



Project management planning of the small house construction in samarinda using the critical path method (CPM)

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ABSTRACT

The house construction project was carried out in a span of 120 days involving 6 people. Data processing is carried out to ensure the smooth implementation of the project in accordance with the predetermined plan. By using the literature study method and secondary data processing, this study aims to develop an effective and efficient house construction project management plan, the method used in this project planning is the CPM critical path method (Critical path method). The project is carried out by 6 people, all materials such as sand, stone, cement and wood have been prepared in advance by the project owner. The information used in this analysis is based on direct interviews between the project owner and the researcher. Thus, the main conclusion is that effective and efficient project management, including careful budget planning and good control, is very important in ensuring the success of house construction. By maintaining a balance between time, budget, and quality, and applying the latest management techniques, the house construction project can be completed well in accordance with the set plan. The house construction project was carried out in a span of 120 days involving 6 people, with Mr. Ardiansyah in charge of project management. All materials such as sand, stone, cement, and wood have been prepared in advance by the project owner, ensuring the availability of construction materials during implementation. Normal and quick duration work network analysis is used to understand the sequence of construction activities, fastest duration, and normal duration of each project activity. By utilizing the CPM method, the critical path of the shophouse construction project can be identified to calculate the estimated project completion time and the minimum duration required.

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INTRODUCTION

The Planning and managing infrastructure is essential for development. Good management is used to perform specific tasks, such as projects Mutia & Momon, (2021) Projects are activities or activities that take place within a limited period of time to achieve the expected targets within a set period of time and the availability of necessary resources. On the other hand, project management describes the sequence of activities in an engineering system, in which all resources, including time, funds, human technological equipment, and materials, are structured and organized to achieve project objectives Abadiyah et al., (2020) .Projects consist of three main steps: planning, scheduling, and controlling. These steps determine the success of a project. Project failure is usually caused by a lack of planning and ineffective control, which can result in delays, decreased quality of work, and increased costs Muhassanah & Annisa Khozinati (2021).

One method that can be utilized in project planning is using the Critical Path Method as revealed by Hadicara and his colleagues in 2023. In their study, Hadicara & Rochim (2023) suggested that the results of the CPM Method not only determine how long it takes to complete the project, but also determine the type of important work that must be completed. The calculation results showed that the construction project required 128 days, two days faster than the previous plan, which required 130 days.

Similar research was conducted by Muhassanah and colleagues in 2021, suggesting that CPM made the completion time of the type 33 house construction project in Kedungrandu Regency Housing 42 days faster than the originally scheduled 64 days. Research conducted by Mutia Astari & Momon Subagyo (2021) is that there are differences between the CPM and PERT methods in project acceleration. The CPM method completed the project in 105 days with an acceleration cost of IDR 8,715,430,218 and additional worker costs of IDR 115,775,313, the PERT method completed the project in 129 days with an acceleration cost of IDR 8,689,619,905 and additional worker costs of IDR 89,965,000, the acceleration of time in the CPM method resulted in a greater increase in costs, while the PERT method provided a more cost-efficient completion. Research by (Perdana & Sari, 2022) CPM which produces optimal scheduling. However, according to Ekanugraha (2016), the course of the development project was not in accordance with the initial plan. As a result, many errors occur, such as delayed projects and increased costs, which can hinder the project process from start to finish. In addition, this study emphasizes the fact that a number of previous studies have focused on time scheduling, and the results show that these studies have not succeeded in optimizing time. Such as research conducted by Aulady et al., (2016) discusses the comparison of project time duration with CPM and CCPM methods. The results show that the CPM method takes less time than the CPM method. The time duration for CPM is 121 days while the CPM method time duration is 169 days, CCPM is 48 days faster than CPM.

The results of previous studies were inconsistent, so this study was conducted to ensure the results directly match the schedule in the field, especially for scheduling house construction projects using the CPM method.

Critical Path Method has proven to be a valuable tool in construction project management, the gaps identified in previous studies highlight the need for further research in areas such as real-time application, cost optimization, integration with technology, and broader consideration of external factors. Addressing these gaps can lead to more effective and resilient project planning and execution in the construction industry.

