Risk Management Affecting the Cost and Time of the Structure Work Development Project of High-Level Building (A Case Study of the Alton Apartment Tembalang City Semarang Project)

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Abstract. Risk prevention using risk management is a process of identifying, measuring, ascertaining risk and developing strategies to manage risk. The purpose of this study was to determine the factors that influence the cost and time on the structure work of The Alton Apartment Development Project. The process is carried out through the identification stage, the analysis phase, and the risk response stage. The identification stage is done through a literature study, then the next step is to conduct a survey with the first stage questionnaire to validate the risks that occur. The analysis phase to determine the dominant risk is done by estimating the frequency and impact on costs and time, then classified with the Probability Impact Grid. The risk response stage is to provide a risk response or a risk prevention solution. From the results of the study, there are six factors that affect costs and time, among others, the placement of moving material, the occurrence of loading and unloading queues, delays in the delivery of material, the existing utility systems that are not detected, and the low productivity of equipment. Having known these risk factors, precautions are taken to minimize the risk factors by providing a solution.

Keywords: high-level building, risk management, cost and time

1. Introduction

Construction business in Indonesia has developed increasingly diverse, sophisticated and very complex. The construction project is a series of activities that are only carried out once and are generally short-term. In the series of activities, there is a process that processes project resources into the results of activities in the form of buildings [1]. Project achievement goals are known as the triple constraints, those are, the exact amount of budget, the exact schedule, and the exact quality that must be met. Project success is measured by the extent of these three objectives can be met. To achieve the three project targets, the possibility of risk arise.

Risk is an unexpected event that may occur due to negligence, policy changes or due to natural events. The occurrence of a risk will affect the implementation of project activities one of which is cost, time, quality and safety. To control the risks that might arise, we need to manage risk properly. Good management can be used as the project risk concept map that will be carried out by the project team and provide an understanding of risk anticipation, so as not to cause losses to the project due to cost overruns and delayed work implementation time.
Risks during the project implementation stage arise during structural, architectural or mechanical electrical work. Based on its location, structural work consists of two kinds, namely the substructure and the upper structure. The substructure work is vital, related to its function as a supporter of all building loads and forwards the building load into the soil below. Whereas upper structural work is structural work on structural elements above ground level. The higher the structure of the building to be built, the higher the risk that it might occur due to the greater weight of the work.

The Alton Apartment Tembalang City Semarang project is a high-rise building or has a lot of risks at the stage of carrying out its structural work, especially with the density of buildings around it. The Alton Apartment Tembalang City Semarang project is a High Rise Building building that has many risks at the implementation stage of structural work. This condition is worsened by the density of buildings around it, thus requiring risk management to minimize the impact that affects the cost of quality and time.

2. Objective of The Study
   a. To identify the dominant risk factors that influence the cost and time of the structure work on the High-rise Building Project.
   b. To determine the level of project risk that affects the cost and time of the project work.
   c. To find out the solutions that will be carried out against the occurrence of dominant risks in the structural work of the project.

3. Literature Study
   3.1 Risk
   Risk is a combination of the frequency and consequences of an event. Not rule out the possibility that there will be more than one consequence for one event. The consequences that arise can be positive or negative [2]. Risk has three main elements, namely:
   a. Events are conditions that occur at a particular place during a certain period of time.
   b. Frequency or likelihood is a qualitative description of frequency.
   c. Impact, is the result of an event, both quantitative and qualitative, in the form of loss [3]

   3.2 Risk Management
   Risk management is all efforts made to manage risk to achieve optimal results through a systematic process [4]. Those process are, risk Identification, risk analysis and risk response. There are several stages regarding the risk management process, including the following:
   a. Risk identification
      The most important stage of the risk management process is to identify the risks that might occur by making a list of possible risks
   b. Risk analysis
      A stage of the process undertaken to understand the significance of the consequences that will result from a risk, on the level of health and sustainability of the project. All causes of risk are looked for levels to get priority treatment. Risk level groups are divided into four, high (H), significant (S), medium (M), and low (L). Determination of the risk level is determined based on two criteria, namely:1. Frequency of events (probability).2. Impact of events (impact/severity). Measuring risk used formula [5]:
      \[ R = P \times I \]  
      Information:
      R = Risk Level
      P = frequency of risks that occur.
      I = Level of risk impact
The scale used in assessing the potential occurrence of risks to the frequency and impact of risks is the Likert scale using a range of numbers 1 to 5:

Measurement of risk frequency:
1 = Very rarely
2 = Rarely
3 = Enough
4 = Often
5 = Very often

Risk impact measurement:
1 = Very small
2 = Small
3 = Medium
4 = Large
5 = Very Large

| Probability Impact Grid |
|-------------------------|
| 5 | 10 | 15 | 20 | 25 |
| 4 | 8  | 12 | 16 | 20 |
| 3 | 6  | 9  | 12 | 15 |
| 2 | 4  | 6  | 8  | 10 |
| 1 | 2  | 3  | 4  | 5  |

**Table 1 Probability Impact Grid**

The following are the methods used to resolve risks, grouped into sections [6]

1) Avoided
One that can be done by not carrying out activities that pose risks. In the case of project execution can be done by the method of changing the project plan to eliminate the project activity although not all risks can be avoided.

2) Transfer
The transfer of negative risk settlement can be transferred to third parties. This transfer of responsibility is the most effective method when considering costs. By entering into a written agreement, it can be used as a supporting tool in the transfer of responsibilities. What is meant by third parties are subcontractors and insurance companies.

3) Reduced (mitigate)
Is a step that is used to minimize the risks that will occur. The initial step to reduce the likelihood of the risk occurring is effective preventive measures rather than corrective actions due to risk. The action to reduce risk is to plan an appropriate response to control risk. If this method is used, it is recommended to comply with procedures properly to monitor and control the risks that arise.

4) Accepted
Accepting risk means to dare to bear the loss if the risk occurs. This situation can be accepted if the impact of the event is small or a situation where there is no way out in dealing with the problem.
3.3 Previous Study
Project types with a lump-sum contract are relatively risky to risk ratio benefits. The results showed that the type of contract does not affect the level of risk of project implementation, because, for the same type of project with a different type of contract, the method of implementation is relatively the same regardless of the form of the contract. The level of risk when implementing a project, depends on the type of project, the location of the project and the experience of the contractor, not on the type of contract [7]. The most influential level of risk based on events, namely; High Risk, consisting of price and budget aspects. Significant Risk, which consists of material and equipment aspects, educational and financial aspects, planning aspects, weather aspects, and supervision. Medium Risk, consisting of aspects of management control and production, aspects of human resource management and social culture, aspects of Health and Safety (K3). The level of risk based on consequences, namely; High Risk, supervision aspect. Significant Risk, location aspects, human resources and quality, socio-cultural aspects and Occupational Health and Safety (K3), planning aspects, weather aspects, and price aspects. Medium Risk, material aspects, equipment and time, budget [8].

4. Data Analysis and Discussion
In the data analysis and discussion, three stages or methods are used to determine the risks that might occur in the Alton Apartments project. These stages are the identification stage, the analysis phase, and the risk response stage.

4.1 Identification Stage
A literature study is an initial stage of risk identification. A literature study is done to find out what risks usually occur in high-rise building construction projects, such as the case study of this research in the Alton Apartment project. The risk identification process is carried out using a questionnaire, through two stages: the first questionnaire and the second questionnaire. The first questionnaire is a questionnaire intended to validate the independent variables/events occurring risk by putting a checklist (√) in the relevant or irrelevant column, and respondents can provide input or add and reduce risk variables. After the first questionnaire was distributed and processed to identify possible risk factors, the second questionnaire was distributed to staff or contractor project staff to determine the frequency and impact values of 20 people as respondents in this study. Table 2 below shows the risk Identification of earthwork.

| Earthwork                           | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 |
|-------------------------------------|----|----|----|----|----|----|----|----|----|----|----|----|
| Earthquake                          | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 |
| The delays of Equipment order       | 7  |    |    |    |    |    |    |    |    |    |    |    |
| The lack quality of the Subcontractors | 8  |    |    |    |    |    |    |    |    |    |    |    |
| The Weakness in cost and time control systems | 9  |    |    |    |    |    |    |    |    |    |    |    |
| The delays of Predecessor work      | 10 |    |    |    |    |    |    |    |    |    |    |    |
| The Placement of material frequently moves around | 11 |    |    |    |    |    |    |    |    |    |    |    |
| The queue of loading and unloading of material | 12 |    |    |    |    |    |    |    |    |    |    |    |
From the questionnaire, there are 12 risk that often occur in the earthwork stage. Table 3 below shows the risk identification of foundation.

