p-ISSN 2656-7288, e-ISSN 2656-7334

ANALYSIS OF RISK MANAGEMENT IN DEVELOPMENT SMK STIKES RAJAWALI BANDUNG (CASE STUDY: WELL FOUNDATION)

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Manuscript information:
Received
2020
Revised
2020
Approved to be published
2020
Published
2020

Abstract

The SMK STIKES Rajawali Bandung project is a unique project because it located in a steep land, which creates various project risks that can hinder project progress and affect project achievement. Based on the s curve, the problem faced in the construction of this project is foundation work. Because foundation work is the most important part in a building construction project to support the buildings on it.

The purpose of this research is to identify risks, find out the causes, and how to overcome the dominant risk if the risk occurs. This research was conducted by surveying the construction actors especially project managers, site engineers, operational sites, and workers. Then analyzed using a qualitative risk analysis, risk acceptance analysis, and risk response to determine the frequency and impact of risks that occur. Based on the results of research using qualitative risk analysis, it was found that the greatest risk was the risk of rain. The method of handling it is by making pump dewatering because the pump dewatering job is able to release groundwater in the foundation hole due to rain, reducing the risk of landslides due to rain, and the groundwater level to drop.

Keywords: risk identification, assessment, mitigation

1. *INTRODUCTION*

Over time, the development of the contruction industry has become increasingly diverse, complex and sophisticated. This development is closely related to the implementation of construction development. Dapu*, et al. (2016) construction development consists of various stages, of which the most decisive stage is the contruction stage, because teh overall quality of the project depens on construction and construction management. Apart from that, the cost and time of the project. Given the importance of the construction phase, the contractor must carefully plan, schedule and manage the project. Management of a project is part of project management.*

Project management is the application of 10 field of science (knowlage), skills, tools, and techniques is project activites ti achieve project goals. Construction project cannot be separated from three aspects, namaly time, cost and implementatin (Annisa A, 2019). *Therefore, every construction project implementation requires good project management, to be able to mange and minimize the various project risks that may occur. The success of a project is determined if it is according to the right time, the cost does not exceed the budget, the quality is in accordance with the provisions, at leasr changesin the scope of work, the results can be well received by the owner* (Kerzner, 2010).

Problems in project implementation are cause by many internal and external factors starting from the initial stages of project implementation, namely the design stage, procurment process, implementation to handover (Utomo, *et al*, 2019). *This problem causes delays in project goals and objectives that have been planned, therefore risks need to be managed properly. Risk is an uncertain situsion that has a positive or negative impact on project results* (PMBOK, 2017). *The magnitude of the impact caused by risk can be know through project risk management. Project risk management is the application of risk management elements, namely risk management planning, risk identification, qualitative risk analysis, quantitative risk analysis, risk response, risk response implementation and risk monitoring* (PMBOK, 2017). *Risk management construction projects need to be managed properly so that the benefits to be obtauned are in accordance with the risks to be faced.*

One of the project conditions that affect construction is the project location. project location affects the risk management of work in the field, including foundation work, structural work, finishing and complementary works (Herdianto A., *et al*, 2015). *Foundation work is the most important part in a building construction project, because the foundation functions as a transfer of the load from the building above the stucture to the soil layer below it* (Wulandari, *et al*, 2017). *This research discusses the risk management of foundation work in a case study of a 5-storey building which has steep and varied contour conditions at* SMK STIKES Rajawali Bandung.

The construction project of SMK STIKES Rajawali Bandung is located in West Bandung Regency and was built on January 9, 2018 to November 7, 2019. The project construction was built on a steep land location, causing various project risks that could hinder the progress of the project and affect project achievement. One of the obstructed jobs is foundation work, where this work is delayed.

Delays in foundation work affect subsequent work items (such as structural work, finishing and auxiliary work). Based on the s curve, The foundation work planning starts on March 2, 2018 to March 22, 2018, but when the field start on March 2, 2018 to April 12, 2018, there is delay in the execution time of 21 days (initial plan was 34 days, but realization in the field 55 days). The delay in this implementation time is due to the steep ground location which result in difficult mobiliztion, weather and lack of material strorage space. Therefore, at the time of carrying out contruction work it is necessary to apply a risk management system at the work site, where this risk issue is also part og project planning and control. Based on the above background, it is necessary to carry out identification research, risk analysis and risk management methods during the construction of the SMK STIKES Rajawali Bandung Project.

