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Risk Management on Road Construction Project of Sumbernanas in Malang

Hasan Munawar Albana[1], Nusa Sebayang[2], Lies Kurniawati Wulandari[3]
[1, 2, 3]Department of Civil Engineering, National Institute of Technology, Malang, Indonesia

Abstract**—** *This paper discusses risk potentials that may come up during road construction project of Sumbernanas located in Malang Regency. It aims at finding out risk potentials which influence the road construction project and determining mitigation actions for that. Field survey, literature review, questionnaire and interview are conducted to obtain data which are then analyzed by using risk management framework. The findings show that there are 12 risk variables and 51 risk indicators in which 11 of them are high risks.*

Keywords**—** *Risk management, Road constructtion project*.

I. INTRODUCTION

Malang regency is the second largest regency in Indonesia. Its area is surrounded by mountains and lowlands. In addition, Malang regency is well-known for their yield crops such as coffee and others. Thus, road plays fundamental role for economic development in Malang. Sufficient length and good condition of roads will ensure smooth movement of people and good from one area to other area in Malang regency or area outside Malang. The price of goods will be kept reasonable due to low cost of transportation. Thus, road construction and maintenance is priority program for regional government of Malang.

In line with statements of vision and mission of Head of Malang Regency, one of the focuses of Public Works Office of Bina Marga of Malang Regency is to provide sufficient length and good condition of road. It functions to support economic and tourism development program in Malang. The program of Public works office of Bina Marga of Malang Regency is not only to maintain existing road but also to build new roads. One of them is road construction project of Sumbernanas.

However, every construction project has its own risks. They are technical and non-technical risks. The first kind of risks are those related to human, equipment, material and technology used for construction. The latter are risks due to weather condition, economic, social and environmental factors as well as financial and other factors which may influence the construction project. Another risk factor that should be taken into serious consideration is work safety and health. Every construction project must have firm standard operating procedures for work safety and health. The absence of such procedure may put not only the construction worker but also the project completion at risk.[1}

In addition, the risks may also affect project budget, time completion and quality of project. Shortly, road construction project is subject to failure due to bad risk management.[2} Therefore, there is a need for risk management analysis to prevent failure of road construction project.

II. REVIEW OF LITERATURE

The first study analysed for review of literature is that conducted by Moi, F and Purnawirati, I.G.A[3]. The study entitled "Risk Management Analysis on Construction Project of Baru Waebetu – Tawaraja Road" aims at finding out risk factors for road construction project. There are eight risk factors found namely planning risk, technical risk, economic risk, human resources risk, political risks, environmental risk and nature risk.

The study entitled "Analysis on Road Project of North Road of Brebes – Tegal" is intended to find out risk factors. Methods used are Probability and Impact Matrix method. It results in 33 risk factors categorized into high risk, medium risk and low risk factors [4]. Faisal., M Tenriajeng T conducted study entitled "Risk Analysis on Construction Stage of Cinere – Jagorawi Depok Freeway". By using questionnaire, it aims at identifying risk factors during construction. 45 risk factors are identified as well as their mitigation action [5].

Sebayang and Wijayaningtyas conducted study entitled "Factors Influencing Reduction of Road Construction Age in Tulungagung". It aims at analysing factors influencing road construction age and finding out the most influential factors for road construction age [6]. The last study conducted by Astiti et al entitled "Risk Analysis on Construction Project of Benoa-Bandara Nusa Dua Freeway". It aims at finding out risk factors during the construction process. There are 54 risk factors that can be identified for which mitigations are formulated [7].

A. Construction Project

Construction project is series of activities covering civil engineering and architectural works. The first concerns with feasibility study, design engineering, procurement and construction stages. It is a complex process because it takes a long time and should meet predetermined target and quality of project. To achieve the project goal, there are three constraints that should be taken into consideration. They are time constraint, schedule and quality [8]. Construction projects should be managed in such a way to anticipate unexpected and uncertain factors.

B. Risk Management

Risk management is a systematic process to identify, analyse, respond and control risk factors [9]. It aims at preventing or reducing negative effect caused unexpected factors that may jeopardize the project. Risk management also aims at finding out contingency measures for the risks.

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Flanagan & Norman also stated that risk management is a decision making process called Risk Management System which consists of five stages. They are risk identification, risk classification, risk analysis, attitude to risk and response to risk [10}.

