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Research Paper

A Risk Management Analysis to Road Rehabilitation Activity of Krebet – Gondanglegi Road at Malang Regency by Applying *Analytical Hierarchy Process (Ahp)* Method

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Abstract
A development of road infrastructures is an essential matter to be the main support for the community's economic activities.With the availability of good road infrastructure, it will support the smooth transportation, distribution and mobilization of goods and services as several important factors for improving the community's economy. In 2022, the Government of Malang Regency through the Public Works Department of Highways setting a planto rehabilitate road infrastructure including the Krebet - Gondanglegi Road Rehabilitation activities financed by the Special Allocation Fund (DAK) from the central government. In the implementation of the road rehabilitation project, there were some risks which much be considered by parties involved in the project. This is related to the impact of the arising riskswhich can hinder and harm the project implementers in terms of cost, time, quality and their scope of work.
This study applied the Analytical Hierarchy Process (AHP) method, where the primary data was obtained from questionnaire distribution to a predetermined sample of respondents, while the secondary data was obtained from literature studies, project contract data, budget plan/RAB and technical specifications.
The result of this study are obtaining 5 (five) risk factors with high influential effect on the Krebet – Gondanglegi Road Rehabilitation activities: (1) dense traffic condition, (2) payment terms waiting for transfer fund from the central government, (3) less number of technical personnel, (4) problem of land usage that adjacent to the assets of PT. Kereta Api Indonesia (KAI) also (5) an increase of asphalt price during the project implementation. Efforts to overcome risk factors can be carried out in various ways depending on each risk factor, but basically the efforts made aimed to mitigate risk by minimizing the risk consequences of these factors so project activities can run smoothly and according to predetermined plan.
Keywords *: risk factor, mitigation, Analytical Hierarchy Process (AHP)*

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I. INTRODUCTION

A construction project has a number of risks in its implementation. Similar to other projects, the risks involved are include external, internal, technical and legal risks. The potential risks encountered by one project will be different from risks found in other types of projects (Wena and Suparno, 2014). Moreover, construction projects have different characteristics of potential risks when compare to risks in other non-construction project.

In many construction projects, whether in building or infrasctructure projects, there are challenges from several risks that may occur. By principal, any construction project implementation is faced to three main constraints namely the *cost*, the *time* and the *quality*. These three constraints can be interpreted as project objectives which are defined as the *right cost*, the *right time* and the *right quality*. A successful project always be associated to the extent of these three objectives can be met. In relation to the dynamic characteristics of a project, a good project management is necessary to doto assure these three objectives fulfilled. Therefore, a management strategy called a project management is needed.

Figure 1.1 Picture of road condition of Krebet - Gondanglegi
Source : Data survey(2021)

As a construction project, the Krebet-Gondanglegi Road Rehabilitation activity has obvious potential risks which must be faced by the constructor. One of the obstacles is a very dense daily traffic on this road section which make it impossible to close road access during the implementation of road rehabilitation. In addition, although the road class type is a regency road,this road is treated similar to the provincial road or national road since many heavy vehicles (that should be on Class 1 Road or Class 2 Road category) pass the Krebet-Gondanglegi road.

So far,discussions related to the risk management analysis in road rehabilitation(which in this study is located atKrebet – Gondanglegi road in Malang Regency) by applying the Analytical Hierarchy Process (AHP) method seldom carried out by many researchers, therefore the authors raising study problems of: (1) which risk factors have high influencial on the Krebet – Gondanglegi Road Rehabilitation activities? (2).how much influence does each risk factor in high category have on the Krebet – Gondanglegi Road Rehabilitation activities?(3)What efforts should be taken to overcome each high influence risk factor on the Krebet – Gondanglegi Road Rehabilitation activities?

II. LITERATURE REVIEW

2.1 Risks

A definition of risk according to *Kamus Besar Bahasa Indonesia* (KBBI) is every possibility of an event that can harm a company. In addition, Flanagan and Norman (1993) define risk as a causal factor of unexpected conditions that can bring loss, damage or lost. Risk is a measure of opportunities and as a result/consequence of the failure in achieving the predetermined project objectives (Kerzner, 2010).

Whereas Hanafi (2014) defines risk as a hazard/danger, result or consequence which can occur as a result of ongoing process or future event. Meanwhile Vaughan (1978) in Darmawi (2016) proposed several definitions about risk, as stated below:

a. *Risk is the chance of loss*

*Chance of Loss*commonly used to indicate a situation where prone to openness to loss or a possibility of loss.

b. *Risk is the possibility of loss*

The term of possibility means the probability of an event lies between zero and one.

c. Risk is *uncertainty*.