2. *LITERATURE REVIEW*

2.1 *Risk Management of Construction Project*

2.1.1 *Project Risk Management*

Risk management is generallyy a process of identifying, measuring, ensuring risks and starategies. Contruction is a complex activity because many fields are involved, so it cannot be separated from the risks that may occur. PMBOK (2017) *risk is an uncertain situation that has a positive or negative impact on project results and objectives.* Kerzner (2010) *This risk has three main elements, namely:*

1. *Events (Situations), that occur at a certain place within certain intervals.*
2. *Probability (Likelihood), is a qualitative description of the probability.*
3. *Impact (Consequences), the result of an event that has an impact on losse.*

SNI 31000:2011 there are main elements of the project risk management stage. This stage can be seen in Figure 2.1

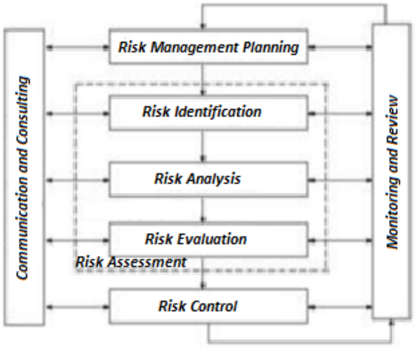

Figure 2.1 *Stages of Risk Management*
Source: SNI ISO 31000: 2011

The following are the stage of risk management:

1. *Risk management planning, is a step in deciding how to approach and plan project risk management activities.*
2. *Risk identification, is the process of determining events that have a negative impact on project objectives.*
3. *Qualitative risk analysis, is an assessment of the dominant frequency and adverse impacts on project objectives.*
4. *Quantitative risk analysis, is a measure of the opportunities and consequences of risk with an estimate of the implications for project objectives.*
5. *Risk Evaluation is comparison of existing risk leveks with standard criteria. if the risk level is set low, then the risk falls intro an acceptable category and may only require monitoring without having to exercise control*
6. *Risk control is a way to reduce the degree of probability and impact by using alternative methods, risk transfer, and other.*
7. *Monitor and review are the results of the risk management system on monitoring and review and identifying changes that need to be changed.*

2.1.2 *Risk Identification*

PMBOK (2017) risk identification is repetitive because risks may only become known during the project cycle. Risk identification aims to accept sources of risk and events that hinder the achievement of project objectives. According to Utomo *(2019) the sources of risk are divided into two parts, namely external causes and internal causes, because the causes of risk do not have a universal standard in their distribution.*

External causes can be divided into two parts, namely:

a. *External can not be detected, among others: changes in laws and regulations, natural disasters (storms, floods, earthquakes, as a result of destructive events, environmental and social impacts) or as a result of the project and failure of project completion.*
b. *Externals can be detected, among others: market risk, operational (after the project is completed), environmental impacts, social impacts, currency changes, inflation, taxes.*

Apart from external causes, there are also internal causes which can be divided into two, namely:

a. *Non-technical internals, among others: management, late schedules, additional costs, cash flow, potential loss of benefits and profits.*
b. *Technical internals include: technological changes, project technology specifications risks, design, law.*

2.1.3 *Qualitative Risk Analysis*

The next step after risk identification is to measure risk by involving the magnitude of the impact that occurs with the frequency of risk occurrence. The results of the qualitative risk analysis are further analyzed by carrying out a risk management action plan in the form of tools and techniques (PMBOK 2017):

a. *Risk Probability and Impact Assessment*

`This technique is to identify the risks resulting from the impact of positive and negative risks on project objectives (such as time, cost, scope and quality).

b. *Probability and Impact Matrix*

Risk is further analyzed quantitatively and responses based on the level of risk. The scale of the risk level measurement is based on the multiplication of the frequency and impact of the risk that occurs The qualitative analysis measurement scale uses the Australian Standard / New Zealand Standard (AS / NZS) 4360: 2004 .

