Unisma Sports Center Building Project Control Analysis Using the Critical Path Method (CPM)

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A B S T R A C T

The purpose of this research is to determine the scheduling activities for the construction of the Sport Center Building at the Islamic University of Malang, to determine and analyze the control of building construction projects managed by the Islamic University of Malang using the CPM (Critical Path Method) method. This research uses the research method used in this research, namely the descriptive method. The data collection techniques used were observation, interviews, and library research. After obtaining information through interviews, data analysis was carried out using the CPM (Critical Path Method) method. The researcher has completed the research and from this analysis, the researcher found that the construction work carried out by the Islamic University of Malang required 180 days of work using the CPM (Critical Path Method) method, so the optimal duration of the project can be accelerated to 33 days so that the initial project duration is 196 days. working days to 163 days with an efficiency of 16,837%

1. Introduction

Construction is the activity of building facilities and infrastructure. Development is an important factor in the development of the Islamic University of Malang. In terms of the form of construction, this building was carried out to increase student creativity according to their fields and to become an added value for the Malang Islamic University Campus. For this reason, the Islamic University of Malang needs to carry out several development projects such as building hospitals, offices, laboratories and etc with the development of this infrastructure, employee welfare will be achieved.

A good construction project implementation method if it meets the requirements [1] (Syah, M. S, 2004), namely: Technical, Economical, Non-technical, Alternative/best choice.

In implementation, of course there is a process, so the definition of process is a series starting from the beginning of determining the target until the end of achieving the target, while

the activities that take place are a function of management [2-4]. Each project will be limited by scope, time and costs [4, 5]

According to [6] In the manufacturing industry there is a scheduling method which when allocating and leveling labor takes into account the position weight value first, then takes into account the float time. This scheduling method is called the Ranked Positional Weight Method (RPWM).

Construction projects can be divided into two types of groups, namely [7]:
1. Buildings, such as: houses, offices, factories and others
2. Civil buildings, such as: roads, bridges, dams and other infrastructure.

According to [8] explains that a project is a project that has a specific goal. The project must produce a specific product, service, and end result, and be temporary. Project work involves several Human Resources whose activities are interconnected and projects usually use effective resources to complete the project efficiently and on time.

In development, problems are often experienced starting from uncertain times, quality that is not maintained costs and so on. This work will result in losses for both parties in terms of time, which will affect costs. For this reason, the CPM method is very important for planning development to be more effective. Because having optimal planning and control will minimize failure in project completion. Often problems arise due to time so in the end the project planning can change. In this case, one example is the multi-purpose building construction project in the Malang Regency area, which is a project that is experiencing time delays.

To overcome this problem, the researcher tried to use project management analysis to overcome the problem of project completion time using the Critical Path Method (CPM).

To overcome this problem, researchers try to obtain data, where research object data is a scientific target to obtain data with a specific purpose and use about something objective[9]. To use project management analysis to overcome project completion time problems using the Critical Path Method (CPM).

Based on the description of the background to the problem above, the author feels interested in "Analysis of Work Control for the Sport Center Building Project Using the Critical Path Method (CPM) to Minimize Work Time on Projects at the Islamic University of Malang".

2. Research Method

Based on the objectives and problems raised, this research is included in quantitative research. This research aims to analyze the critical flow, the fastest time in the Unisma Sports Center project. This research was conducted on Jalan Mayjen Haryono 193, Donoyo Village. Lowokwaru District, Malang City or in the Malang Islamic University Campus area.

Critical Path Method (CPM) is a technique for analyzing a network of activities/activities when running a project in order to predict the total duration.

CPM can provide valuable insight into how to plan projects, allocate resources, and schedule tasks. Here are some reasons you should use this method: Improve future planning: CPM can be used to compare expectations with actual progress.

According to [10] project scheduling includes people, money and materials being linked to specific activities and connecting each activity to one another.

According to[7, 11] Project management is the activity of planning, organizing, leading and controlling company resources to achieve targets within a predetermined short time period.

According to Eddy Herjanto [3] defining network planning is one of the models that is widely used in project implementation, the product of which is information about the activities in the network diagram in question.

[5] state that a project is a temporary effort to produce a unique product, service or result. Projects always have three components: 1. Specific Scope or Product, namely there are

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results or products with a specific scope that are expected to be achieved, 2. Schedule, namely having a set date regarding when project work starts and when project work is completed.

[10] explain that a project can be described as a series of related tasks aimed at a main result. The more advanced human civilization becomes, the bigger the projects undertaken and of course they require good management.

[12] explains that a project can be defined as an effort or activity organized to achieve important goals, objectives and hopes using budget funds and available resources, which must be completed within a certain time period.