Risks will continue to emerge during the entire life of the project, so, a risk management process of a project must be carried out repeatedly. In the beginning, risks are initially been handled by developing a project strategy during the project planning stage. It must also be monitored throughout the project time to ensure the project stays on track so the unexpected risks (emergent risks) are manageable (PMI, 2017). According to the above definition, it can be concluded a risk is associated with events that may occur which may resultedimpact tothe project objectives: the *time,* the *cost,* the *quality.* Within this definition, there is also an understanding about risk that related to uncertainty.

Risk can be associated to possibility of unwanted bad consequence (losses). In other words, the possibility indicates an existence of uncertainty, where the causal of the uncertaintyare the distance/gap and time from the beginning of project planning until the project activity ends, or the limited availability from necessary information, also lackness or limitation of knowledge, skills, techniques in decision making (Kezner, 2010). Whereas Darmawi (2016) stated, when studied even further, uncertain condition arises for various reasons, including:

a. Time interval at the beginning of the planning activity until the end of the project activity. The longer the time interval, the greater the uncertainty.

b. Limited availability of the necessary information.

c. Limited knowledge/skills/decision-making techniques.

Moreover, Ismael (2013) revealed that risk affects time performance, causing delays in construction project work and directly harming project owners and contractors. There are several types of risks often arise in the world of construction services which directly able to bring losses, such as:

a. Mismatch/inappropriate data between field condition to the previously obtained data, although the contract has a lump sum payment.
b. Late installments from the owner
c. Delay in credit disbursement
d. Weather condition at the site location,
e. Price surge,
f. Monetary changes and others

2.2 Risk Management

In factual reality, factors of good planning and good control do not necessarily guarantee a realization of project objectives/target.Bearing in mind, for every project implementation there is always a chance of failure in achieving a goal or there is always uncertainty over any decision taken. According to Cooper and Chapman (2003) some assumptions are required to estimate data and information which are not yet available during the project process, starting from the planning stage to implementation stage. In this matter, risk management is required to look at the risks hovering the project and review their impact on the project objectives.

A risk management is a systemic process of identifying, analyzing and responding to project risks. Further, risk management is defined as a procedure to control the level of risk and to reduce the impact. According to Kerzner (2010) risk management is a structured way to identify and measure risk and to advance, to select and to manage options in dealing with the risks. It is not only identifies risk but also has to calculate risks and their impact on the project with a result is a decision whether these risks can be accepted or not. Risk management is an activity for responding any identified/known risks to minimize the adverse consequences that may arise. Meanwhile, according to Flanagan and Norman (1993) risk management has 5 (five) stages, namely the risk identification, risk communication and riskinformation, also risk review and risk monitoring.

The project risk management are include the process of carrying out risk management planning, identification, analysis, risk response planning, risk response implementation and risk monitoring within a project (PMI, 2017). Furthermore, Labombang (2011) added in every construction project, it is very important to carry out risk management to avoid losses in aspects of cost, quality and project schedule.

In general, risk management includes planning stage of risk management, risk identification, risk analysis, risk management (handling the risk), and risk monitoring (Smith, 2006). The first step in implementing risk management is risk identification where becomes an important stage in the project implementation. With a risk identification, risks occured during project implementation will be recognized, from the project started until the project is ready to be handed over (or until project completed).Afterwards, the magnitude of these risk potentials able to affect the achievement of project objectives can be exposed (Kerzner, 2010).

2.3 Risk Management Planning

A Risk Management Planning is the process of defining the ways to carry out risk management activities in a project. The risk management planning describes how risk management is properly structured and implemented in a construction project.

The key benefit of this process is assuring the degree, type, and visibility of risk management will be proportionate to the risks and to the project importance for its organization and other stakeholders. The process will be performed one time (once) or at the predefined points in the project.An accomplishment of a project is measured by success, whereas accomplishment of a project is working according to the time execution, according to the predetermined cost, and according to the expected quality.Meanwhile, the project risks can be categorized as low, moderate, or high, where it depends on how the risk will be affected the project.

2.4 Risk Identification

According to PMI (2017), risk identification is a repetitive process since many individual risks in a new project will likely to arise during the project is ongoing its life cycle, where the overall project risks will also have a possibility to change. The repetition frequency and who are the personnel will be involved in the risk identification cycle will vary greatly depending on the situation, and these considerations will be planned in the risk management.

According to Godfrey, *et.al* (1996) there are several ways can be used for identifying risks, including:

a. What can go wrong analysis

The implementation of identification process to risks which may occur, also its consequence that will arise on the basis of sources of risk, events and consequences of risk.

b. Brainstorming
The implementation of identification process to risks of a problem through brainstorming, exchanging ideas or suggestions or discussions with those who own expertise or compentency in their fields (expert).
c. *Use of record*.
The implementation of identification process through a structured interviews. The process of identifying risks by interview technique to those who have competencies according to the needs of risk identification, by collecting and recording existing data sources, both in the form of recording minutes (*notulen)*or record meeting (result of discussion of the related project).
d. *Promp Lists* (Daftar yang cepat).
The risk identification process is carried out by compiling a structured and detailed list related to the problems that will be observed.