***Table 2.1** Frequency Level of Risk*

Level	***Descriptor***	***Descriotion***
1	*Very Unlikely*	*Lets never happen*
2	*Unlikely*	*Can happen, but rarely*
3	*Possible*	*Can occur under certain conditions*
4	*Likely*	*Can occur periodically*
5	*Almost Certain*	*Can happen at any time*

Source: Risk Management Guidelines Companion to AS / NZS 4360: 2004

***Table 2.2** Impact Level of Risk*

Level	***Descriptor***	***Descriotion***
1	*Very Unlikely*	*No injuries, small financial losses*
2	*Unlikely*	*Minor injury, moderate financial loss*
3	*Possible*	*Moderate injury, large financial loss*
4	*Likely*	*Serious injury, big loss*
5	*Almost Certain*	*The loss was very large and had a long impact, the cessation of all activities*

Source: Risk Management Guidelines Companion to AS / NZS 4360: 2004

Kerzener (2010) *risk level is formulated as follows:*

Risk = Frequency x Impact

Where, the risk results are substituted into numbers it can be seen as follows:

Table 2.3 *Risk Matrix*

Probability	Consequences 1 (Insignifant)	2 (Minor)	3 (Moderate)	4 (Major)	5 (Catastrophic)
1 (Very Unlikely)	LOW	LOW	LOW	MEDIUM	MEDIUM
2 (Unlikely)	LOW	MEDIUM	MEDIUM	MEDIUM	HIGH
3 (Possible)	LOW	MEDIUM	MEDIUM	HIGH	HIGH
4 (Likely)	MEDIUM	MEDIUM	HIGH	HIGH	VERY HIGH
5 (Almost Certain)	MEDIUM	HIGH	HIGH	VERY HIGH	VERY HIGH

Information:

Low	= 1-3
Medium	= 4-9
High	= 10-16
Very High	= 20-25

Source: Risk Management Guidelines Companion to AS / NZS 4360: 2004

c. *Risk Data Quality Assessment*

Qualitative risk analysis requires accurate and inaccurate data. Risk data quality analysis is a technique to evaluate the usefulness of data in risk management.

d. *Risk Catagorization*

Project risks can be categorized based on the source of risk to find out which project areas are exposed to uncertainty.

e. *Risk Urgency Assessment*

This risk requires action in the near future which can be catagorized intro very improtant risks and needs immediate analysis.

2.1.4 *Risk Acceptability*

The level of risk recognition is a very important tool in making decisions, because through risk ratings, management can determine priorities and treatments at the construction stage (Dharma, et al, 2017).

According to Godfrey, PS (1996) the level of risk acceptance (risk acceptability) depends on the result of multiplying the frequency with the impact. The level of risk acceptance can be clarified as follows:

1. *Unacceptable, is a risk that cannot be accepted and must be eliminated*
2. *Undesirable, is a risk that is not expected and must be avoided*
3. *Acceptable, is an acceptable risk*
4. *Negligible, is a risk that is completely acceptable*

Table 2.4 *Risk Acceptability*

Assessment	***Acceptance Scale***
Unacceptable	$x \geq 15$
Undesirable	$5 \leq x < 15$
Acceptable	$3 \leq x < 5$
Negligible	$x < 3$

Source: Godfrey, P.S, 1996

2.1.5 *Risk Mitigation*

According to Soputan, et al (2014), risk treatment is a strategy carried out to reduce the consequences of identified risks. Risk management strategies can be seen in Table 2.5.

Table 2.5 *Risk Mitigation*

Strategy	***Information***
Avoid or Reject	*Take no risks*
Reduce	*Reducing the risk may occur*
Fund or receive	*Funding or receiving the risk of occurence*
Overcome	*Minimizes the consequences of risks*
Take a turn	*Shifting the risk to the other ride*

Source: Soputan, dkk (2014)

2.1.6 *Scale and Size of Research*

The scale used in measuring the potential risk to frequency and impact is the Likert scale. The likert scale used ranges from 1 to 5. The scale of frequency and impact can be can be seen in Table 2.6 and Table 2.7.