Project management is very important in the context of infrastructure development in Indonesia, and this can be understood through several main aspects, namely, time and cost efficiency. In this aspect, budget control, good project management helps in controlling costs and budgets. In Indonesia, where infrastructure projects often have large budgets and involve public funds, strict budget management is essential to prevent waste and corruption. Next is the aspect of quality of work, High-quality infrastructure is the foundation for long-term development. Project

management ensures that these projects are built according to established standards, so that they are safe, durable, and functional. In addition, social and economic impacts, Reliable infrastructure is a major driver of economic growth. Well-managed projects are not only completed on time and on budget, but also provide sustainable economic benefits to the community.

Project management is a key element in the success of infrastructure development in Indonesia. With strong project management, the government and project implementers can ensure that infrastructure projects are not only completed on budget and on schedule but also provide optimal quality and benefits to the community.

Project Management, Management is the art of leading an organization, which includes planning, implementing, and controlling limited resources to achieve goals and targets. (Siswanto & Salim, 2019). To ensure that the management of limited resources achieves maximum results in accuracy, speed, savings, and overall work safety, management strives for the most optimal rarity. Dwi Akbar et al. (2024) Project management is an integrated process by which individuals from an organization are engaged to maintain, develop, control, and execute programs efficiently, effectively, and on time.

According to the Project Management Body of Knowledge (PMBOK), project management is the application of knowledge, skills, tools, and techniques used to design activities in accordance with project objectives. In addition, project management is also referred to as a collection of people, materials, information, or resources that use modern management methods to achieve predetermined goals (Siswanto & Salim, 2019) In other words, project management means the application of science, skills, "senses and techniques", and "the science and art of managing, coordinating resources such as people and materials using an up-to-date management technique, according to predetermined objectives, such as: scope, quality, time, and budget, desired by the work owner". According to the Project Management Institute, projects can be divided into five parts based on their process: (1) initiation process; (2) planning process; (3) execution process; (4) control process; and (5) closure process. (Siswanto & Salim, 2019).

As mentioned earlier, the concept of project management has several key objectives. First, it is completed on time by setting a schedule that ensures tasks start and finish at the set time. Continuous monitoring is done to ensure the project runs on schedule, even with accelerated execution if needed. Second, maintaining the budget by finding a balance between the minimum budget and achieving project objectives efficiently. Third, maintaining project quality by setting quality standards that must be met from the start of planning, so that the project is not only completed quickly but also with adequate quality. Finally, it is to smooth the project by completing it according to the initial planning, including the time, budget, and quality that has been set. With effective project management, project work can be completed properly according to the plan that has been set Panjaitan et al., (2023).

Project management is the art and science of managing human and material resources with the latest management techniques to achieve project objectives. The goal is to achieve the highest level of accuracy, speed, economy, and safety. It encompasses the application of knowledge, abilities, and techniques required to plan, execute, control, and close a project. Initiation, planning, execution, controlling, and closing are the five components that make up the process. In project management, the main objectives are to complete the project on time, adhere to the budget, maintain quality, and start the project according to the original plan.

Labor, Alamsyah et al. (2020) Labor is a very important factor in production, because labor is a driving factor for other input factors, without labor, other production factors will be meaningless. With the increase in labor productivity, it will encourage increased production so that income will also increase. There are several definitions of labor, including according to Law No. 13 of 2003 Chapter I article 1 paragraph 2, it is stated that labor is every person who is able to do work in order to produce goods and / or services both to meet their own needs and for the community. Broadly speaking, the population of a country can be divided into two groups, namely labor and

non-labor. Based on Article 1 Point 2 of Law No. 13 of 2003 concerning Manpower is every person who is able to do work in order to produce goods and services to meet their own and community needs. The definition of labor in Law No. 13 of 2003 perfects the definition of labor in Law No. 14 of 1969 concerning basic provisions of Manpower. Every production activity that will be carried out will definitely require labor. Labor does not only mean laborers found in the economy. The meaning of labor also includes the expertise and skills they have. In terms of expertise and education, labor can be divided into three groups: a. Manual labor, which is labor that is not educated or has low education and has no expertise in a field of work. b. Skilled labor, which is labor that has expertise from education or work experience. c. Educated labor, which is labor that has a high education and is an expert in certain fields Budihardjo et al. (2020).

Labor is crucial in production, driving all other input factors. Increased labor productivity boosts production and income. According to Law No. 13 of 2003, labor includes anyone capable of producing goods or services. Labor can be categorized into manual, skilled, and educated, based on their education and expertise. Every production activity requires labor, making it an essential component of the economy.