- Risk identification
  It deals with process to finding out potential risks during project implementation. It is a systematic and continuous process. Godfrey identifies several risk sources. They are political risk, environmental risk, economic risk, planning risk project risk, technical risk, financial risk, human risk, material risk, tools risk, criminal risk, safety risk[11]
- Risk classification
  It is a process of classifying risks based on their risk level. It might be classified into three category namely Risk on Material and Equipment, Risk on Manpower, Risk on Project Implementation, Risk on Design and Risk of Nature.
- Risk analysis
  After classifying the risks, then they are analysed based on their impact and occurrence level.
- Attitude to risk
  It deals with how risks are handled.
- Response to risk
  It concerns with how relevant personnel formulate necessary measures to respond to risk. It aims at reducing risk impact. The process is also called risk mitigation.

III. Research Methodology

This is a descriptive study employing quantitative approach which is aimed at obtaining accurate and systematic description on the study object.

A. *Types of Data*

There are two types of data used in this study.

- Primary data
  This data is obtained directly from respondents through questionnaires and interviews.
- Secondary data
  It is obtained from journal, books, relevant studies and field survey to support this study especially in formulating risk factors for road construction project.

B. *Study Variables*

In this study, risk variables are formulated from preliminary studies, journals and interview as well as field observation. The variables are then put into questionnaire and given to respondents. Study variables used in this study is presented in following table.

TABLE 1. Study Variable

No	Risk Variables	Code	Reference
1	Political Factor		
	a. Policy of regional government	A1	Interview
	b. Change on design and work technical aspects	A2	Previous study
	c. Problems concerning conflict resolution with other parties	A3	Previous study
	d. Lack of coordination among related parties	A4	Previous study
	e. Substitution on person in charge in government	A5	Previous study
2	Environment factor		
	a. Noise due to the use of heavy equipment	A6	Previous study
	b. Insecure environment of project	A7	Previous study
	c. Permission from local people	A8	Previous study
	d. Difficult access to project site	A9	Previous study
	e. Change on site usage	A10	Interview
3	Planning factor		
	a. Design change	A11	Previous study
	b. Fault design by engineer	A12	Previous study
	c. Incomplete design data	A13	Previous study
	d. Vagueness of information on project scope	A14	Previous study
	e. Selection of road solidification type	A15	Previous study
4	Project Factor		
	a. Contract and work order signing	A16	Interview
	b. Change on work schedule	A17	Previous study
	c. Change on work scope	A18	Interview
	d. Different measurement scale between work design and field condition	A19	Previous study
	e. Different elevation on excavation to that in work design	A20	Previous study
	f. Lack of supervision during project implementation	A21	Previous study
5	Material Factor		
	a. Fault time frame for material order	A22	Previous study
	b. Delay of material delivery	A23	Previous study
	c. Lack of material during project	A24	Previous study
	d. Availability of material used	A25	Previous study
	e. Material placement during project	A26	Previous study
6	Equipment Factors		
	a. Inadequate number of equipment	A27	Previous study
	b. Damage on equipment	A28	Previous study
	c. Wrong specification of equipment	A29	Previous study
7.	Manpower factors		
	a. Incompetent manpower	A30	Previous study
	b. Carelessness of manpower	A31	Previous study
	c. Inadequate number of manpower	A32	Previous study
	d. Culture of manpower	A33	Previous study
	e. Fatigue on the part of manpower due to extra work	A34	Previous study
8	Financial Factors		
	a. Noncurrent cash flow	A35	Previous study
	b. Payment Delay to supplier	A36	Previous study
	c. High operational cost and overhead	A37	Previous study
	d. Payment delay from owner	A38	Previous study
9	Nature Factors		
	a. Rain fall	A39	Previous study
	b. Landslide	A40	Previous study
10	Economic Factors		
	a. Tax increase	A41	Previous study
	b. Fuel price increase	A42	Previous study
	c. Price escalation during project implementation	A43	Previous study
11	Criminal Factors		

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	a. Theft	A44	Previous study
	b. Lack of project security	A45	Previous study
	c. Damage	A46	Previous study
12	Safety Factors		
	a. Lack of safety equipment use	A47	Previous study
	b. Lack of Self-safety equipment	A48	Previous study
	c. Manpower awareness to apply safety procedures	A49	Previous study
	d. Dangerous substance	A50	Previous study
	e. Structure collapse	A51	Previous study