Table 2.6 *Frequency Level Scale*

Scale	***Frequency Rate***
1	*Very Low*
2	*Low*
3	*Moderate*
4	*High*
5	*Very High*

Source: Godfrey, P.S, 1996

Table 2.7 *Impact Value Scale*

Scale	***Frequency Rate***
1	*Very Small*
2	*Small*
3	*Moderate*
4	*Large*
5	*Very Large*

Source: Godfrey, P.S, 1996

3. *Research Methodology*

3.1 *Data Collection*

This research uses qualitative data. The data that has been obtained are then grouped according to the type of data source, namely as follows:

a. Primary Data
Primary Data obtained from interviews and questionnaires

b. Secondary Data
Secondary data were obtained from the project site engineering manager, besides that, it was also obtained from literature studies on construction project risk management such as books, journals, regulations and sources that support research.

3.2 *Research Variables*

The variables in this study used two types of variables, namely:

a. Independent variable
Independent variables are variables that are related to other variables. The independent variables in this study are the causes of undetectable external, detectable external, technical internal, and non-technical internal.

b. Dependent variable
The dependent variable is a variable that is related to other variables. The dependent variable in this study is an indicator of risk

Table 3.1 *Research Variables*

No.	***Source of risk***	***Risk indicators***	***Reference***
1	***External cannot be detected***	*Avalanche*	Magna, et al (2017)
		Flood	Magna, et al (2017)
		Earthquake	Subiyanto (2010)
2	***External can be detected***	*Inflation or an increase in prices and a decrease in purchasing power*	Subiyanto (2010)
		Rain	Subiyanto (2010)
		Project locations that are difficult to reach (access/road including location)	Magna, et al (2017)
3	***Internal technical***	***Land Investigation Work***	
		Inaccurete soil data	Subiyanto (2010)
		Excavation work	
		Sting errors of the soil are excavated	Magna, et al (2017)
		Excavation has not yet reached the elevation plan	Magna, et al (2017)
		Work Foundation	
		Errors in determining drilling points and on foundation	Subiyanto (2010)
		Non-alignment of foundation drilling	Subiyanto (2010)
		The ground collapses were found around the borehole	Subiyanto (2010)
		Concrete pouring error	Subiyanto (2010)
		Labor	
		Low labor productivity	Magna, et al (2017)
		Equipment	
		Low equipment productivity	Subiyanto (2010)
		Tool damage	Ismael, et al (2014)
		If there is no provision of construction equipment at the project site	Messah, et al. (2013).
		Material	
		The quality and quantity of the material does not match the specifications	Messah, et al. (2013).
		Delays in delivery of materials to locations	Messah, et al. (2013).
		Lack of material storage space	Magna, et al (2017)
		Delay in ordering material	Messah, et al. (2013).
		Material fabrication failure	Subiyanto (2010)
		Material breakdown	Magna, et al (2017)
		Disain	
		There are design changes	Messah, et al.. (2013).

		Incomplete planning (drawing)	Messah, et al. (2013).
		Delay in the process of requesting and approving work spaces by the owner	Messah, et al. (2013).
4	***Internal non technical***	***Cost***	
		Time and Cost control systems are weak	Subiyanto (2010)
		Late payment owner	Subiyanto (2010)
		There is work that is not recognized as a bill	Subiyanto (2010)
		Scheduling	
		Lack of time control information to monitor and analyze schedule estimation errors that affect project performance	Subiyanto (2010)
		Sequencing that is not good enough	Subiyanto (2010)
		Nother job that goes before, is too late	Subiyanto (2010)

4. *ANALYSIS AND DISCUSSION*

The risks identified in the SMK STIKES Rajawali Bandung Project on foundation work were 32 risks and 4 risk source categories, namely: external can not be detected, external can be detected, internal is technical, and internal is non-technical.

4.1 Risk Analysis

Risk analysis is a process of risk identification and risk assessment. Risk analysis is carried out qualitatively by multiplying the frequency by the impact of the identified risk. The identified risks can be grouped based on risk sources, namely 3 detectable external, 3 undetectable external, 21 technical internal and 6 non-technical internal. Analysis and identification of this can be seen in Table 4. 1

Table 4.1 *Risk Analysis and Identification*

No.	***Source of risk***	***Risk indicators***	***Risk Value***	***Risk Matrix Grouping***
1	***External Cannot Be Detected***	*Avalanche*	4	*Medium*
		Flood	4	*Medium*
		Earthquake	3	*Low*
2	***External Can Be Detected***	*Inflation or an increase in prices and a decrease in purchasing power*	15	*High*
		Rain	20	*Very High*
		Project locations that are difficult to reach (access/road including location)	16	*Very High*
3	***Internal Technical***	***Land Investigation Work***		
		Inaccurete soil data	4	*Medium*
		Excavation work		
		Sting errors of the soil are excavated	2	*Low*