2.5 Risk Analysis

Risk analysis is a procedure of identification and evaluation. According to Godfrey, *et.al* (1996) a systematically risk analysis can help to give a clear identification, assess and rank risks, focus attention on the main risks, clarify the limits of loss, minimize potential damage in the worst case situation, examine uncertainties in the project, clarify and emphasizing the function of each person or entity involved in risk management. Meanwhile, Thompson and Perry (1991) stated, qualitative risk analysis and management has two objectives: the risk identification and the initial risk assessment. In a qualitative analysis, it is possible to determine the risks that have an effect by multiplying the probability with the impact of the risks that have been identified, when the probability is high and the impact also high, then it will result in a high level risk and vice versa, when the probability is low and the impact is low, it will result in a level of low risk.Then, how to manage or handling the main riks is called as the risk management.
According to Australia/New Zealand (1999) there are 4 (four) steps in the risk management procedure as stated below:
a. *Establish the Context*. It means determining the internal and eksternal boundaries or parameters will be taken into consideration and to be discussed in risk management. Also determine the work scopes and risk criteria for the next process.
b. *Identify the Risk*. Risk identification is a step to obtain relevant risk variables.
c. The goal of risk identification is to develop a comprehensive list of risk sources and events that have an impact on achieving the identified goals and targets from the context.
d. *Analyse Risk*
Risk analysis includes consideration of the risk sources, consequences and likelihood of these risks. The risk is analyzed by combining likelihood (probability of frequency) and consequences (impact or effect). The likelihood and consequences of each risk will determine the level of that risk. Moreover, from Australia/New Zealand standard (1999) each risk is assessed qualitatively in five categories. The assessment of each likelihood and consequence is presented in Table 2.1 and Table 2.2.

Table 2.1 The Probability Assessment

Level	Assesments	Definition
A	Likely	Likely often to occur
B	Probable	Will occur several times
C	Occasional	Likely to occur sometime
D	Remote	Unlikely but possible to occur
E	Improbable	Very unlikely to occur

Source: AS/NZS 4360: 1999 *Risk Management*

Tabel 2.2 The ConsequencesAssesment

Level	Consequences	Definition
1	Insignificant	No injuries, low financial losses, have a very little impact in a very short time.
2	Minor	Requires first aid help, moderate financial losses, having a little impact in a short time
3	Moderate	Requires medical treatment with high financial losses
4	Major	Creating wide losses, serious injuries, the production ability is disrupted, huge financial losses
5	Very damaging/ Very Heavy	Causing death, creating serius damage, and very huge finansial losses

Source: AS/NZS 4360:1999 *Risk Management*)

2.6 Risk Evaluation

The purpose of risk evaluation is assisting the decision-making process based on the result analysis. Risk evaluation process will determine of which risks that require treatment and what are the priorities. It can be conducted by make a group or classifying the likelihood and consequence values into a risk matrix. Once the value of likelihood and consequences found, they can be plotted on the risk matrix table to find out how high the risk is. The following risk matrix is explained in table 2.3 below.

Table 2. 3 The Risk Matrix

	Consequences				
(*Likelihood*)	(1) Insignificant Very Little	(2) Minor	(3) Moderate	(4) Major	(5) Very Damaging/ Very Heavy
(A) Likely	H	H	E	E	E
(B) Probable	M	H	E	E	E
(C) Occasional	L	M	E	E	E
(D) Remote	L	L	M	H	E
(E) Improbable	L	L	M	H	H

Source: AS/NZS 4360:1999 *Risk Management*

Note:

E: *Extreme risk*, unable to tolerate and requires a quick handling

H: *High risk*, unwanted and can be accepted when any reduction of risk is failed, need a special attention from the manajement division

M: *Moderate risk*, accepted with agreement and requires clear responsibility from the management division.

L : *Low risk*, accepted with agreement from management division and able to be handled through routine procedures.

The results of the risk evaluation are risk rating data that require further treatment on the basis of the remaining risks and the effectiveness of existing risk controls.

2.7 Road Classification

According to Law of the Republic of Indonesia Number 38 of 2004 concerning Road, the definition of road is land transportation infrastructure which includes all parts of the road, including the buildings and their equipment intended for public traffic, which located on the ground surface, above the ground level, below the ground and/or water level, as well as above the water level, except for railroads and cable roads. The roads can be classified according to the road network system, road function, road status and road class.