Time Schedule, To ensure that the project goes according to plan and can meet its time targets, project time management defines the processes that need to be carried out during the project to guarantee that the project goes according to plan, reduce costs, and maintain product or service quality (Faza, 2019). Time management means reliable and optimum project planning, resource and cost management, and schedule control that can detect delays immediately for effective and efficient handling. In other hand, Scheduling is an early description of the process of how to complete and control the project. Scheduling is the allocation of available time to carry out each job in order to complete a project to achieve optimal results by considering existing limitations (Husen, 2009: 133) in Soplanit et al. (2021).

Project time management ensures the project goes according to plan, reduces costs, and maintains quality with reliable planning, resource management, and schedule control. Scheduling allocates time for each job to optimally complete the project considering the constraints.

Network Planning, Herjanto (2009) In project execution, the most common model is network planning, which shows information about the activities being performed in a network diagram. With network planning, you can analyze the project completion schedule, possible project delays, dilemmas that may arise if the project is delayed, and other issues. CPM (Critical Path Method) and PER (Price Revenue Calculation) are two popular work network planning methods. The work network model is the dependency relationship between the parts of the work described/visualized in the work network diagram. This it is known which parts of the work should take precedence, if overtime is necessary (with additional costs), which work is waiting for the completion of other work, which work does not need to be rushed so that tools and people can be shifted elsewhere for efficiency (Badri, 1991, p. 13) in Aini et al. (2023)

In project execution, network planning is a common model that visually represents activities and their dependencies. It helps analyze project schedules, delays, and potential issues. Two popular methods are CPM (Critical Path Method) and PER (Price Revenue Calculation). Network planning clarifies which tasks should take precedence, when overtime might be needed, which tasks depend on others, and which tasks can be delayed for resource efficiency.

Critical Path Method (CPM), According to Siswanto (2007) in Bukhori & Assidiqi (2020) CPM is a method for analyzing work in the field of management. CPM is a model or method of management science in every project control, which was developed at the Du Pont company to build a factory by determining a schedule and a series of financing on time and at the right cost. CPM basically focuses on the issue of balancing cost and time to complete large projects. CPM makes the assumption that the activity time is known for sure, so only one factor is needed for each activity. In CPM, a "deterministic" method is used, which uses one estimate number (Heizer and Render, 2006) in Yuwono et al. (2021)

CPM (Critical Path Method) is a method for analyzing work in project management. This method focuses on the balance between cost and time to complete a large project, assuming that activity times are known with certainty and using a deterministic method with one estimate for each activity.

Critical Path, A critical path is a path that combines different parts of the activity with the longest time. Critical paths are found by looking at activities with zero EET and LET values ($EET - LET = 0$). If there is more than one critical path on the Network diagram, the path with the longest time duration is selected. Tanjung et al. (2021).

Some of the terms associated with forward and backward calculations in project management provide an understanding of the timing and sequencing of activities in a project. Early Start (ES) indicates the earliest time an activity can start, while Late Start (LS) indicates the latest time limit an activity can start without slowing down the project. Early Finish (EF) is the fastest finish time of an activity if started at its initial time, and Late Finish (LF) is the latest time limit an activity can be completed without disrupting the project schedule. It also involves the number and name of activities and the required duration, providing a basis for effective project planning and control Tanjung et al. (2021). The critical path is a very important part of CPM and PERT. Critical Path is a path that connects critical activities in the project. This critical meaning is an activity whose time delay will have an impact on the delay of the entire project. So that these activities must be maintained so that the completion time is not late Putra & Gandhi (2019)

The critical path method (CPM) and Program Evaluation Review Technique (PERT) are essential tools in project management for determining the sequence and timing of project activities. The critical path is the longest path through a project's activity network, consisting of activities with zero slack ($EET - LET = 0$). Key terms include Early Start (ES), Late Start (LS), Early Finish (EF), and Late Finish (LF), which help identify the earliest and latest times activities can start and finish without delaying the project. The critical path includes activities whose delays will impact the entire project's timeline, making their timely completion crucial.

