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# Time and Cost Planning Using the Crashing Method in the Construction of the Nuclear Medicine Building of dr. Soedarso

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**Abstract:** The construction of the Nuclear Medicine Building of dr. Soedarso is a strategic effort to improve health services in West Kalimantan, especially in dealing with internal diseases such as cancer and heart. This project has an implementation deadline, so effective and efficient planning is required. This research aims to plan project time and costs using the crashing method, as well as consider aspects of human resources (HR), Occupational Health and Safety (K3), and project communication. The methodology used in the preparation of this final project is secondary data analysis in the form of RAB, AHSP, S curve, and basic price in 2024. The calculation of time and cost is carried out based on two approaches to project acceleration, namely the addition of working hours (overtime) and the addition of manpower. The analysis is complemented by the identification of the amount of labor needed, potential hazards at the work site, PPE needs, and communication used in the project. Normally for structural work, this project requires a cost of IDR 8.17 billion with a duration of 84 days. The results of this planning show that the crashing method with the alternative of adding working hours (overtime) costs IDR 8.19 billion, with a duration of 72 days (12 days faster than the normal duration). The crashing method with the alternative of adding labor costs 1DR 8.18 billion, with a duration of 67 days (17 days faster than the normal duration). Based on the results of these calculations, the crashing method can speed up project completion by considering labor productivity and cost-effectiveness. Recommendations from these results can be used as a consideration in making decisions on the implementation of project acceleration by contractors or other project implementing parties.

**Keywords:** Crashing Method, Time, Cost, HR, K3, Project Communication

## 1. Introduction

One form of health facility development is the construction of a Nuclear Medicine Building, especially in the Pontianak City area. This city until now does not have adequate facilities and infrastructure for the handling and prevention of serious diseases such as Cancer, Heart, Stroke, and Urenophology (KJSU), as well as Maternal and Child Health (KIA) which requires the use of radioactive-based technology. As a result, people suffering from these diseases have to travel long

distances to get appropriate treatment. Therefore, the construction of the Nuclear Medicine Building in Pontianak is very urgent, and must be carried out effectively and efficiently so that the benefits are immediately felt by the community. In an effort to accelerate project completion, the method that can be applied is the crashing method. This method allows for faster project execution time than originally planned. The acceleration of the project is carried out by increasing working hours (overtime) by 3 hours and adding 15% of the normal workforce. The calculation of additions is carried out by making a normal analysis and crashing analysis to achieve the final result of the discussion. In the end, this study is expected to provide an overview of how the increase in labor or working hours (overtime) affects project costs and time.

# 2. Literature Review

### *2.1. Construction Management*

Project management is an effort made to organize and control the activities of a project from start to finish to achieve results that are in accordance with the goals and objectives and ensure that the project is executed at the right cost, the right quality. and on time with the efficiency of resource use through the management process, namely planning, implementation and control [1].

### *2.2. Crashing Method*

Crashing method is an effort made to reduce or accelerate the project completion time earlier than the planned time under normal circumstances. Efforts to accelerate projects will have an impact on changes in project completion time and required costs. With the acceleration of this project, there will be a reduction in the duration of activities [2].

### *2.3. Crashing Method Alternatives*

#### *2.2.1. Increase in Working Hours (Overtime)*

The addition of working hours (overtime) must take into account the productivity index. Productivity is defined as the ratio between output and input, or it can be said to be the ratio between production output and total resources used. In a construction project, the ratio of productivity is the value measured during the construction process that can be separated into labor costs, material costs, tools and methods [3].