C. *Respondents of Study*

Respondents of this study are those involved in road construction process of Sumbernanas. They are 12 respondents to whom questionnaire will be given. They are

- Commitment making officials (CMO)
- Technical project implementer officials for Planning and Supervision
- Technical project implementer officials for road construction project.
- Site supervisor from Public works office of Bina Marga.
- Director of company
- Site manager
- Safety officials.
- Director of planning consultant.
- Project planning team.
- Director of Supervisory Consultant
- Field site inspectors

D. *Data Analysis*

Procedure of data analysis is as follows

- Identifying and classifying risk factors
  Risk factors are formulated through literature review and field observation.
- Analyzing data obtained from questionnaire I distributed during field survey I
  Risk factors that have been identified are then put in questionnaire and distributed to respondents. Then from the questionnaire, relevant risk factors are identified. After that, survey 2 is conducted to find out probability level of risk occurrence and risk impact.
- Analyzing data from questionnaire 2
  Method of severity index and probability matrix of impact method is used to analyze the data. It aims at obtaining combination of probability and impact of risk.
  The following formula is used to obtain severity index

$$SI = \frac{\sum_{i=0}^{4} ai.xi}{4\sum_{i=0}^{4} xi}(100\%)$$

Where

ai : scorer contants
xi : frequency of respondents
I : 0,1,2,3,4,……n
x1,x2,x3,x4,x5 : frequency of respondent's respons
a1 = 1, a2 = 2, a3=3, a4=4, a4=5
x1 : "very low/small" frequency. Then a1 = 1
x2 : "very low/small" frequency. Then a2 = 2
x3 : "low/small" frequency, then a3=3
x4 : "high/big" frequency, then a4 = 4
x5 : "very high/big" frequency, then a5=5

- Analyzing risk factors
  Data from the second survey are then analyzed by using scale of scoring ranging from "very small" (occurrence possibility ≤20%), "small" (occurrence possibility <40%), "moderate" (occurrence possibility <60%), "Big (occurrence possibility 80%) and "very big" (occurrence possibility >80 - 100%)
- Ranking risk factors
  Risk factors are ranked by using the following formula
  FR = (L+I) – (L x I)
  Where
  FR = risk factors, scale 0-1
  L = probability of risk events (0 – 100%)
  I = scale of risk impact.
- Composing risk matrix
  It is conducted by plotting risk value into matrix. It is then used to find out which risk factors with big possibility of occurrence and big impact.

IV. Finding and Discussion

A. *Expert Validation for Questionnaire*

Questionnaire should be validated before being distributed to respondents. There are seven experts involved. The criteria of validity is that the risk factors is valid or relevant if the answer for each factors are at least 4 variables and if the responses are >50%. The result of the expert validation is presented in following table

TABLE 2. The Result of expert validation for questionnaire

No	Risk Indicators	Relevant	Irrelevant	Status
1	Regional government Policy	7	0	Used
2	Change on design and work technical aspects	5	2	Used
3	Problems concerning conflict resolution with other parties	5	2	Used
4	Lack of coordination among related parties	4	3	Used
5	Substitution on person in charge in government	6	1	Used
6	Noise due to the use of heavy equipment	5	2	Used
7	Insecure environment of project	5	2	Used
8	Permission from local people			
9	Difficult access to project site	5	2	Used
10	Change on site usage	5	2	Used
11	Design change	5	2	Used
12	Fault design by engineer	5	2	Used
13	Incomplete design data	4	3	Used
14	Vagueness of information on project scope	5	2	Used
15	Selection of road solidification type	5	2	Used