1. Road Classification According to Road Function

1. *Arterial Road,* is a public road function to serve the main transportation with characteristics of long-distance travel, high average speed, with a number of accessed roads is efficiently limited. The arterial road is divided into two types: the Primary Arterial road and Secondary Arterial road.
2. *Collector road,* is a public road function to serve the collector transportation or divider transportation with medium-distance travelling characteristic, moderate average speed and limited number of access roads. Collector roads are divided into two types: Primary Collector road and Secondary Collector road.
3. *Local road,* is a public road function to serve the local transportation with charactertistic of short distance travel, low average speed, and unlimited number of access road. The local road divided into two types: the Primary Local road and the Secondary Local road.
4. *Neigborhood road,* is a public road functions to serve the environmental transportation with short-distance travel characteristics and low average speed.

2. Road Classification According to Road Class

The road classification according to road class are related to the ability of the road to accept the traffic load expressed in the Heaviest Axle Load (MST) in tons. For purpose of regulating the usage and fulfillment of transportation needs, the roads are divided into several classes based on transportation needs, selection of the right mode by considering the advantage of the characteristic of each mode, development in motorized vehicle technology, and the heaviest axle loads of motorized vehicles also the road construction. The classification of roads according to axle loads also popular with the term of road classes which consists of:

a. *Class I Road*, is an arterial road which able to be passed by motorized vehicles including the vehicles with loads with a width not exceeding 2,500 milimeters, a length not exceeding 18,000 milimeters and the maximum permitted axle load greater than 10 tons (which currently still not establish in Indonesia, yet, it has begun to be developed in many develop countries such as in France with heaviest axle load of 13 tons).
b. C*lass II Road* is an arterial road that can be passed by motorized vehicles including with cargo with a width not exceeding 2,500 milimeters, a length not exceeding 18,000 milimeters and a maximum permitted axle load of 10 tons. This is a suitable class road for container transportation.
c. *Class III A Road* is an arterial road or collector road that can be passed by motorized vehicles including with loads, with a width not exceeding 2,500 milimeters, a length not exceeding 18,000 milimeters, and the heaviest permitted axle load of 8 tons.
d. C*lass III B road* is a collector road that can be passed by motorized vehicles with loads with a width not exceeding 2,500 milimeters, a length not exceeding 12,000 milimeters and the heaviest permitted axle load of 8 tons.
e. *Class III C Road* is a local road and environmental road that can be passed by motorized vehicles with loads, with a width not exceeding 2,100 milimeters, a length not exceeding 9,000 milimeters and the heaviest permitted axle load of 8 tons.

Table 2. 4 Road Division and Load Carrying Capacity

Road Class	Road Function	Vehicle Characteristic		Heaviest Axle Load
		Length	Width	
I	Arterial	18	2,5	> 10 ton
II	Arterial	18	2,5	10 ton
III A	Arterial/Collector	18	2,5	8 ton
III B	Collector	12	2,5	8 ton
III C	Local	9	2,1	8 ton

(Source:Road Law No 22, 2009)

3. Road Classification According to Road Construction Authority
According to road construction authority, roads are classified into National Road, Provincial Road, Regency Road, Municipal Road and Special Road.
a. National Road
Type of roads included into the national road group are the primary arterial road, the primary collector road that connect the provincial capitals, also other roads that have strategic value to national interest. The determination of road status as a national road will be established by a Ministrial Decree.
b. Provincial Road
Type of roads included into the provincial road are:
1) Primary Collector road connects the provincial capital to municipal/regency capital.
2) Primary Collector road connects between the capitals of municipalities or regencies.
3) Other road that has strategic value to provincial interest.
4) Roads within the Country Capital Region of Jakarta which are not included as national roads.
Determination of road status as a provincial road will be carried out by Ministrial of Home Affair Decree on the proposal from the Level I Regional Government by considering the Minister’s opinion.
c. Regency Road
Type of roads included in the Regency roads are:
1) Primary Collector road which are not included into national road and provincial road.
2) Primary Local road

d. Municipal Road
Type of roads included in the Municipal road group are the secondary road networks within the municipality area. Determination of secondary arterial road or secondary collector road established into a Municipal road will be carried out by Governor Decree of the Level I Region by a recommendation of the related Municipal Government. The determination of the secondary local road section to be a Municipal road status is established by the Mayor Decree of the related Level II region.
e. Village Road
Village roads are type of primary neighborhood and primary roads which are not included in the regency road within the rural areas and they are the public roads that connect areas and/or between settlements within villages.

III. RESEARCH METHOD

3.1 Research Variables

Variable is a matter that becomes the focus of researchers to conduct a research. From the results of studies of road rehabilitation risk events that were carried out, the independent variables were several aspects determined from this study that listed below.