1. Labor productivity in the addition of working hours (overtime)

The duration of the crash is calculated by taking into account that the total number of normal working hours is equal to the total effective number of overtime work, if overtime effective working hours are working hours that have been reduced due to a decrease in productivity. The calculation of the duration of crashing by increasing the working hours of three hours/day takes into account the decrease in labor productivity during overtime [4]. The stages of calculating the acceleration of the project duration using the addition of working hours (overtime) [5], namely:

$$\text{Productivity overtime} = \frac{\text{Normal productivity per hour}}{\text{Productivity index}}$$

$$\text{Labor effectiveness} = \frac{\text{productivity of hours}}{\text{normal productivity of hours}} \text{ x } 100$$

$$\text{Decreased productivity} = 100\% - \text{workforce effectiveness}$$

After getting the value of overtime labor productivity, then you can then find the duration of work after being accelerated, the formula used [5] is as follows:

$$\text{Duration of crashing work} = \frac{(\text{Dn x h})}{\text{h} + (\text{ho x e})}$$

Information:

Dn : Normal duration
h : Normal working hours per day
Ho : Overtime hours per day
e : Effectiveness

2. Labor wages on the addition of working hours (overtime)

In the calculation of labor wages, there are several stages that must be considered, such as knowing the normal wages of labor, the type of work and the volume of work. Labor wages due to the increase in working hours can be calculated using a formula based on the provisions written in the Decree of the Minister of Manpower Number KEP. 35/MEN/IV/2021 article 32 as follows:

$$\text{1st Hourly overtime wages} = 1{,}5 \text{ x normal wages per hour}$$

$$\text{2nd Hour overtime wage, etc.} = 2 \text{ x normal wages per hour}$$

#### *2.2.2. Workforce Enhancement*

Adding manpower is a common method to accelerate projects in the field. According to Suharto (1999), the acceleration of projects is achieved by allocating more labor for certain jobs so that they can be completed in a shorter time. In pursuing a schedule, additional labor is needed, but this will cause a decrease in work productivity. The higher the number of workers per area, the moredense the activities per area, will eventually reach a point where the smooth running of work is disrupted and results in a decrease in productivity [6].

1. Labor productivity in the addition of labor

In planning the workforce to be used, productivity analysis should be carried out and indications of variables or factors that affect the work project, such as skills, experience factors or applicable regulations. Labor productivity will have a major effect on the total cost of the project [7]. Labor productivity can be searched [5] using the formula:

$$\text{Normal productivity per day} = \frac{\text{volume}}{\text{normal duration}}$$

$$\text{Labor productivity} = \frac{\text{normal productivity per day}}{\text{number of employees}}$$

$$\text{Normal hourly productivity} = \frac{\text{labor productivity}}{\text{normal duration of work}}$$

After obtaining the value of labor productivity, the next step is to find the number of workers per day [5] using the formula:

$$\text{Increase in the workforce} = \frac{\text{volume x coeficin}}{\text{crashing duration}}$$

2. Labor wages on labor increases

In the calculation of labor wages, there are several stages that must be considered, such as knowing the normal wages of labor, the number of labor workers, and the duration of work. Labor wages due to labor increase can be calculated using the following formula:

$$\text{Crashing wages} = \text{Number of workforce additions x daily wages}$$

$$\text{Crash cost} = \text{Total crashing wages x crashing duration}$$

### *2.4. Human Resources*

The crashing method in project management is usually applied by adjusting the human resource aspect such as involving adding labor or using a workforce with higher skills to speed up the completion of an activity. The amount of labor addition (individuals or groups) is formulated in general terms [5], namely:

$$\text{Increase in workforce per day} = Rc - Rn$$

$$\text{Total} = \text{Normal labor force} + \text{Crashing labor force}$$

Information:
Rc = Labor crashing
Rn = Normal labor

### *2.5. Occupational Health and Safety (K3)*

The main objective of the K3 project is to manage safety and health in the project work environment. K3 also aims to ensure that all parties involved in the project understand the importance of safety, health and implement safe and healthy practices in the project work environment. K3 is commonly applied to projects, namely hazard identification and the use of Personal Protective Equipment (PPE) [8].

### *2.6. Project Communication*

Project communication can also be interpreted as the boundaries of information related to the groups on the project verbally or nonverbally. Communication is needed so that communication between groups does not occur, for example, in projects. Communication on a project can be verbal, usually this communication is carried out by informal groups on a project. Meanwhile, non-verbal communication is usually carried out by formal groups in the form of documents, both letters and reports, and non-formal such as the use of project signs and the use of PPE [1].

