E	17	15	D
6	Exterior Craftsmanship	F	11	8	D
7	Path Work and Existing	G	15	12	E,F
8	Finishing Stage	H	10	8	G
9	Mechanical and Electrical Installation Stage	I	14	12	H
10	Handover of Jobs	J	1	1	I

Source: Processed Data (2025)

Normal Duration Work Network Using CPM

Based on Table 1, the researcher will explain the arrangement of work with an estimate of normal duration. The construction project of a 2-door rental house type 55 will be carried out starting on October 29, 2025 and completed on April 23, 2025, with a total normal implementation time of 176 working days. The preparation of this project schedule uses the CPM method which aims to map the sequence of activities and identify the critical paths of all stages of work.

The flow of project implementation starts from the preparation stage, followed by the foundation work stage, after which it continues to construction, followed by roof and cover work. Furthermore, interior work, exterior work, line and existing work were carried out. After the entire main structure is completed, the project enters the finishing stage. In the next stage, mechanical and electrical installations were carried out, and the last handover of work was carried out. The grid diagram is arranged as follows:
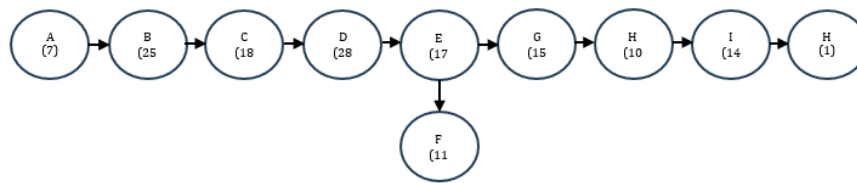
Fig 1: Normal Time Plan Scheme

Job Networking with *Quick Time* Using CPM

Preparation of work networks with accelerated duration (*Quick time*) follows the same steps as the normal duration method, but uses a shorter execution time for each activity. Fixed activity data refer to Table 1, using duration *Quick time* aims to speed up project construction time.

Table 2: Quick Time Activities

No	Work	Code	Duration (Day) *Quick Time*	predecessor
1	Preparation Stage	A	6	-
2	Foundation Stage	B	22	6
3	Development Stage	C	46	28
4	Roof and Covering Work	D	25	74
5	Interior Craftsmanship	E	15	99
6	Exterior Craftsmanship	F	8	99
7	Path Work and Existing	G	12	114
8	Finishing Stage	H	8	126
9	Mechanical and Electrical Installation Stage	I	12	134
10	Handover of Jobs	J	1	146

Source: Processed Data (2025)