- **Aspect of Material**

X1 Materials used are not according the specification
X2 The schedule of material deliveries are late
X3 Lacking of material availability

- **Aspect of Economy**

X4 Company's *cash flow* is not too well (not good)
X5 The increase of asphalt price during the implementation of the project
X6 Payment term is waiting the disbursement of fund transfer from the central government
X7 High overhead operating cost

- **Aspect of Safety**

X8 Low awareness of workers for wearing the PPE (Protective Personal Equipment)
X9 Less number of warning signs
X10 Less personnel who regulate the road traffic

- **Aspect of Human Resource/Manpower**

X11 Less capable / incapability of the implementer workers
X12 Less number of implementer workers
X13 Less number of technical workers
X14 Exhaustive workers due to overtime work

- **Aspect of Implementation Method and The Equipments**

X15 Innacurate implementation method
X16 Inappropriate implementation stages
X17 Inappropriate types of equipments
X18 Poor equipment condition (lesser condition)

- **Aspect of Environment**

X19 Unpredicted weather condition
X20 Dense traffic condition
X21 Many sugarcane trucks parked on the road bank
X22 Problem in the land usage which adjacent to assets of PT. KAI

- **Aspect of Managerial**

X23 Poor control and personnel division
X24 Poor distribution of data and information
X25 Poor communication between related parties in the project

3.2 Determination of Population and Sample of the Study

According to Sugiyono (2016) population is a generalization area to objects/subjects that have certain quantities and characteristics which determined by the researchers to be studied and then to be usedfor drawing a conclution. Population of this study are the parties involved in a road rehabilitation project including from Department of Public Highways, providers of materials/services for the project, supervisory consultant and representative of community in the area surrounding the implemented project. Sugiyono (2016) further added, sample is a part of numbers and characteristics possesed by the population. When the population of the study is large, then it is impossible for the researchers to study everything in the population. Thus, a sample method will be used for the study. In this study, the sampling technique applied was a purposive sampling, a sampling technique based on the researcher's consideration about which samples are appropriate, useful and considered representative from the observed population in the study. This sampling technique is based on a grid and limitation of certain criteria with the total sample for this study were 20 individuals related to the road rehabilitation project.

3.3 Analytical Hierarchy Process (AHP)

AHP is a method of decision-making support that developed by Saaty (2012), an Iraqi-born mathematics Proffesor at University of Pittsburgh. AHP is a method for creating sequences from many alternative decisions and selecting the best alternative when the decision maker has several objectives or several criterias for making a decision.

The first step of this analysis is creating a paired matrix for the risk frequencies and for the risk consequences (impact risks) obtained based on the assessment to each criterion according to table 2.6 (the AHP Rating Scale table). To carry out the weighing and risk assessment using the Analysis Hierarchy Process (AHP) method, the initial step is to create a paired matrix for the risk frequency and risk consequence (risk impact), then to determine the matrix weighing, to calculate the matrix consistency, to determine value of risk factors, and to determine the ranking and the risk level.

Table 3. 1 The AHP Rating Scale

Intensity of Importance	Definition	Explanation
1	Equal importance compared to others	Judgment favors both criteria equally
3	Moderate importance compared to others	Judgment slighty favor one criterion
5	Strong importance compared to others	Judgment strongly favor one criterion
7	Very Strong importance compared to others	One criterion is favored strongly over the another
9	Absolute or extreme importance compared to others	There is evidence affirming that one criterion is favored / dominant among other in the project's practice
2,4,6,8	Immediate values between two considerate / close scale values	Absolute judgment cannot be given and a compromise is required between the two closed values

Source: Saaty, (2012)

IV. RESULT AND DISCUSSION

4.1 Analytical Hierarchy Process (AHP)

Analytical Hierarchy Process (AHP) analysis was performed to determine the value of each risk factor. Priorities are arranged based on the cumulative weight of all respondents' answers to risk events. Referring to the theory of Saaty (2012), the steps for calculating the weight for the risk level are:

a. Determine numbers for the pairing comparison matrix where in this study is stated into 5 levels of risk (the number drawn were 1,3,5,7 and 9).

b. Create a pairing comparison matrix for the risk levels.