## 3. Methodology

The methodology is carried out by analyzing secondary data to calculate time and cost using the crashing method with the addition of working hours (overtime) and labor. The analysis is carried out by making a normal analysis and crashing analysis. In addition, it also calculates the number of manpower (HR) and identifies hazards and PPE (K3) as well as communication used in the project both verbally and nonverbally.

## 4. Results and Discussion

The acceleration of the implementation time is carried out by the alternative of adding working hours (overtime) and adding labor using normal analysis and crashing analysis which will later be considered for effectiveness to be applied in structural work (starting from foundation to roof). In addition, it also discussed Occupational Health and Safety and Communication in the construction of the Nuclear Medicine Building of dr. Soedarso Hospital.

### *4.1. Increase in Working Hours (Overtime)*

The acceleration of the duration of the crashing method by adding working hours (overtime) obtained a completion time of 72 days or accelerated by 12 days from the normal duration. The crashing cost of adding working hours (overtime) for 72 days amounted to IDR 8.19 billion from the normal cost of IDR 8.17 billion.

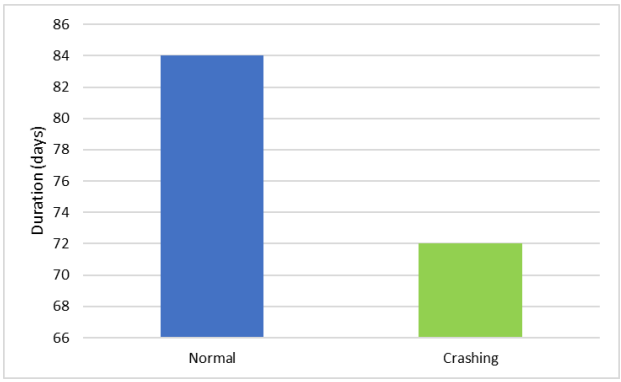


***Figure 1.*** *Comparison of normal duration and crashing duration with the alternative of adding working hours (overtime)*

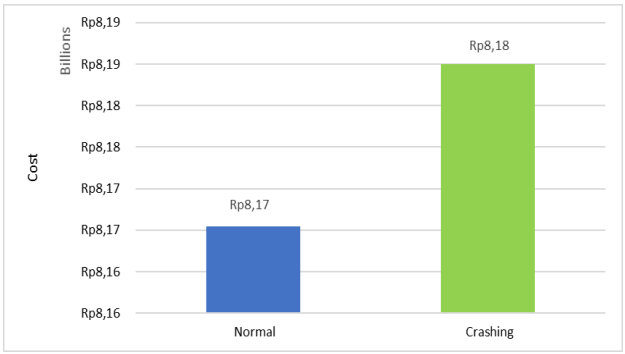


***Figure 2.*** *Comparison of normal costs and crashing duration with the alternative of increasing working hours (overtime)*

From the comparison of the data above, it can be seen that the use of the crashing method can speed up the completion of the work, but there is an increase in the cost of the acceleration. The increase in costs that occurred in the alternative of increasing working hours (overtime) was 0.24% of normal costs.

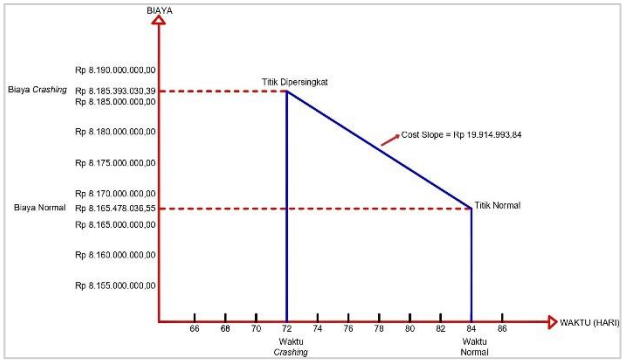


***Figure 3.*** *Graph of the relationship between time and cost with the alternative of adding working hours (overtime)*

The graph shows that based on the calculation of crashing time and costs with the alternative of adding 3 hours of work (overtime), there is a reduction in duration by 12 days, causing an increase in work costs. The additional cost is also called the cost slope, in the alternative of adding working hours (overtime) to the cost slope of IDR 19.9 million.