		Excavation has not yet reached the elevation plan	4	*Medium*
		Work Foundation		
		Errors in determining drilling points and on foundation	4	*Medium*
		Non-alignment of foundation drilling	4	*Medium*
		The ground collapses were found around the borehole	5	*Medium*
		Concrete pouring error	4	*Medium*
		Labor		
		Low labor productivity	4	*Medium*
		Equipment		
		Low equipment productivity	4	*Medium*
		Tool damage	4	*Medium*
		If there is no provision of construction equipment at the project site	3	*Low*
		Material		
		The quality and quantity of the material does not match the specifications	4	*Medium*
		Delays in delivery of materials to locations	9	*Medium*
		Lack of material storage space	12	*High*
		Delay in ordering material	5	*Medium*
		Material fabrication failure	4	*Medium*
		Material breakdown	5	*Medium*
		Disain		
		There are design changes	3	*Low*
		Incomplete planning (drawing)	4	*Medium*
		Delay in the process of requesting and approving work spaces by the owner	4	*Medium*
4	***Internal Non Technical***	***Cost***		
		Time and Cost control systems are weak	16	*Very High*
		Late payment owner	4	*Medium*
		There is work that is not recognized as a bill	4	*Medium*
		Scheduling		
		Lack of time control information to monitor and analyze schedule estimation errors that affect project performance	4	*Medium*
		Sequencing that is not good enough	4	*Medium*

		Nother job that goes before, is too late	9	*Medium*

4.1.1 *Risk Acceptability*

Next, the risk acceptability is grouped. Acceptance of risk obtained 4 types of risk acceptance, namely unacceptable amounting to 3 riks (9,375%), Undesirable amounting to 4 risks (12,5%), acceptable amounting to 24 risk (75%), and negligible amounting to 4 (12,5%). The results of this study show that acceptance of risk that fall into the catagory requires tratment, namely anaccaptable and undesirable risks. Acceptance of risk can be seen in Table 4.2.

Table 4.2 *Risk Acceptability*

No.	*Stages of Work*	*Risk Identification*	*Risk Value*	*Risk Acceptability*	*Source of risk*
1	*Foundation Work*	*Inflation or an increase in prices and a decrease in purchasing power*	15	*Undersirable*	*External Can Be Detected*
2	*Earth Work* *Excavation Work* *Foundation Work*	*Rain*	20	*Unaccaptable*	*External Can Be Detected*
3	*Earth Work* *Excavation Work* *Foundation Work*	*Project locations that are difficult to reach (access/road including location)*	16	*Unaccaptable*	*External Can Be Detected*
4	*Foundation Work*	*Delays in delivery of materials to locations*	9	*Undersirable*	*Internal Technical*
5	*Foundation Work*	*Lack of material storage space*	12	*Undersirable*	*Internal Technical*
6	*Foundation Work*	*Time and Cost control systems are weak*	16	*Undersirable*	*Internal Non Technical*
7	*Foundation Work*	*Nother job that goes before, is too late*	9	*Undersirable*	*Internal Non Technical*

4.1.2 *Risk Mitigation*

Risk mitigation that falls into the risk catagory is unacceptable and undesirable. Risk treatment can be seen in Table 4.3.

Table 4.3 *Risk Mitigation*

No.	*Risk Identification*	*Causes of Risk*	*Risk Mitigation*	*Information*
1	*Inflation or an increase in prices and a decrease in purchasing power*	*The increase in the price of iron due to the game on the market price reached 30-50% of the estimated price or iron*	• *Make an estimate of the increase in raw material prices* • *Making contracts with suppliers with an umbrella contract system* • *Looking for material supplier that offer lower prices*	*To avoid the addendum*
2	*Rain*	*The groundwater level becomes high because, it often rains during foundation work*	• *Prepare for dewatering* • *Provide a drainage system*	*To avoid the addendum*
3	*Project locations that are difficult to reach*	*When it rains, access to the project entrance becomes*	• *Prepare alternative access roads to*	*To avoid the addendum*