S-curve, The S curve is a graph of the scheduling performance of all stages of work characterized by an S-shaped curve to control resource performance during construction implementation. The S curve in construction management is one of the variance identification techniques to spur the implementation of work and control resources and costs so that it can be applied properly in construction implementation Sari & Pratama (2024). S curve, According to Ir. Abrar Husen, MT (2011) Hidayat & Ramadhany (2021) the S curve is a graph developed by Warren T. Hanumm on the basis of observations of a large number of projects from the beginning to the end of the project. The S curve can show project progress based on activities, time and work weight represented as a cumulative percentage of all project activities. The S-curve is a graph developed by Warren T. Hanumm on the basis of observations of a large number of projects from start to finish. The S-curve can show project progress by activity, time and work weight represented as a cumulative percentage of all project activities. The S curve is a graph that represents the cumulative of all project activities. S curve visualization provides information on project progress by comparing the planned S curve with the realization. The S curve formulation is the sum of the cumulative percentage of the weight of each activity at a period between the project duration and plotted against the vertical axis so that if the lines are connected, it will form the letter S. Such a curve shape occurs because the volume of activities in the early part of the project is usually still small, then in the middle increases in a large enough amount, then at the end of the project the volume of activities decreases again Fadhlurrahman et al. (2024). The S curve is an S-shaped graph used in construction management to control the performance of resources, costs, and project progress based on activity, time, and work weight represented as a cumulative percentage of all project activities.

Draft Budget Cost (RAB), In development planning, planning budget cost (RAB) is basic. By using RAB, we can find out the strength of the material and the type of material used in making

the house, so that the costs incurred are more focused and in accordance with the plan Irawan & Yanto (2007). On the other hand, the cost budget design is a calculation of the amount of costs required in a construction project consisting of material costs, labor costs, and other costs related to the project based on the calculation of the volume of work that has been done before Junaidi et al. (2023). The preparation of a Cost Budget Plan (RAB) is to calculate the necessary costs of a building and with this cost the building can be realized as planned Marcelin et al. (2021).

In development planning, the Planning Budget Cost (RAB) is essential for determining material strength and types, ensuring focused and accurate cost allocation. It involves calculating total project costs, including materials, labor, and other expenses, based on the volume of work previously calculated. This helps in managing resources efficiently and staying within budget.

RESEARCH METHOD

Research Location

The research location or project location is on Jl. Mas Penghulu, Rapak Dalam, kec. Samarinda Sebrang, Samarinda City.

The selection of the location on Jl. Mas Penghulu, Rapak Dalam, Kec. Samarinda Sebrang, Samarinda City, is a relevant location for this research because this location has good access and adequate supporting infrastructure, such as easily accessible roads, which are important to support research activities or development projects. Samarinda Sebrang is an area with developing development potential, so research at this location can provide important insights into urban growth and socio-economic dynamics in developing areas. In addition, this location may have been chosen because of the availability of sufficient data or the ease of obtaining relevant information for research, such as demographic, economic, or other technical data.

Literature Study Method

The literature study method is carried out by searching and collecting reading materials or books related to the research title to make it easier for the author to understand the subject matter.

Secondary Data Collection

Secondary data is obtained from the second party directly with the project concerned. The secondary data obtained is the time schedule.

Pertama, Review the Time Schedule Start by thoroughly reviewing the time schedule data obtained from the project. This schedule should include all tasks, their durations, dependencies, and the sequence in which they must be completed, yang kedua Task Breakdown organize the data into a breakdown of all activities involved in the project. Assign each task a code for easy reference and identify any missing or unclear information that may need clarification.

