



House construction of time scheduling using critical path method (CPM) in selili district

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ABSTRACT

Project time management is the process of planning, compiling, and monitoring the project activity schedule. This is an approach to meeting needs in construction projects that involves managing the planning, design and project implementation processes in an integrated manner. The aim of this research is to determine the effect of accelerating work duration using the CPM (Critical Path Method) method on the Selili sub-district project. The acceleration alternative used is by cutting work time and combining several jobs that can be done at one time by looking for advanced calculations and backward and critical path calculations use the critical path which is then accelerated in the form of shortening the time of activities on the critical path. Then a float diagram is created to determine the work that has been cut. The results obtained from the work using the CPM method are a summary of work days of 15 days from the initial plan which was planned to be completed within 163 days, after going through the critical path using the critical path and knowing the results of the forward and backward calculations then depicted in a float diagram that the work can be completed within 148 days.

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INTRODUCTION

Along with the increasing need for housing in metropolitan areas, such as in Samarinda City, it is becoming increasingly important because many people are migrating to cities to find work or pursue education. In this context, home business is a very promising opportunity, especially in the metropolitan city of Samarinda which has large universities and industry. The arrival of many students, college students and workers from outside the area has resulted in the demand for houses increasing, making this business even more popular. Therefore, many companies aim to market their properties to various levels of society.

In the midst of this opportunity, competition among home developers is becoming increasingly fierce as they compete to meet consumer demand by building houses or rentals according to their preferences and needs. One of the areas experiencing rapid growth in the property industry is the Selili area, Samarinda City.

In addition, home development companies that are able to complete projects on time and cost efficiently have greater sales opportunities. However, this strategy must be implemented carefully and thoroughly, starting from initial planning to the final completion stage, to ensure the smooth running of the project and avoid obstacles. Aspects that need to be considered include selecting the location of the house, designing the house according to the target market, and the overall project implementation stage.

The success of a project really depends on the level of effectiveness and efficiency, because the aim is to complete the project according to the predetermined schedule without additional costs exceeding the Cost Budget Plan that has been prepared. If the project can be completed ahead of schedule, it will result in cost savings and become more efficient. This cost savings benefits the project not only in terms of efficiency, but also in terms of effectiveness in implementation time.

The success and success of a construction project is the result of careful planning, by avoiding ineffective work processes in the project and ensuring that there are no additional costs from those planned at the beginning of the project (Yuliarty dalam Tamalika et al., 2022)

In addition to effective time management, it is also important to ensure project implementation according to plan. In construction projects, aspects of cost, time and quality are the main focuses that must be considered and achieved. Cost and time are interrelated, so if one of them exceeds the planned estimate, it will usually have an impact on increasing costs in general.

This is a concern when carrying out work, with the hope that time and costs are according to planning and quality is maintained (Rahmanto & Janizar, n.d.). When construction is found that does not achieve the desired performance to complete the project on time, it is necessary to analyze the time management of house construction by the contractor company. This aims to identify deficiencies and weaknesses that may occur during the construction process, so that it can provide valuable input for contractors to improve the quality of time management in implementing home construction projects.

In research conducted by Lilyana (2020) believes that the time management carried out by construction companies in Medan has been implemented well, but has not been able to be carried out optimally due to the obstacles encountered in implementing the time management system. Problems that arise in updating the schedule are having to change the master schedule and project completion date if there are changes to milestones and experiencing difficulties in procuring materials at remote project locations due to changes in activity duration, whereas in Pratasik, et al.'s research (2013) argue that shortening the duration of the critical path provides optimal time compared to the duration of non-critical activities. The accelerated duration of project implementation with additional working hours is 16 working days faster than the previous project implementation schedule. Implementation of this development project uses performance indicators, namely time, cost and quality. These indicators have long been the success criteria used to transmit the performance of a construction project.