[13] explains that project management is an activity to achieve goals that have been clearly defined and determined as efficiently and effectively as possible. In order to achieve the agreed targets, resources are needed, including human resources, which are the key to everything.

To minimize project time for development, the Critical Path Method (CPM) method is used.

3.   Description and Technical

1. Research Location

   This research was conducted on Jalan Mayjen Haryono 193, Donoyo Village. Lowokwaru District, Malang City or in the Malang Islamic University Campus area.

2. Data Collection Techniques

   The following data collection methods will be carried out in this research by submitting data requests to the relevant agencies, namely:

   A. RAB Project Time Schedule data
   B. Project Working Drawing Data
   C. Project Tool Method Data
   D. Human Resources Data in the Project

3. Instrument Analysis Tools.

   The CPM method is Network Analysis, Network Diagram, Time Activity Duration and Critical Path. Data collection is from work implementation items and time schedules. The CPM planning method involves collecting data, analyzing data processing, planning the CPM method and flowcharts.

   In this step, it is first necessary to carry out forward and backward calculations, namely forward calculations *(Forward Computation)* and backward calculations *(Backward Computation)*.

   [14] In forward calculation, the calculation starts moving from the initial event to the terminal event. The point is to calculate the earliest time for an event to occur and the earliest time for an activity to start and finish (TE, ES, and EF).

   Formula :

   $EF(i,j) = ES(i,j) + t(i,j)$

   In backward calculation, the calculation moves from the terminal event to the initial event, the aim is to calculate the latest time for the event to occur and the latest time for the start and completion of all activities (TL, LS, and LF).

   Formula :

   $TL = LS (i,j) = LF (i) - t (i,j)$

   Based on the results of time comparison with network planning analysis using the CPM (critical path method)

   $$E = \frac{\text{W.P Actual} - \text{W.P using Analysis CPM}}{\text{Actual Work Time}} \times 100 \%$$

4. Results and Discussions

In this research, the object of research is the Sport Center Building Project at the Islamic University of Malang on Jl. MT Haryono 193 Malang, East Java. Aktif "The Critical Path Method (CPM) method is used to minimize construction time for construction projects".

The following is a table regarding the total time for completion of the construction of a multi-purpose building carried out by the Islamic University of Malang:

Table 1. Total Time for Completion of Multipurpose Building Construction by the Islamic University of Malang

No	Type of work	Processing time (Aktual)
1	Excavation	21
2	Backfill	12
3	Foundation	28
4	Column	35
5	Wall	63
6	Beam	52
7	Plate	54
8	Mechanical (Water Installation)	32
9	ME (electric)	32
10	Roof	52
11	Finishing	62

Source: Malang Islamic University Project.

From Table 1 it can be seen that the construction of the Sports Center building carried out by the Islamic University of Malang required a completion construction time of 196 days.

In this step, it is first necessary to carry out forward and backward calculations, namely forward calculations *(Forward Computation)* and backward calculations *(Backward Computation)*.

This calculation can identify the critical path which can be calculated as *slack* or *float*, which is the time allowance for completing an activity.

(Forward Computation)

[14] In forward calculation, the calculation starts moving from the initial event to the terminal event. The point is to calculate the earliest time for an event to occur and the earliest time for an activity to start and finish (TE, ES, and EF).

Formula :
$$EF(i,j) = ES(i,j) + t(i,j)$$
$$TE(j) = ES(i,j) = 0$$
Where :
ES = fastest start of activity
EF = the fastest time for an activity to be completed
TE = the fastest time for an event to occur
t = the time required for an activity

(Backward computation)

In backward calculation, the calculation moves from the terminal event to the initial event, the aim is to calculate the latest time for the event to occur and the latest time for the start and

completion of all activities (TL, LS, and LF).

Formula :
TL = LS (i,j) = LF (i) – t (i,j)
LF (i,j) = TL Where TL = TE
Where :
LS = the latest time for the activity to start
LF = the latest time for the activity to be completed
TL = the latest time for the event to occur
t   = the time required for an activity