The implementation process of the Type 55 2-Door Rental House began on October 29, 2025 and was completed on March 24, 2025 From this process, a network diagram with a more efficient duration was produced, as shown in the following diagram:
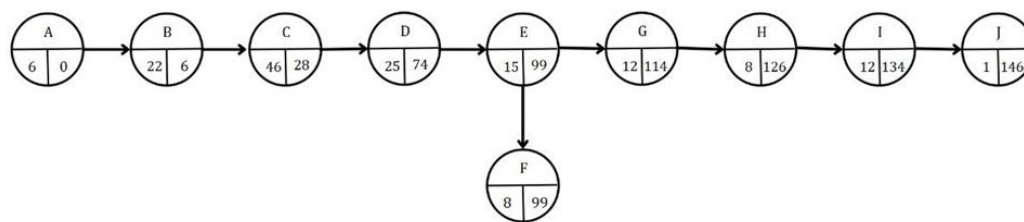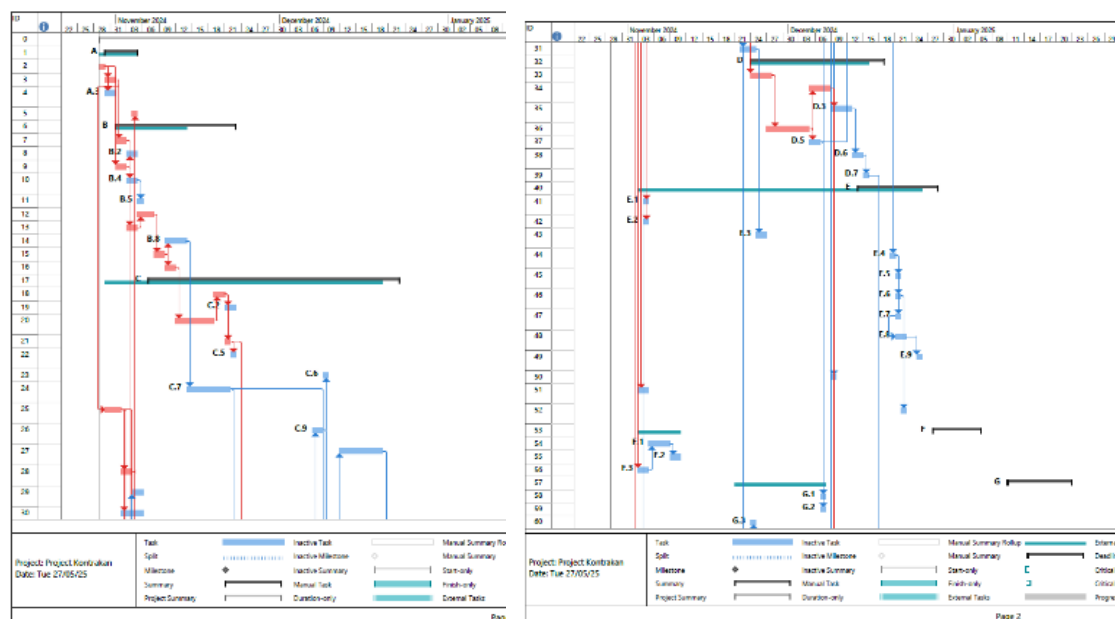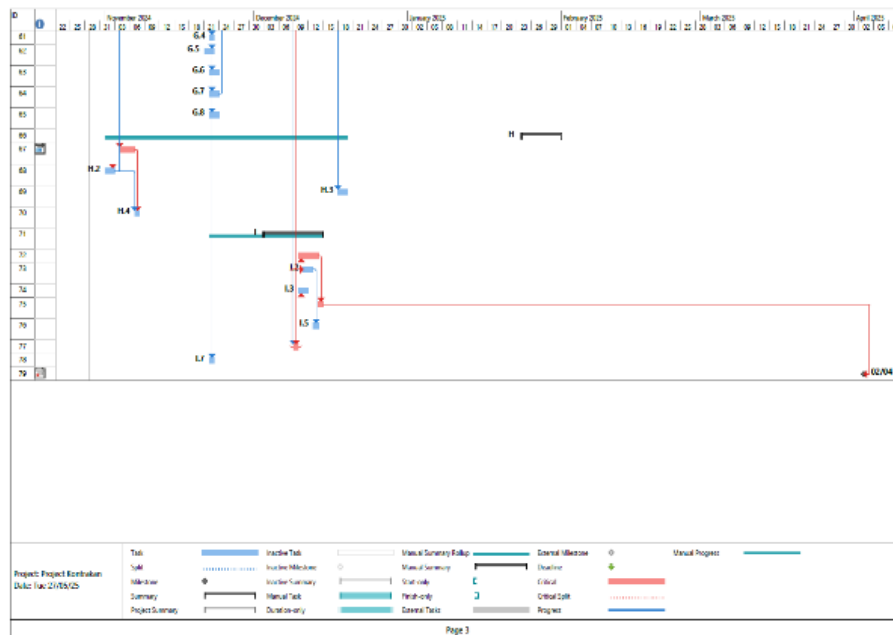

Fig 2: Quick Time Plan Scheme

Description: Critical Path

Based on Figure 2, the most efficient time sequence can be seen through the Gantt Chart as follows:

Fig 3: Gantt Chart Quick Time on Microsoft Project

Figure 3 shows the process of identifying critical paths and calculating the duration needed for each activity in the construction project of a 2-door rental house type 55. The main difference between a normal time chart and a critical path lies in the total duration of the execution of the entire series of activities. In this schema, the critical path is consistently defined as a series of activities: A-B-C-D-E-F-G-H-I-J.

This critical path describes a series of activities that determine the overall duration of the project and does not have any free time (float), Therefore, if there is a delay in any of the activities in this path, it will directly affect the overall project completion time (Basyri *et al*., 2024) [6]. CPM is used as a tool to systematically project the duration of a project by accumulating the duration of interconnected activities (Ama, 2021) [3].

Based on the sequence of activities on the critical path, the estimated minimum time to complete the type 55 rental house construction project is calculated using the CPM method. The total duration of all activities in this path is summed up to get the most efficient estimated completion time. The results of the analysis show that the fastest time required to complete this project is 146 days.

5. Conclusion
This study proves that the Critical Path Method (CPM) method is an effective approach in optimizing the implementation time of the type 55 two-door rental house construction project. Through the identification of critical activity paths and mapping relationships between jobs, CPM is able to simplify the project scheduling process in a systematic and data-driven manner.

The results of the application of this method show that the total project duration can be shortened from 176 days to 146 days, resulting in a time efficiency of 17.05%. The critical path consisting of a series of A-B-C-D-E-F-G-H-I-J activities is the main focus in time control because all activities on this path do not have a float and have a direct effect on the overall completion of the project.

The application of CPM to small-scale projects shows that the method is not only relevant for large infrastructure projects, but also provides real benefits in the context of simple residential construction. In addition, the use of software such as Microsoft Project in Gantt Chart visualization and network charts has been proven to support the project planning and monitoring process more efficiently and professionally.

Thus, this research makes a practical contribution for construction industry players, especially in the small-medium scale housing sector, in managing project time in a more structured, adaptive, and results-oriented manner. CPM can be used as a strategic tool in reducing the risk of delays while improving the accuracy of development schedule management.

6. Thank-You Note

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