Therefore, time management plays a very important role here. In addition to clarifying priorities, the aim is also to improve the efficiency and effectiveness of project management, so that optimal results can be achieved with available resources. All of this helps in achieving the goal of success of your home improvement project, while maintaining the established time (schedule) and cost (budget) criteria. In this study, we adopted the CPM (Critical Path Method) method to evaluate cost estimates and time periods, including the types of materials to be used, labor costs, and other aspects for house renovation projects in the Palaran area. In addition, we will develop project management based on cost and schedule control. We will explain the implementation in detail.

literature review, The word management comes from the words *manos*, *managio*, *manage*, which means training horses to lift their legs, a quote from Latin / Italian / French. Therefore, it is understood that organized steps are needed in stages, therefore management is very identical to organizing and organizing with its functions.

Management is a field that studies how to manage businesses from small to large scale with specific goals. by using the same management system by people and organizations that are different from each other. This is due to differences in culture, experience, environment, social conditions, economic level, nature of human resources, and ability to understand the basic principles of management (Kiswati & Chasanah, 2019). Projects are the use of various techniques to manage human, material and financial resources, as well as carrying out work tasks independently within a certain time period in accordance with relevant business plans, with the aim of achieving quality and quantity targets set by indicators (Rembulan & Yuhao, 2023).

Planning is one of the functions of project management that aims to make the work can run to achieve the goal without much deviation. Project control is a systematic effort to determine the standards in accordance with the planning objectives. Design and compare the implementation with the standards, analyze the possibility of deviations between the standard and the project. possible deviations between implementation with the standard, and take necessary corrective action so that resources are used effectively and efficient use of resources in order to achieve objectives (Gst Ketut Sudipta, 2013).

Planning is one of the function of project management which aims so that the work can run achieve the target without much deviation. Project control is a systematic effort to determine standards in accordance with the objectives planning. designing and comparing implementation with standards, analyzing possible deviations between implementation with the standard, and take necessary corrective action so that resources are used effectively and efficient use of resources in order to achieve objectives (yuliana, n.d.)

Project management is the process of planning, organizing, directing, and controlling the activities of organizational members and other resources so that the organization's stated goals can be achieved (Padma Arianie & Budi Puspitasari, 2017).

Project management involves managing limited time and resources to achieve predetermined end goals. In the process of achieving these goals, project activities are constrained by budget, schedule and quality standards, which are generally referred to as the triple constraint (Mutia Astari & Momon Subagyo, n.d.). Project management is a field of science related to organizational management. This includes designing activities and organizing how to use limited resources to produce an effective and efficient project, of course taking into account its limitations (Pangestu et al., 2021).

Project time management is the process of planning, compiling, and monitoring a schedule of project activities. Time management is included in the processes required to ensure project completion time, and planning and scheduling have provided specific guidelines to complete project activities faster and more efficiently (Hidayat & Ramadhany, n.d.).

Rahardjo Adisasmita in yusdiana & satryawisudarini inne, n.d.) states that "Effectiveness is a series of inputs, processes and outputs in looking at a certain thing". In an organization or company, programs or activities are considered effective if the output produced can meet the expected goals. Effectiveness is a condition or situation where in choosing the goals to be achieved and the means or equipment used accompanied by the desired goals can be achieved with satisfactory results.

Project activities can be defined as a unique activity carried out within a limited period of time, allocating certain resources and aimed at producing a product with clearly defined quality standards (Soeharto Imam in (Wilson Simanungkalit et al., 2022). Project implementation requires proper planning, scheduling, and time management of project activities. There are several factors that affect the progress of a development project, including adequate resources, the availability of

tools and materials that meet project work standards, and natural conditions that may not yet exist when the project is implemented. Project success depends on the adequacy and timeliness of project implementation (Ilwaru et al., 2018). Therefore, time management is very important to streamline project time, and in addition to clarifying priorities, efficiency, and effectiveness of project management to achieve maximum results with available resources also aims to increase success in meeting the criteria of time (schedule), cost (budget) and quality (quality) (Prawira NST, 2020).