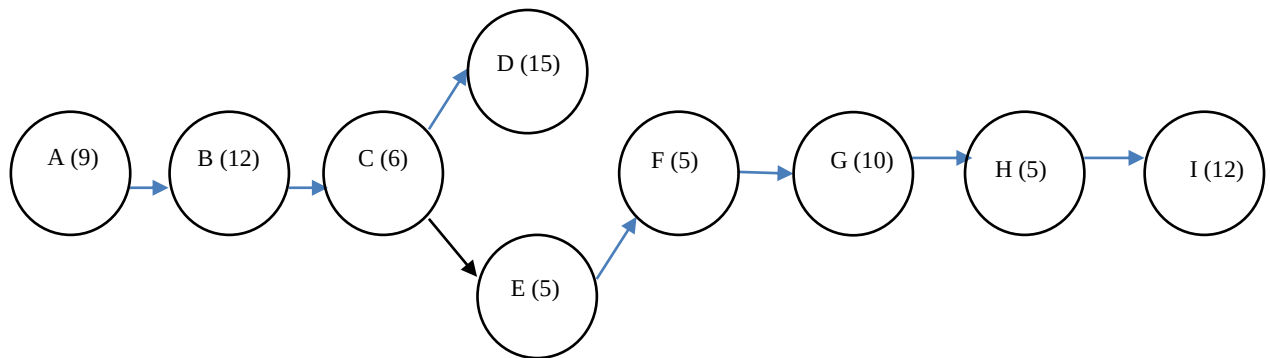
Data Processing

The steps that must be taken are as follows: (a) Determine the code and duration of each job to be carried out to facilitate network planning. (b) Making network diagrams in accordance with the logic and dependence between activities. (c) Earliest Event Time (EET) is determining when the fastest event occurs. (d) Latest Event Time (LET) is determining when the slowest event occurs. (e) Critical trajectory is a trajectory through events with $EET=LET$

Explanation

No.	Task Code	Kode	Duration (Days)
1.	Preparation	A	9
2.	Foundation	B	12
3.	Building Frame & Wall	C	6
4.	Roof	D	15
5.	Door & Window Frame	E	5
6.	Toilet/WC	F	5

7.	Floor	G	10
8.	Painting	H	5
9.	Finishing	I	12



RESULTS AND DISCUSSIONS

Overview of Project Activity Process

The house was completely built within a span of 120 days. The project was carried out by 6 people, Mr. Ardiansyah was responsible for project management. All materials such as sand, stone, cement and wood were prepared in advance by the project owner. The information used in this analysis is based on direct interviews between the project owner and the researcher. The data collected included the sequence of construction activities, subsequent activities, fastest duration and normal duration of each activity.

Table 1. Recapitulation of Project Activities

No.	Task	Kode	Duration (Days)		Prodeccessor
			Normal	Quick Time	
1.	Preparation	A	9	6	-
2.	Foundation	B	12	10	5
3.	Building Frame & Wall	C	6	6	11
4.	Roof	D	15	15	16
5.	Door & Window Frame	E	5	5	28
6.	Toilet/WC	F	5	5	20
7.	Floor	G	10	8	24
8.	Painting	H	5	5	33
9.	Finishing	I	12	7	39FS-1day

Normal Time Work Network Analysis Using CPM

From the results of the project activity summary in table 1, the researcher will proceed to explain the standard work duration network. The house construction process starts on February 5, 2024 and is expected to be completed on June 5, 2024, with a total normal duration of 120 working days. From the information contained in Table 1, we can construct a normal duration work network diagram as follows:

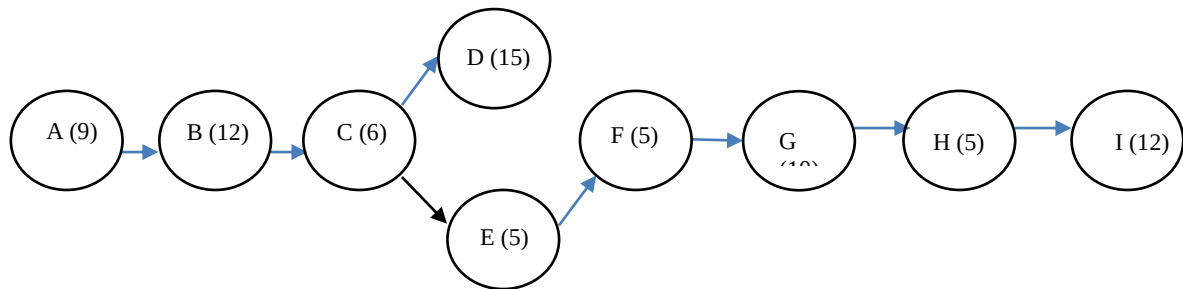
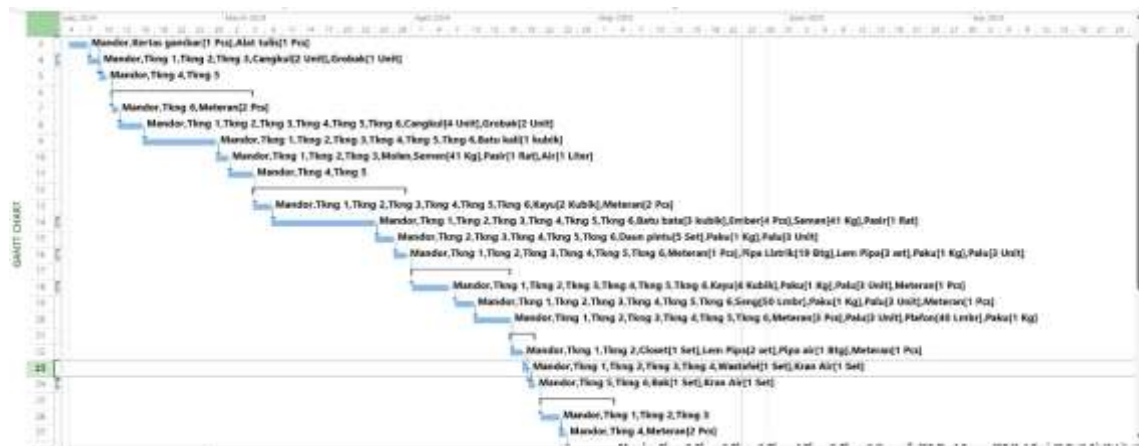