Tabel 2. Network Information

Activity	Event Number	Activity Time (Days)	Start (ES)	Finish (EF)	Start (LS)	Finish (LF)	*Slack Time*	Total *slack*	Critical Path
A	1-2	21	0	21	0	21	0	0	Y
B	2-3	12	21	33	21	33	0	0	Y
C	2-4	28	21	49	21	49	0	0	Y
D	3-5	35	33	68	77	112	44	44	-
E	4-5	63	49	112	49	112	0	0	Y
F	5-6	52	112	164	112	164	0	0	Y
G	4-7	54	49	103	49	103	0	0	Y
H	3-8	32	33	65	33	65	0	0	Y
I	6-9	32	164	196	164	196	0	0	Y
J	8-9	52	65	117	144	196	79	79	-
K	7-9	62	103	165	134	196	31	31	-
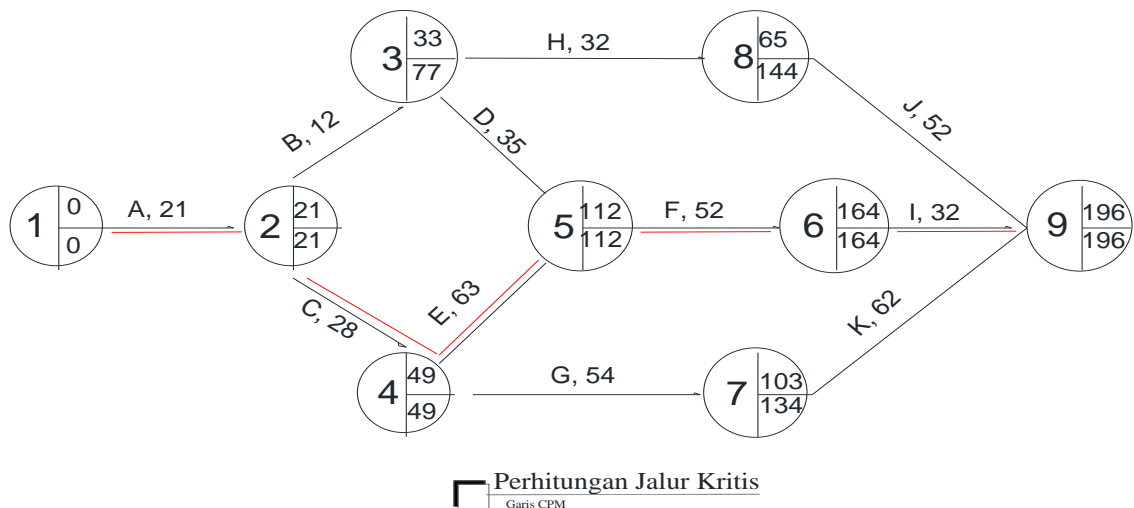
Figure 1. Critical Path Calculation

From the results of the CPM (Critical Path Method) calculation above, it is concluded that the optimal duration of the project can be accelerated to 33 days so that the initial project duration is from 196 working days to 163 working days.

Comparison of Multipurpose Building Construction Time Efficiency

An activity can be said to be optimal if it uses resources effectively and efficiently. By comparing the scheduling carried out by the company with the scheduling carried out using the CPM (Critical Path Method) method, the optimal time can be identified.

The following is a comparison of the construction time for a multi-purpose building:

Tabel 3. Comparison of Multipurpose Building Construction Time Efficiency

Plan Time	Day
Company	196
CPM Method (*Critical Path Method)*	163

Source: Data Processing Results.

Based on data from the Unisma Sports Center Building Construction Project, data was obtained on the average completion time for the Sports Center building construction project on Jl. MT Haryono 193 Malang City, East Java, takes 196 days. From the results of the analysis of the multi-purpose building construction project using planning analysis using the CPM (Critical Path Method) method, it was found that the completion time was 163 days.

Based on the results of time comparison with network planning analysis using the CPM (critical path method), it can be seen that the time and cost of the Sports Center building construction project is more optimal with the building construction time being 33 days faster. By processing the comparison results, it can be seen that scheduling the Sports Center building construction project using the critical path method is more optimal in terms of processing time.

The time efficiency of construction work carried out by the Islamic University of Malang using the CPM and PERT methods is:

$$E = \frac{\text{W.P Actual} - \text{W.P using Analysis CPM}}{\text{Actual Work Time}} \times 100\%$$

$$E = \frac{196 - 163}{196} \times 100\% = 16{,}837\%.$$

5. Conclusion and Suggestion
5.1   Conclusions

This research uses the Critical Path Method (CPM) to analyze the control of the Sports Center building construction project managed by the Islamic University of Malang. Based on the background, literature review, framework of thought, research results and discussion, it can be concluded as follows:

1. The construction work carried out by the Islamic University of Malang, based on the company's experience and estimates, was completed in 196 days. When working on the project, it can be more effective and efficient by using the CPM (critical path method) method, which can minimize the time for working on the project.
2. The construction work was carried out using the CPM (Critical Path Method) method by the Islamic University of Malang. This means that the project work time can be accelerated to the most optimal 33 days so that the initial project duration is from 196 working days to 163 working days.

5.1   Suggestions

For further research developments, it is recommended to:

1. The Islamic University of Malang should apply network planning analysis using the Critical Path Method (CPM) so that the acceleration results in terms of time obtained are more optimal.

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2. Can save time by using the Critical Path Method (CPM) so that costs can be reduced.
3. Supervision and control in project work must be carried out properly and correctly so that critical path activities can be prioritized so that the project can be completed on schedule.

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