### *4.2. Workforce Enhancement*

The acceleration of the duration of the crashing method with the addition of labor was obtained with a completion time of 67 days or accelerated by 17 days from the normal duration. The crashing cost of adding workers for 67 days amounted to IDR 8.18 billion from the normal cost of IDR 8.17 billion.

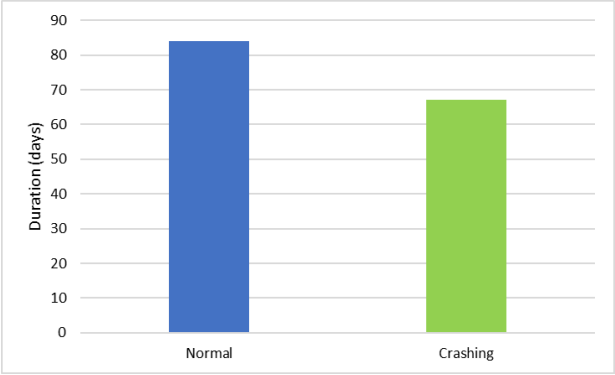


***Figure 4.*** *Comparison of normal duration and crashing duration with the alternative of adding 15% of the workforce*

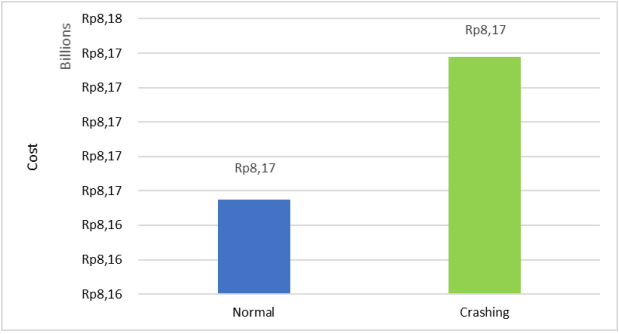


***Figure 5.*** *Comparison of normal costs and crashing duration with the alternative of adding 15% of the workforce*

From the comparison of the data above, it can be seen that the use of the crashing method can speed up the completion of the work, but there is an increase in the cost of the acceleration. The cost increase that occurs in the alternative of adding 15% of the workforce is 0.15% of the normal cost. The relationship between the cost and normal time and the crashing time and cost will be made in the form of a graph as follows.

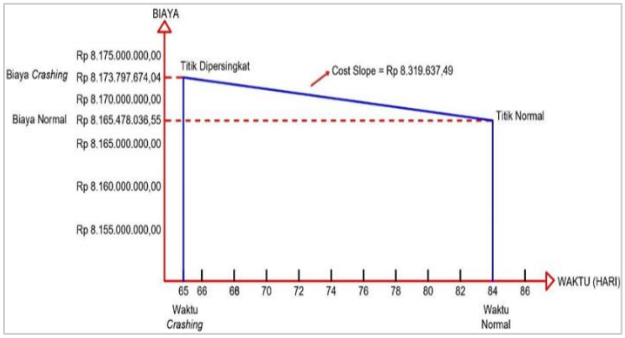


***Figure 6.*** *Time-cost relationship graph with the alternative of adding 15% workforce*

The graph shows that based on the calculation of crashing time and costs with the alternative of adding 15% of the workforce, there is a reduction in duration by 17 days, causing an increase in work costs. The additional cost is also called the cost slope, in the alternative of adding working hours (overtime) to the cost slope of IDR 8.4 million.