Table 4.4A Paired Matrix for Risk Frequency and Risk Consequence/Risk Impact

No	Very Low	Low	Moderate	High	Very High
Very Little	1	3	5	7	9
Little	0.33	1	3	5	7
Moderate	0.2	0.33	1	3	5
Big	0.14	0.2	0.33	1	3
Very Big	0.11	0.14	0.2	0.33	1
Total	1,79	4,68	9,53	14,33	25

(Source: Analysis, 2023)

Table 4.5 Calculation of Weighing The Risk Elements

No	Very Low	Low	Mode rate	High	Very High	Total	Mean	Percent age (%)
Very Little	0,56	0,64	0,52	0,49	0,36	2,57	0,51	100,00
Little	0,19	0,21	0,31	0,21	0,28	1,20	0,24	0,47
Mode rate	0,11	0,07	0,10	0,21	0,20	0,70	0,14	0,27
Big	0,08	0,04	0,03	0,07	0,12	0,35	0,07	0,13

Very Big	0,06	0,03	0,02	0,02	0,04	0,18	0,04	0,07
Total	**1**	**1**	**1**	**1**	**1**			

(Source: Analysis, 2023)

As displayed on table 4.5, the result of calculation from weighing the risk elements are obtaining result for each weight where stated as:

1) Very Low : 0,07
2) Low : 0,13
3) Moderate : 0,27
4) High : 0,47
5) Very High : 1

After the weight of each element risk had been found, then the average/mean frequency and the risk impact (risk consequences) is calculated by employing the risk element weights above. The result of mean frequency calculation is presented in table 4.6.

Table 4.6 The Mean Values of Risk Frequency

Variables	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Average**
	0.07	**0.13**	**0.27**	**0.47**	**1**	
1	2	7	8	3	0	0.23
2	0	5	11	4	0	0.28
3	0	0	8	10	2	0.44
4	0	4	12	4	0	0.28
5	0	2	10	5	3	0.42
6	0	0	4	8	8	0.64
7	0	4	10	6	0	0.30
8	4	8	8	0	0	0.17
9	0	4	12	4	0	0.28
10	4	8	8	0	0	0.17
11	0	4	12	4	0	0.28
12	0	0	5	12	3	0.50
13	0	0	4	12	4	0.54
14	0	4	12	4	0	0.28
15	0	1	5	8	6	0.56
16	0	0	5	9	6	0.58
17	2	5	11	2	0	0.24
18	0	4	12	4	0	0.28
19	0	1	4	11	4	0.52
20	0	1	9	8	2	0.42
21	0	4	8	8	0	0.32
22	1	3	11	3	2	0.34
23	4	8	7	1	0	0.18
24	0	0	4	12	4	0.54
25	0	1	6	10	3	0.47

(Source: Analysis, 2023)

As displayed on table 4.6, the average risk frequency value for each variable is ranging from 0.17 to 0.64. Meanwhile, the average risk impact (risk consequence) value for each variable is stated on table 4.7 below.

Table 4.7 The Mean Value of Risk Impact/ Risk Consequence

Variables	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Average**
	0.07	**0.13**	**0.27**	**0.47**	**1**	
1	3	8	7	2	0	0.20
2	0	1	7	5	7	0.57
3	0	2	9	6	3	0.43
4	0	1	8	9	2	0.43
5	0	2	9	3	6	0.51
6	2	2	15	1	0	0.25
7	0	2	13	4	1	0.33
8	0	9	9	1	1	0.25
9	9	9	1	1	0	0.13
10	1	2	13	4	0	0.29
11	0	3	6	11	0	0.36
12	0	3	6	11	0	0.36
13	0	4	6	8	2	0.40
14	2	4	7	4	3	0.37
15	0	5	11	4	0	0.28
16	0	8	8	3	1	0.28
17	2	9	7	2	0	0.21
18	6	11	3	0	0	0.13
19	1	3	7	8	1	0.36
20	0	2	7	4	7	0.55
21	1	5	10	3	1	0.29
22	0	0	7	7	6	0.56
23	2	6	10	2	0	0.23
24	0	11	6	3	0	0.22
25	0	2	7	9	2	0.42

(Source: Analysis, 2023)

As displayed from table 4.7, the calculation result on the mean/average risk frequency value for each variable is ranging from 0.13 to 0.57. Of the average value from the risk frequency and the risk consequence/risk impact above, then, the risk factor value will be calculated using the risk factor equation thatdefined as a multiplication between frequency to impact of risks, through the following formula (SNI 8615: 2018):

FR = L + I – (L x I) ………. (1)

Note :
FR = risk factor on scale 0 – 1
L = frequency of risk occurence
I = magnitude of risk consequences/risk impact

By employing the above equation, riks factor values able to be obtained and displayed in table 4.8 below.