Construction management is an approach to meeting needs in construction projects. This involves managing the planning, design and implementation processes of a project in an integrated manner (Penerapan et al., 2018). These tasks are assigned to a management team consisting of the owner, manager, and design organization, with possible inclusion of contractors and/or financial support agencies. Contractual relationships between team members aim to reduce conflict as much as possible and increase cooperation within the team.

according to (Sutomo et al., n.d.) Network Planning or Critical Path Method (CPM) is the one of the methods used to planning and controlling project time. project. Network diagrams are often called with arrow diagrams, because the activities in the activities in the network are expressed with arrows, drawn with certain symbols symbols. The Critical Path Method (CPM) is usually used to plan, monitor and control large and complex projects (Iluk et al., 2020). While obeying (Budhy Prasetya, n.d.)The critical path method (CPM) is a project planning technique designed by Morgan R. Walker from Dupont and James E. Kelley from Remington Rand in the late 1950s. In addition, the CPM (critical path method) method helps prioritize the process of moving previous activities before carrying out the next activity (Ilwaru et al., in Susilowati & Hartono, 2023). According to Maley in Prabowo & Anhar, n.d. states that "CPM presupposes that the duration of activities in a project is known and can be used to shorten the duration. activities in a project are known and can be used to shorten the duration of the project by allocating more resources to some activities. by allocating more resources to some important activities. activities. Four kinds of time terminology used in the CPM implementation process include (Maryani & Murni in Husna et al., 2022): (1) earliest start time. (2) latest start time. (3) earlist finish time. (4) latest finish time.

RESEARCH METHOD

Network (network planning) is the relationship between work components displayed in a network diagram, helping determine the sequence of work and ensuring the smooth running of the project for optimal results from the available resources.

The CPM method involves estimating time for each project activity. There are normal and accelerated estimates, with the critical path concept being important in determining project completion time. Identifying the critical path is essential to avoid delays that can affect the entire project. Some projects may have multiple critical paths. There is some terminology involved in connection with the forward calculation and backward calculation of the Activity On Arrow (AOA) method, namely Early Start (ES) is the earliest time before an activity can start after the previous activity has finished, Late start (LS) is the latest time before an activity can start. completed without slowing down the completion of the project schedule, Early Finish (EF) is the earliest time before activities can be completed if they are started at the earliest time and completed, Late Finish (LF) is the latest time before activities can be started without slowing down project completion (Siswanto, Agus B & M. Afif Salim dalam Clara Aprillia & Qurrota, 2023)



Figure 1. Work network

Information:

ES: earliest start time (Early Start)

LS: slowest start time (Late start)

EF: earliest finish time (Early Finish)

LF: slowest finish time (Late Finish)

i: previous activities

j: activities reviewed

To determine the working network on CPM, there are two calculation methods used, namely (Widya Santi and Lenggogeni, 2014: 62-64 in Nadia Mulia & Candra, 2023):

Forward calculation (forward pass): Except for the initial job, a job can be started if the previous job (predecessor) has finished. Earliest finish time for a job = 0. Earliest finish time for a job is the same as the earliest start time and added to the period. the time of the work in question.

$$[EF=ES+D]$$

Earliest Start + Duration

If a job has two or more previous jobs, then ES is the largest EF of that job.

Backward pass: The countdown starts from the last day of project completion in a work network. The latest start time for a job is the same as the earliest start time and minus the duration of the activity in question.

$$[LS=LF-D]$$

Latest Finish - Duration

If a job is divided into two or more jobs, then the LF of that job is the same as the LS of the next smallest job.

Float/Slack: Float/Slack is a delay time initiated by an activity without causing delays to the entire project (Khusniyah, 2019:62). Activities with a slack value = 0 are called critical activities and are on the critical path.

$$TF = LS-ES \text{ or } LF-EF$$

RESULTS AND DISCUSSION

The construction work on this house project was completed in 163 days. The work of building this house was carried out by 4 workers. Supplies of materials such as sand, cement and wood are provided by the home owner and some tools are provided by workers. The information we get is through direct interviews with home owners.