**Table 3 The Risk Identification of Fondation**

| FONDATION |   |
|-----------|---|
| 1         | Earthquake               |
| 2         | The flooded project area  |
| 3         | Undetected existing utility system |
| 4         | The Violation of legal and environmental aspects |
| 5         | Low labor productivity   |
| 6         | Low equipment productivity|
| 7         | The Failure of Dewatering |
| 8         | The delays of Equipment order |
| 9         | The lack quality of the Subcontractors |
| 10        | The Weakness in cost and time control systems |
| 11        | The collapse of the retaining wall |
| 12        | The Placement of material frequently moves around |
| 13        | The queue of loading and unloading of Material |
| 14        | The incorrect arrangement of former excavated land |

From the questionnaire, there are 14 risk that often occur in the fondation stage. Table 4 below shows the risk identification of column.

**Table 4 The Risk Identification of Column**

| COLUMN |   |
|--------|---|
| 1      | Earthquake               |
| 2      | Low labor productivity   |
| 3      | The Changes of Design    |
| 4      | Low equipment productivity|
| 5      | The delays of material delivery |
| 6      | The delays of Equipment order |
| 7      | The Weakness in cost and time control systems |
| 8      | The mismatch of Construction specifications |
| 9      | The Placement of material frequently moves around |
| 10     | The queue of loading and unloading of Material |

From the questionnaire, there are 10 risk that often occur in the column stage. Table 5 below shows the risk identification of beam and slab.
Table 5 The Risk Identification of Beam and Slab

| Rank | Work Phase | Risk Variable                                         | Cost Risk Value | Risk Level | Time Risk Value | Risk Level |
|------|------------|-------------------------------------------------------|-----------------|------------|-----------------|------------|
| 1    | Earthwork  | The Placement of material frequently moves around     | 16              | H          | 16              | H          |
| 2    | Earthwork  | The queue of loading and unloading of material        | 16              | H          | 16              | H          |
| 3    | Earthwork  | The flooded project area                              | 12              | M          | 12              | M          |

From the questionnaire, there are 11 risk that often occur in the beam and slab stage.

4.2 Risk Analysis Stage

The results obtained from the second stage questionnaire about frequency assessment, the impact of cost and time risks on building structure work to determine the level of risk, then processed with the help of the Microsoft Excel program to determine the level of risk at each stage of structural work. The next stage sets the 3 biggest risk levels marked in red on each structural work with a high potential risk. Here are the results of the analysis conducted by researchers.

Table 6 The Risk Level of Excavation Work

| Rank | Work Phase | Risk Variable                          | Cost Risk Value | Risk Level | Time Risk Value | Risk Level |
|------|------------|----------------------------------------|-----------------|------------|-----------------|------------|
| 1    | Earthwork  | The Placement of material frequently moves around | 16              | H          | 16              | H          |
| 2    | Earthwork  | The queue of loading and unloading of material | 16              | H          | 16              | H          |
| 3    | Earthwork  | The flooded project area                | 12              | M          | 12              | M          |

From table 6 it can be known that in the Excavation Work, “the placement of material frequently moves around” and “the queue of loading and unloading of material” have the highest risk mostly because of the limited area of the project, while “The flooded project area” has the medium risk because of the water seepage and the rest of the risk shown in table 2 have a low risk.
Table 7 The Risk Level of Foundation Work

| Rank | Work Phase         | Risk Variable                                           | Cost Risk Value | Risk Level | Time Risk Value | Risk Level |
|------|--------------------|---------------------------------------------------------|-----------------|------------|-----------------|------------|
| 1    | Foundation Work    | The Placement of material frequently moves around       | 16              | H          | 16              | H          |
| 2    | Foundation Work    | The queue of loading and unloading of material          | 16              | H          | 16              | H          |
| 3    | Foundation Work    | Undetected existing utility system                      | 12              | M          | 12              | M          |

From table 7 it can be known that in the Foundation Work, “the placement of material frequently moves around” and “the queue of loading and unloading of material” have the highest risk mostly because of the limited area of the project, while “Undetected existing utility system” has the medium risk because of the insufficient data from the initial survey, and the rest of the risks shown in table 3 have a low risk.