### *4.3. The Relationship of Time and Cost*

The time obtained from the crashing analysis with the alternative of adding working hours (overtime) is 12 days, or 86% faster than the normal duration. Meanwhile, with the alternative of adding 15% of the workforce for 17 days, or 80% faster than the normal duration. The costs needed due to the acceleration of the duration of work, with the alternative of adding working hours (overtime) of IDR 8.19 billion, while the alternative of adding 15% of the workforce is IDR 8.17 billion. The cost slope of the increase in working hours (overtime) is greater than the increase of 15% of the workforce, because the costs required for the increase in working hours (overtime) include labor costs and overtime costs, while the costs required for the addition of labor are only labor costs, not overtime costs. Therefore, the additional cost of working hours (overtime) is greater than the cost of naming labor.

### *4.3. Human Resources*

In human resources, the number of additional manpower per day will be calculated after the crashing method is carried out.

***Table 1.*** *Total increase in workforce after crashing*

| Job Description | Duration (days) | Normal Workforce (people) | Addition of 15% Workforce (people) | Total Crashing Workforce (people) |
|---|---|---|---|---|
| Pile Piling | 18 | 39 | 2 | 41 |
| Pile Blowing | 13 | 10 | 2 | 12 |
| Pile Welding | 18 | 5 | 2 | 7 |

The total increase in manpower after crashing was 2 people, according to an alternative of 15% increase from the total

normal workers. The data listed is data from foundation work.

### *4.4. Occupational Health and Safety (K3)*

The implementation of K3 starts from preliminary work to finishing work. In this study, the application of K3 that will be identified is the hazard and what use of PPE is needed in accordance with the identification of these hazards, from structural work alone. The identification process is carried out by analyzing the hazards that will occur in each work item.

***Table 2.*** *Hazard identification and PPE used*

| Job Description * | Hazard Identification | Required Personal Protective Equipment (PPE) |
|---|---|---|
| Pile Piling | • Broken Sling Strap<br>• Broken piles<br>• Workers exposed to material fragments during the pole collision | Project helmets, masks, vests, gloves, boots |
| Pile Blowing | • Workers exposed to dust/material debris<br>• Noise from the tool | Project helmets, vests, masks, earmuffs, gloves, boots |
| Pile Welding | • Workers exposed to welding smoke<br>• Welding light radiation<br>• Workers exposed to welding sparks | Project helmets, vests, masks, welding goggles, gloves, boots |
| Foundation | • Falling into the quarry<br>• Workers exposed to materials in the ground<br>• Workers exposed to mining tools | Project helmets, vests, gloves, boots |

Based on hazard identification, the personal protective equipment that must be present on the project is a project helmet, mask, vest, gloves, boots and other protective equipment that fits the work items such as welding goggles and earmuffs. The data listed is data from foundation work.

### *4.5. Project Communication*

Project communication is applied from preliminary work to finishing work. However, in this study, communication will be identified only from structural work. Communication is carried out by project management to workers verbally and nonverbally.

***Table 3.*** *Identification of communication on the project*

| Job Description * | Hazard Identification | Required Personal Protective Equipment (PPE) |
|---|---|---|
| Pile Piling | • Briefing before starting work<br>• K3 supervisor gives reminder to use PPE<br>• Provide workers with working drawings of foundation point plans<br>• The operator's assistant gives the signal to start or end the staking | Verbal<br>Nonverbal |
| Pile Blowing | • Briefing before starting work<br>• K3 supervisor gives reminder to use PPE | Verbal |
| Pile Welding | • Briefing before starting work<br>• K3 supervisor gives reminder to use PPE | Verbal |

## 4. Conclusion

The normal relationship of time and cost with crashing time and cost suggests that work will be completed faster with crashing alternatives such as increased working hours and labor, but these additions will increase the costs incurred. Of the 2 alternative options that have been analyzed, the use of the alternative of adding 15% of the workforce is more effectively used than the increase in working hours (overtime), because the cost increase of 0.10% of the normal cost with a time saving of 20% of the normal duration is effectively done for the hospital project.

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