Table 4.8 The Values of Risk Factors

Variable (X)	Mean Frequency Value	Mean Impact/Consequence Value	Risk Factor (RF)
1	0.23	0.20	0.39
2	0.28	0.57	0.69
3	0.44	0.43	0.68
4	0.28	0.43	0.59
5	0.42	0.51	0.71
6	0.64	0.25	0.73
7	0.30	0.33	0.53
8	0.17	0.25	0.38
9	0.28	0.13	0.37
10	0.17	0.29	0.41
11	0.28	0.36	0.54
12	0.50	0.36	0.68
13	0.54	0.40	0.72
14	0.28	0.37	0.55
15	0.56	0.28	0.68
16	0.58	0.28	0.70
17	0.24	0.21	0.39
18	0.28	0.13	0.38
19	0.52	0.36	0.69
20	0.42	0.55	0.74
21	0.32	0.29	0.52
22	0.34	0.56	0.71
23	0.18	0.23	0.37
24	0.54	0.22	0.64
25	0.47	0.42	0.69

(Source: Analysis, 2023)

According to the calculation of risk factor values, each risk factor can be classified based on their risk level, where the values are ranging from 0.37 to 0.74. Furthermore, in determining the risk category, there is a risk category table will be used as presented in table 4.9.

Table 4.9 The Risk Categories

RF Values	Category	The Management of Risk / Handling Steps
> 0.70	High	Must conduct a risk reduction
0.40 - 0.70	Moderate	Corrective Steps within a certain period of time
<0.40	Low	Corrective Steps if possible

(Source: SNI 8615:2018)

From the obtained results of risk factor values, the risk categories of each variable are presented in table 4.10.

Table 4.10 The Risk Category for Each Risk Factor

No	Risk Variable	X	Risk Factor	Risk Category
1	Materials used are not according the specification	1	0.39	Low
2	The schedule of material deliveries are late	2	0.69	Moderate
3	Lacking of material availability	3	0.68	Moderate
4	Company's *cash flow* is not too well (not good)	4	0.59	Moderate
5	The increase of asphalt price during the project implementation	5	0.71	High
6	Payment term is waiting the disbursement of fund transfer from the central government	6	0.73	High
7	High overhead operating cost	7	0.53	Moderate
8	Low awareness of workers for wearing the PPE (Protective Personal Equipment)	8	0.38	Low
9	Less number of warning signs	9	0.37	Low
10	Less personnel who regulate the road traffic	10	0.41	Moderate
11	Less capable / incapability of the implementer workers	11	0.54	Moderate
12	Less number of implementer workers	12	0.68	Moderate
13	Less number of technical workers	13	0.72	High
14	Exhaustive workers due to overtime work	14	0.55	Moderate
15	Innacurate implementation method	15	0.68	Moderate
16	Inappropriate implementation stages	16	0.70	Moderate
17	Inappropriate types of equipments	17	0.39	Low
18	Poor equipment condition (lesser condition)	18	0.38	Low
19	Unpredicted weather condition	19	0.69	Moderate
20	Dense traffic condition	20	0.74	High
21	Many sugarcane trucks parked on the road bank	21	0.52	Moderate
22	Problem in the land usage which adjacent to assets of PT. KAI	22	0.71	High
23	Poor control and personnel division	23	0.37	Low
24	Poor distribution of data and information	24	0.64	Moderate
25	Poor communication between related parties in the project	25	0.69	Moderate

(Source: Analysis, 2023)

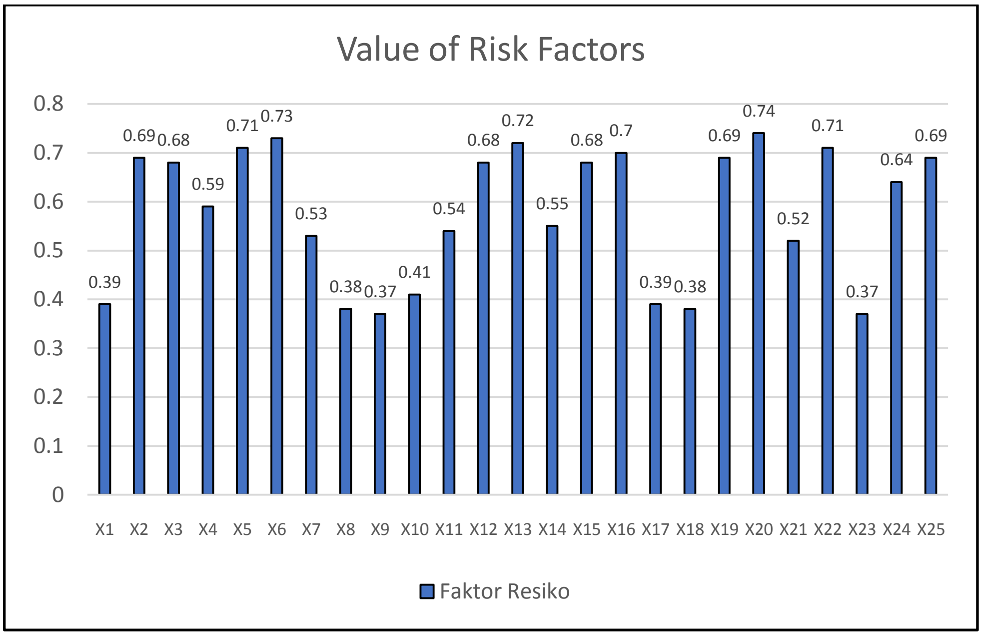

Figure 4.1 The Risk Factor Values
(Source: Analysis, 2023)