Table 8 The Risk Level of Column Work

| Rank | Work Phase     | Risk Variable                                           | Cost Risk Value | Risk Level | Time Risk Value | Risk Level |
|------|----------------|---------------------------------------------------------|-----------------|------------|-----------------|------------|
| 1    | Column Work    | The Placement of material frequently moves around       | 16              | H          | 16              | H          |
| 2    | Column Work    | The queue of loading and unloading of material          | 16              | H          | 16              | H          |
| 3    | Column Work    | Low equipment productivity                              | 12              | M          | 12              | M          |

From table 8 it can be known that in the Column Work, “the placement of material frequently moves around” and “the queue of loading and unloading of material” have the highest risk mostly because of the limited area of the project, while “Low equipment productivity” has the medium risk because of the errors in the selection of work equipment, and the rest of the risk shown in table 4 have a low risk.

Table 9 The Risk Level of Beam & Slab Work

| Rank | Work Phase     | Risk Variable                                           | Cost Risk Value | Risk Level | Time Risk Value | Risk Level |
|------|----------------|---------------------------------------------------------|-----------------|------------|-----------------|------------|
| 1    | Beam & Slab Work | The Placement of material frequently moves around       | 16              | H          | 16              | H          |
| 2    | Beam & Slab Work | The queue of loading and unloading of material          | 16              | H          | 16              | H          |
| 3    | Beam & Slab Work | The delays of material delivery                        | 12              | M          | 12              | M          |
From table 9 it can be known that in the Beam & Slab Work, “the placement of material frequently moves around” and “the queue of loading and unloading of material” have the highest risk mostly because of the limited area of the project, while “The delays of material delivery” has the medium risk because of inadequate stock of material from the supplier, and the rest of the risk shown in table 5 have a low risk.

From all risk level tables the placement of material frequently moves around and the queue of loading and unloading of material, are risks that always arise as the highest risk level. This risk occurs due to the narrow land that requires careful handling.

4.3 Risk Response Stage

The dominant risk is obtained after knowing the level of risk. In every work of structures that have been examined, the top three highest risk levels that affect the cost and time of The Alton Apartment are the dominant risk. After determining the dominant risk, the next step is to respond to these risk factors. This phase is carried out through interviews and literature studies to provide feedback on solutions and actions to be taken when faced with the dominant risk to prevent and minimize the project risk that has some impact on the cost and time. The Risk Response is presented in the table 10.

| No. | Risk Variable | Risk Causes | Risk Response |
|-----|---------------|-------------|---------------|
| 1.  | The Placement of material frequently moves around | Limited stockyard land | - Manage the placement of the materials properly  
- Select and place the materials in the storage  
- Conduct surveys in project locations that can be used as temporary material areas. |
| 2.  | The queue of loading and unloading of material | Inadequate access to project sites | - Arrange the material arrival schedules to the project area  
- Prioritize the main materials needed for the work needs.  
- Choose more than one supplier to minimize the risk of material unavailability  
- Re-calculate the number of material needs  
- Make a material procurement schedule due to the distance from the quarry to the project site  
- The well-prepared water drainage system |
| 3.  | The delays of material delivery | Inadequate stock of material from the supplier | - Installing a ready-to-use pump to speed up de-watering  
- Coordinate with related stakeholders (PDAM, PLN, PAM, etc.) to ensure the location of public utility system in the project area  
- Move the existing utility systems that are interfering with the project area  
- Changing the building design, in the case of existing utility systems cannot be moved |
| 4.  | The flooded project area | Water seepage in the work area | |
| 5.  | Undetected existing utility system | The insufficient data from the initial survey | |
Low equipment productivity - Replace the initial equipment with the new equipment which has more sufficient capacity.
- Add the number of equipment to increase work productivity.

5. Conclusion
Conclusions obtained from data processing:

a. There are 6 dominant risk factors that affect the cost and working time of the Alton Apartment structure. These factors are:
   1) Placement of material frequently moves around.
   2) loading and unloading queues.
   3) Late delivery of material.
   4) The project area is flooded.
   5) the existing system utility is not detected.
   6) Low equipment productivity.

b. The highest level of risk that influences the cost and time of the Alton Apartment development project work in every work-phase are:
   1) The Placement of material frequently moves around
   2) The queue of loading and unloading of material

c. The Risk responses of these risk factors are used to prevent, reduce and minimize risks that have an impact on the project costs and time, are shown in the table 10

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