	(access/road including location)	*difficult for material delivery to the project site*	*facilitate mobilization*	
4	*Delays in delivery of materials to locations*	*The supplier did not send iron material according to schedule, so this project had to wait a long time for iron supplay*	• *Make schudule, evaluate the arrival and amount of material* • *Contact the supplier to negotiate the material ordered, speed up immediately* • *Speed up the work of the upper structure*	*To avoid the addendum*
5	*Lack of material storage space*	*The difficulty of determining the desired material due to the accumulation of material in the warehouse*	• *Schedule delivery periodically* • *Renting a material strorage area*	*To avoid the addendum*
6	*Time and Cost control systems are weak*	*The foundation work was delayed, so the casting was too late*	• *The cost and time control system is kept simple but quite up to date* • *Monitoring and reviewing the implementation schedule periodically* • *If there is a deviation from the implementation schedule, a recovery is carried out which is discussed in the meeting to plan follow-up*	*To avoid the addendum*
7	*Nother job that goes before, is too late*	*Rain conditions become difficult when removing the sludge from the foundation work, so that the dump truck cannot enter and exit the project because it is muddy. In addition, when drilling is not cast immediately, the foundation hole that has been drilled will collapse and the next work will be delayed*	• *Doing project crashing* • *Do fast tracking* • *Cover additional time with contingency time*	*To avoid the addendum*

4.1.3 *Rain Strategy*

Unpredictable weather conditions are the biggest risk for foundation work at SMK STIKES Rajawali Bandung. The results of calculations carried out using qualitative analysis obtained a risk value of 20. So, risk management is required for foundation work.

Maharani (2011), risk management for the rain variable is by preparing a dewatering or making a drainage system. From the comparison of the two strategies, the writer looks for the most *appropriate and efficient risk handling resuly in the SMK STIKES Rajawali Bandung Project. The picture of alternatives to minimize foundation word at SMK STIKES Rajawali Bandung is ad follows:*

Table 4.4 *Comparison of Drainage and Dewatering*

	Dewatering Pump	***Open Drainage***
Material	-	*Concrete*
Tools	*Electric pump and generator*	*Hoe and Raskam*
Principles of Action	*Ground water is pumped out, so that the ground water levek around the excavation will flow into the pump hole by gravity, and cause a decrease in ground water level around the pump area*	*Flow water that comes from the rain to another channel to the disposal place, namely a river or a temporary water reservoir*
Advantage	• *The groundwater level drops* • *Improve soil stability* • *Landslides are down* • *Removing water in the excavation due to rain*	• *Land use can be optimized* • *Freeing standing water in the project area due to rain*
Joy	• *The surrounding land springs into down* • *The suction of fine particles from the groundby the pipe* • *Consolidation of silt, clay or losse due to increased effective stress*	• *Minimizes the project work area* • *Often seen as shabby and smelly*

Based on the comparison between the two alternatives, the ideal for handling the risk or rain at SMK STIKES Rajawali Bandung is to use pump dewatering. it is due to dewatering pump capable speding water the soil in the hole foundations result due to rain, reducing the risk of landslides due to rain and surface water ground becomes down.

5. *Conclusion*

The results of the research analysis that have been carried out can be concluded as follows:

1. *There are 32 identified risks, 3 very high risk, 2 high risk, 23 medium risk, and 4 low risk. Thr biggest risk comes from external risk that can be detected, namely very high with a rain risk value of 20.*
2. *The causes of delays in implementing the foundation at SMK STIKES Rajawali Bandung are Inflation or an increase in prices and a decrease in purchasing power, rain, Project locations that are difficult to reach (access/road including location), delays in delivery of materials to locations, lack of material storage space, time and Cost control systems are weak, nother job that goes before, is too late*
3. *Based on the result of the qualitative risk analysis calculation, it is found that the dominant risk rain. So it is necessary, the risk of rain is to use a dewatering pump. The comparison between the two alternatives above which is ideal for handling the risk of rain at SMK STIKES Rajawali Bandung is to use a pump dewatering. This is because the pump dewatering work is able to release groundwater in the foundation hole due to rain, and the groundwater level decreases*

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