Table 4.11 Risk Ranking

Risk Factors	X	Risk Category	Risk Rank
Dense traffic condition	20	0,74	1
Payment term is waiting the disbursement of fund transfer from the central government	6	0,73	2
Less number of technical workers	13	0,72	3
Problem in the land usage which adjacent to assets of PT. KAI	22	0,71	4
The increase of asphalt price during the project implementation	5	0,71	4
Inappropriate implementation stages	16	0,70	5
The schedule of material deliveries are late	2	0,69	6
Unpredicted weather condition	19	0,69	6
Poor communication between related parties in the project	25	0,69	6
Lacking of material availability	3	0,68	7
Less number of implementer workers	12	0,68	7
Innacurate implementation method	15	0,68	7
Poor distribution of data and information	24	0,64	8
Company's *cash flow* is not too well (not good)	4	0,59	9
Exhaustive workers due to overtime work	14	0,55	10
Less capable / incapability of the implementer workers	11	0,54	11
High overhead operating cost	7	0,53	12

Many sugarcane trucks parked on the road bank	21	0,52	13
Less personnel who regulate the road traffic	10	0,41	14
Materials used are not according the specification	1	0,39	15
Inappropriate types of equipments	17	0,39	15
Low awareness of workers for wearing the PPE (Protective Personal Equipment)	8	0,38	16
Poor equipment condition (lesser condition)	18	0,38	16
Less number of warning signs	9	0,37	17
Poor control and personnel division	23	0,37	17

(Source: Analysis, 2023)

Note :

(orange)	High risk
(yellow)	Moderate risk
(green)	Low risk

According to table 4.10, table 4.11 and figure 4.1, the risk factors occured in road rehabilitation project for Krebet – Gondanglegi Road in Malang regency are able to be revealed and can be explainedas follow:
Risk factors included into the high risk category are: (1) dense traffic condition, (2) payment term is waiting for the disbursment of fund transfer from the central government, (3) less number of technical personnels, (4) Problem in the land usage which adjacent to assets of PT. KAI, and (5) an increase in asphalt price during the road rehabilitation project implementation.
Risk factors included into moderate risk category are: (1) Inappropriate implementation stages, (2) The schedule of material deliveries are late, (3) Unpredicted weather condition,(4) Poor communication between related parties in the project, (5) Lacking of material availability , (6) Less number of implementer workers , (7) Innacurate implementation method, (8) Poor distribution of data and information, (9)Company's *cash flow* is not too well (not good), (10) Exhaustive workers due to overtime work , (11) Less capable / incapability of the implementer workers , (12) High overhead operating cost , (13) Many sugarcane trucks parked on the road bank, (14) Less personnel who regulate the road traffic.
Risk factors included into low risk category are: (1) Materials used are not according the specification, (2) Low awareness of workers for wearing the PPE (Protective Personal Equipment), (3) Less number of warning signs, (4) Inappropriate types of equipments, (5) Poor equipment condition (lesser condition), (6) Poor control and personnel division.

5 CONCLUTION

According to the conducted research, some conclusions are drawn as explained below:
5.1 There are 5 (five) high risk factors which greatly affected the Krebet – Gondanglegi Road Rehabilitation in Malang Regency:
a) Dense traffic condition(X_{20}).
b) Payment term is waiting the disbursement of fund transfer from the central government (X_6).
c) Less number of technical workers(X_{13}).
d) Problem in the land usage which adjacent to assets of PT. KAI (X_{22}).
e) The increase of asphalt price during the project implementation (X_5).

5.2 The magnitude of influencial value for each risk factor included into high category are stated as follow:
a) Dense traffic condition(X_{20}) with amounted value of 0, 74.
b) Payment term is waiting the disbursement of fund transfer from the central government (X_6) with amounted value of 0,73.
c) Less number of technical workers(X_{13}) with amounted value of 0, 72.
d) Problem in the land usage which adjacent to assets of PT. KAI(X_{22}) with amounted value of 0,71.
e) The increase of asphalt price during the project implementation (X_5) with amounted value of 0,71.

5.3 Efforts in overcoming risk factors can be carried out in various ways depending on each risk factor.Yet, in general, attempts for overcome risks are by minimizing the risk consequences of these factors so the work activities of the project can run without any distrubances and according to the predetermined work plan.

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