Image 1 Schematic of Normal Network Time Plan

Description:

→ : Critical Path

From the illustration in Image 1, an efficient duration schedule can be obtained using the attached Gantt Chart:



In Image 2, it illustrates the sequence of activities involved in a house construction project starting from the excavation of the foundation to the completion stage. The critical path to complete the project can be identified from Figure 1 through A, B, C, D, E, G, H, and J. This path includes preparation, foundation work, building frame and wall construction, roof installation, toilet construction, floor finishing, garden construction, and finishing. The timely completion of the project relies heavily on this critical path; any delays in these activities will have a significant impact on the overall project schedule.

By utilizing the Critical Path Method in project modeling, these main paths are critical in estimating the project completion duration for a home construction project. The total duration required for each activity in the project network diagram amounted to up to 120 days, representing the standard time required to complete the entire project.

Quick Time Work Network Analysis Using CPM

In the implementation of the Quick Duration Work Network Analysis, the steps taken are similar to the Normal Time Work Network Analysis. This is based on the summary of project activity data contained in Table 1.

Table 2. Quick Time Activities

No.	Task	Code	Duration (Days) Quick Time	Predecessor
1.	Preparation	A	6	-
2.	Foundation	B	10	5
3.	Building Frame & Wall	C	6	11

4.	Roof	D	15	16
5.	Door & Window Frame	E	5	28
6.	Toilet/WC	F	5	20
7.	Floor	G	8	24
8.	Painting	H	5	33
10.	Finishing	I	7	39FS-1day

The implementation process of the shophouse construction started on February 5, 2024 and finished on June 5, 2024. This results in a quick duration network diagram in the figure below.

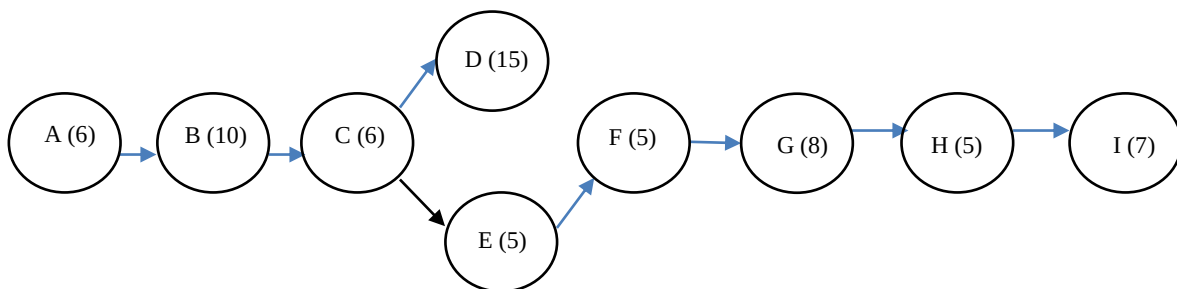
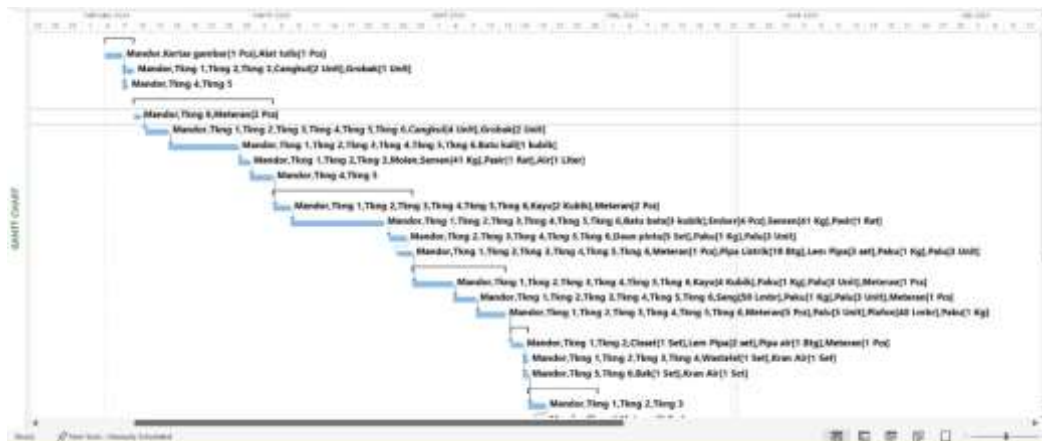