Table 1. Project design data

No	Job Name	Job Symbol	Previous Work	Time (day)
1.	Preliminary work	A	-	6
2.	Foundation	B	A	16
3.	Sloof casting	C	A	8
4.	Wall	D	B, C	30
5.	Door and window frame work	E	D	7

6.	Roof	F	D	34
7.	Ceramics	G	E, F	50
8.	Plumbing installation	H	G	6
9.	Finishing	I	H	6

Based on the table above, there are several types of work in the process of building houses on the streets of Samarinda. This process starts from the beginning to the end of project activities. These activities are symbolized by several letters and are followed by follow-up work and there is also time for working on the project. Below is a picture of the working network obtained from the table above:

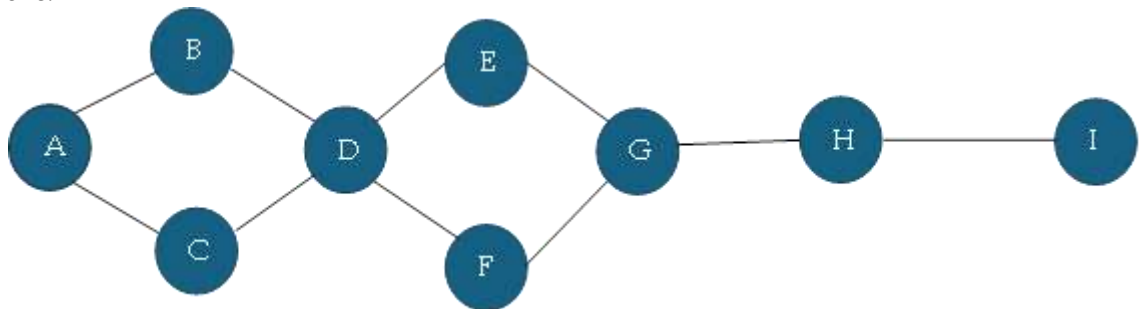


Figure 2. CPM work network

After creating and knowing the working network, we will create a working network by determining the critical path by carrying out forward calculations to find the ES and EF values, followed by doing backward calculations to find the LS and LF values (Nadia Mulia & Candra, 2023).

Table 2. Results of forward and backward calculations

No	Symbol	Time (day)	Advanced calculations		Countdown	
			ES	EF	LS	LF
1	A	6	0	6	0	6
2	B	16	6	22	6	22
3	C	8	6	14	6	22
4	D	30	22	52	22	52
5	E	7	52	59	52	86
6	F	34	52	86	52	86
7	G	50	86	136	86	136
8	H	6	136	142	136	142
9	I	6	142	148	142	148

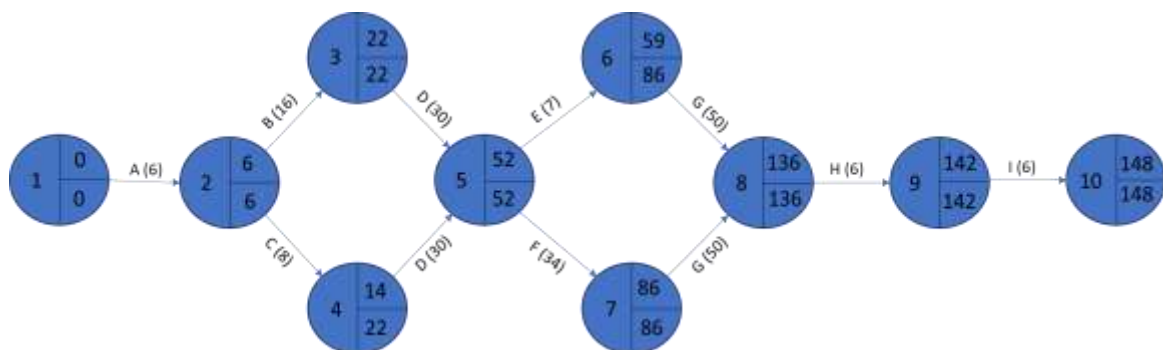


Figure 3. Forward and backward calculation network

After knowing the critical path and knowing the results of the forward and reverse calculations, then calculate the total float as follows:

Total float result formula:

Total float = LF - EF or LS - ES

$$TF(A) = 6 - 6$$

$$= 0 \text{ (Critical)}$$

$$TF(B) = 22 - 22$$

$$= 0 \text{ (Critical)}$$

$$TF(C) = 22 - 14$$

$$= 8 \text{ (Not critical)}$$

$$TF(D) = 52 - 52$$

$$= 0 \text{ (Critical)}$$

$$TF(E) = 86 - 59$$

$$= 27 \text{ (Not critical)}$$

$$TF(F) = 86 - 86$$

$$= 0 \text{ (Critical)}$$

$$TF(G) = 136 - 136$$

$$= 0 \text{ (Critical)}$$

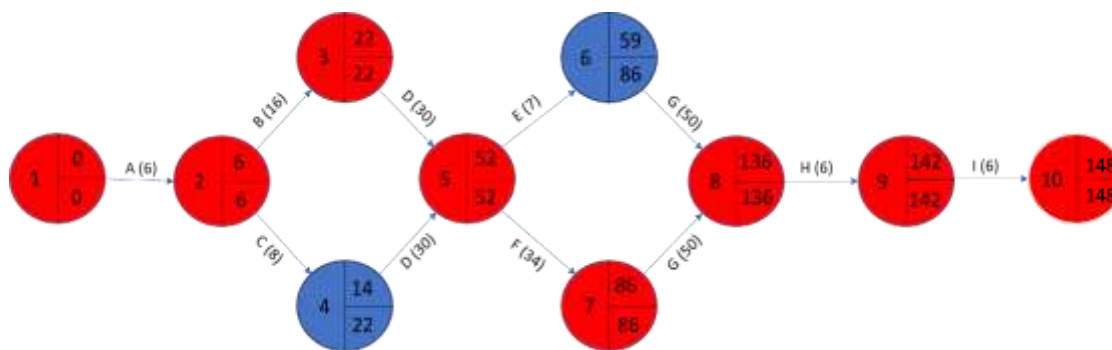
$$TF(H) = 142 - 142$$

$$= 0 \text{ (Critical)}$$

$$TF(I) = 148 - 148$$

$$= 0 \text{ (Critical)}$$

The results of the forward and backward calculations whose float time has been calculated to form a critical network can be seen in the following figure:

**Figure 4.** Critical path

Based on the picture above, a critical network is formed, namely activity A: initial preparation, activity B: foundation, activity D: wall work, activity F: roof work, activity G: ceramic work, activity H: plumbing work, activity I: finishing. So, the amount of time required for a development project through critical path calculations is $(6+16+30+34+50+6+6 = 148 \text{ days})$

The following is a view of the Microsoft report for the house construction project located in the Selili area, which can be seen below:

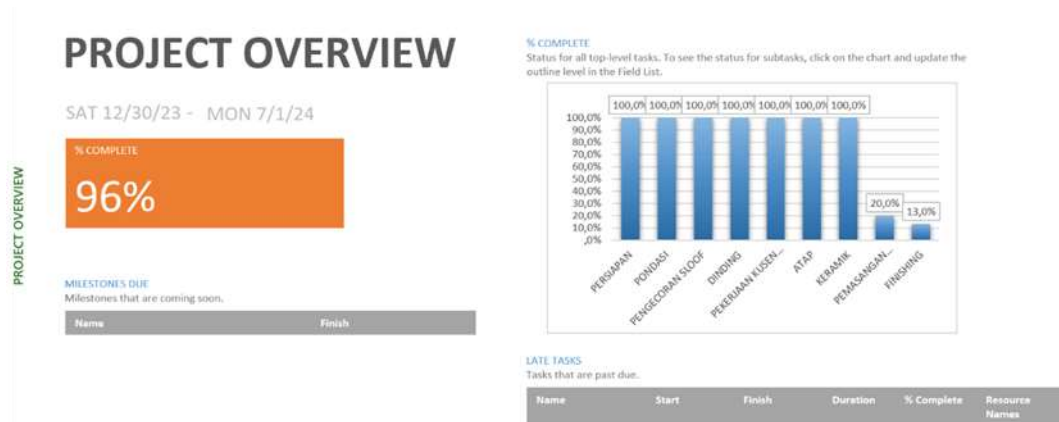


Figure 5. Project overview

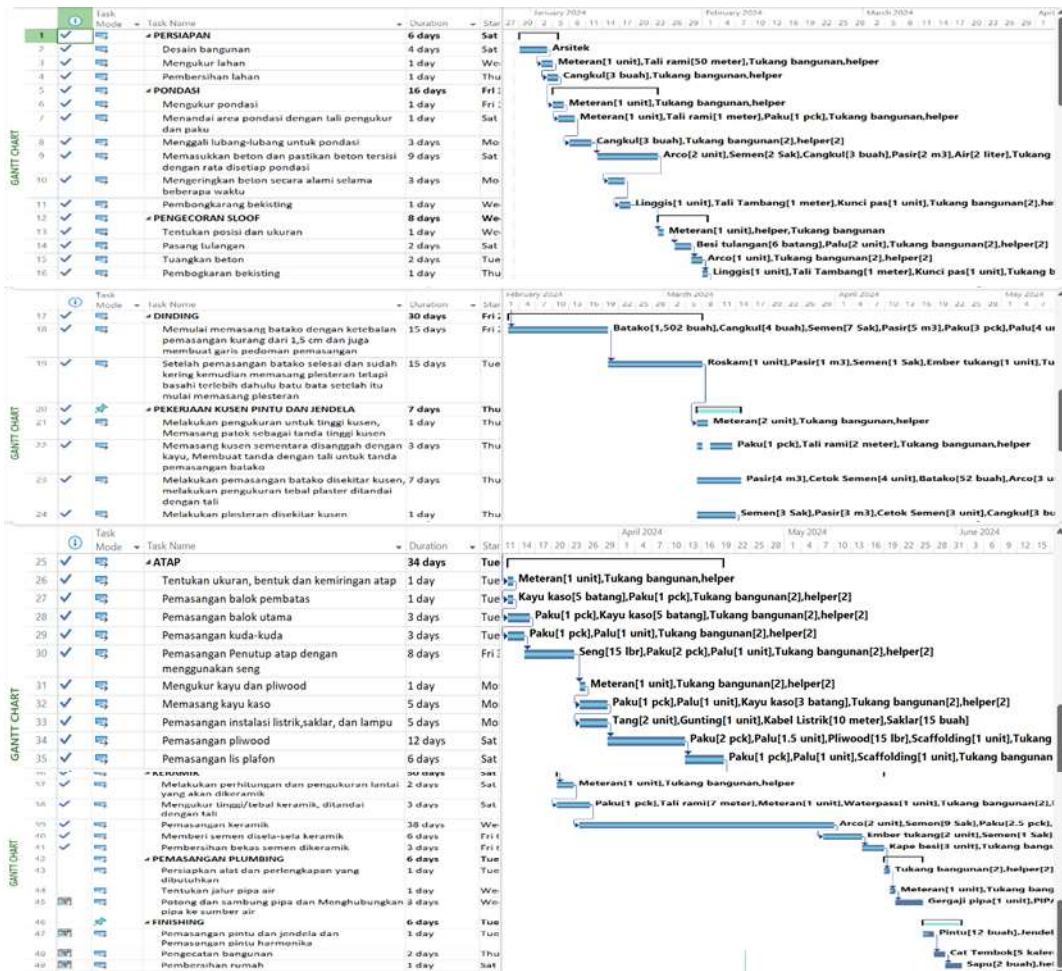


Figure 7. Gantt chart

CONCLUSION

Network planning is the relationship between work components displayed in a network diagram. This CPM method helps determine the sequence of work and ensures the smooth running of the project to achieve optimal results from available resources. The application of time management strategies on the float diagram in the CPM method can help project managers to find out which activities are prioritized to do and pay attention to first and also as an effort to accelerate and time efficiency.

The result of scheduling the construction time of the house using the Critical Path Method (CPM) in the Selili village is that there is a difference between the planning time and the original work time. That's because by using the cpm method, workers can distinguish which work must be done and completed first (priority scale), and with this cpm method workers can also combine two types of work at one time (parallel method) so that time efficiency occurs. So that the project was originally planned to be completed in 163 days with 4 workers. The necessary materials have been provided by the homeowner and some work tools provided by workers can be streamlined by this CPM method.

Based on the critical path that has been made, a critical network is formed, namely activity A: initial preparation, activity B: foundation, activity D: wall work, activity F: roof work, activity G: ceramic work, activity H: plumbing work, activity I: finishing. So, the amount of time required in this project after making the critical path is $(6+16+30+34+50+6+6 = 148 \text{ days})$ which means that using the CPM method in this project has saved time for 15 days from the initial plan count.

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