Image 3 Schematic of the Fast Network Time Plan

Description:

→:Critical Path

From Image 3, an efficient time arrangement using a gantt diagram can be seen as follows:



The fourth illustration outlines the process of identifying the critical path and determining the duration required for task completion in a home project, which mirrors the technique used in the Normal Time Work Network Diagram. However, the main difference lies in the overall duration required to complete the entire project. In the Normal Time Network Diagram, the critical path remains consistent, specifically as A B C D E G H I.

By utilizing this critical path, it becomes feasible to estimate the completion time of the shop house construction project through the CPM project modeling approach. To ascertain the minimum duration required for project completion, the total duration of each activity in the work network diagram was calculated. The findings revealed that the minimum time required to complete the house construction project was 107 days.

CONCLUSION

Based on the results and discussion presented, the following conclusions can be drawn. The house construction project was carried out in a span of 120 days involving 6 people, and Mr. Ardiansyah was responsible for project management. All materials such as sand, stone, cement, and wood were prepared in advance by the project owner, ensuring the availability of construction materials during project implementation. Normal and quick duration work network analysis was used to understand the sequence of construction activities, quickest duration, and normal duration of each project activity. By utilizing the CPM method, the critical path of the shophouse construction project can be identified to calculate the estimated project completion time and the minimum duration required. The findings revealed that the minimum time required to complete the house construction project was 107 days. the efficiency time is 13 days.

Further studies could evaluate the use of alternative construction materials and their impact on project timelines and costs. For instance, prefabricated materials or modern building techniques could potentially reduce the duration of the construction process.

Examine the cost implications of achieving the 13-day time efficiency. This could include analyzing whether the additional costs of accelerating the project (e.g., overtime pay, expedited material delivery) are justified by the benefits of an earlier project completion.

Based on the results and discussions presented, several conclusions can be drawn as follows. The house construction project was carried out within a period of 120 days involving 6 people, and Mr. Ardiansyah as the person in charge of project management. All materials such as sand, stone, cement, and wood were prepared in advance by the project owner, to ensure the availability of construction materials during the project implementation. Normal and fast duration network analysis was used to determine the sequence of construction activities, the fastest duration, and the normal duration of each project activity. By utilizing the CPM method, the critical path of the shophouse construction project can be determined to calculate the estimated project completion time and the minimum duration required. The results of the study showed that the minimum time required to complete the house construction project was 107 days. The efficient time required was 13 days

The 13-day time saving in a house construction project can be explained by several factors that contribute to the time efficiency. Several factors that may influence the time savings and the steps taken to achieve this efficiency are: careful planning, which uses the CPM method to identify the project's critical path, which is a sequence of activities that must not be delayed without affecting the overall completion time of the project and also proper scheduling, seen from the Normal duration and fast duration for each activity are calculated, allowing management to choose the most efficient approach without sacrificing quality. By utilizing this analysis, the project can be completed in a shorter time. Furthermore, resource optimization with efficient utilization of labor and the application of efficient construction techniques. Using more efficient methods or technologies in construction implementation, such as prefabrication techniques or the use of appropriate heavy equipment, can speed up the completion of the work.

Time efficiency can result in cost savings if planned and managed properly. However, if project acceleration requires additional resources or affects quality, project costs can increase. Therefore, the decision to accelerate a project must consider the balance between the additional costs that may be required and the potential savings or benefits generated.

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