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16	Contract and work order signing	4	3	Used
17	Change on work schedule	5	2	Used
18	Change on work scope	5	2	Used
19	Different measurement scale between work design and field condition	6	1	Used
20	Different elevation on excavation to that in work design	6	1	Used
21	Lack of supervision during project implementation	5	2	Used
22	Fault time frame for material order	5	2	Used
23	Delay of material delivery	6	1	Used
24	Lack of material during project	5	2	Used
25	Availability of material used	5	2	Used
26	Material placement during project	6	1	Used
27	Inadequate number of equipment	6	1	Used
28	Damage on equipment	6	1	Used
29	Wrong specification of equipment	6	1	Used
30	Incompetent manpower	5	2	Used
31	Carelessness of manpower	6	1	Used
32	Inadequate number of manpower	6	1	Used
33	Culture of manpower	6	1	Used
34	Fatique on the part of manpower due to extra work	6	1	Used
35	Noncurrent cash flow	5	2	Used
36	Payment Delay to supplier	6	1	Used
37	High operational cost and overhead	5	2	Used
38	Payment delay from owner	6	1	Used
39	Rain fall	5	2	Used
40	Landslide	5	2	Used
41	Tax increase	6	1	Used
42	Fuel price increase	5	2	Used
43	Price escalation during project implementation	5	2	Used
44	Theft	5	2	Used
45	Lack of project security	6	1	Used
46	Damage	7	0	Used
47	Lack of safety equipment use	5	2	Used
48	Lack of Self-safety equipment	6	1	Used
49	Manpower awareness to apply safety procedures	5	2	Used
50	Dangerous substance	5	2	Used
51	Structure collapse	5	2	Used

B. Occurrence and Impact of Risk

After distributing the questionnaire, then data on occurrence and impact of risk evens are obtained. The occurrence of risk is measured by using 1 – 5 scale. The data on risk occurrence is presented in following table

TABLE 3. Risk Occurrence

No	Risk Indicators	Mode	Mean
1	Regional government Policy	3	3.17
2	Change on design and work technical aspects	1	1.50
3	Problems concerning conflict resolution with other parties	2	2.67
4	Lack of coordination among related parties	3&4	3.50
5	Substitution on person in charge in government	3	3.00
6	Noise due to the use of heavy equipment	4	2.33
7	Insecure environment of project	3&4	3.25
8	Permission from local people	4	3.58
9	Difficult access to project site	3	3.00
10	Change on site usage	3	2.92
11	Design change	4	3.17
12	Fault design by engineer	2	2.42
13	Incomplete design data	2	2.58
14	Vagueness of information on project scope	3&4	3.25
15	Selection of road solidification type	4	3.58
16	Contract and work order signing	3&4	3.25
17	Change on work schedule	3	3.00
18	Change on work scope	4	3.33
19	Different measurement scale between work design and field condition	3	3.00
20	Different elevation on excavation to that in work design	2	2.33
21	Lack of supervision during project implementation	2&3	2.50
22	Fault time frame for material order	2&3	2.83
23	Delay of material delivery	3&4	3.25
24	Lack of material during project	4	3.75
25	Availability of material used	4	3.42
26	Material placement during project	4	3.33
27	Inadequate number of equipment	2	2.75
28	Damage on equipment	2	2.42
29	Wrong specification of equipment	2	2.42
30	Incompetent manpower	3	3.00
31	Carelessness of manpower	3	3.00
32	Inadequate number of manpower	4	3.42
33	Culture of manpower	3&4	3.25
34	Fatigue on the part of manpower due to extra work	4	2.75
35	Noncurrent cash flow	3	3.08
36	Payment Delay to supplier	4	3.58
37	High operational cost and overhead	3&4	3.17
38	Payment delay from owner	3	3.00
39	Rain fall	1	2.25
40	Landslide	2	2.67
41	Tax increase	2&3	2.50
42	Fuel price increase	3	2.92
43	Price escalation during project implementation	3	3.08
44	Theft	3&4	3.25
45	Lack of project security	3	3.08
46	Damage	1	2.17
47	Lack of safety equipment use	2	2.58
48	Lack of Self-safety equipment	2	2.58
49	Manpower awareness to apply safety procedures	3&4	3.25
50	Dangerous substance	2	2.75
51	Structure collapse	1	1.75

The result of questionnaire on impact of risk during road construction of Sumbernanas is presented below.

TABLE 4. Risk Impact

No	Risk Indicators	Mode	Mean
1	Regional government Policy	3&4	3.17
2	Change on design and work technical aspects	2	2.75
3	Problems concerning conflict resolution with other parties	2	2.83
4	Lack of coordination among related parties	3&4	3.50
5	Substitution on person in charge in government	3	2.75
6	Noise due to the use of heavy equipment	2	2.08

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7	Insecure environment of project	3&4	3.25
8	Permission from local people	3&4	3.17
9	Difficult access to project site	3	3.67
10	Change on site usage	3	3.00
11	Design change	3&4	3.25
12	Fault design by engineer	2&3	2.50
13	Incomplete design data	2	2.33
14	Vagueness of information on project scope	3&4	3.25
15	Selection of road solidification type	3	3.17
16	Contract and work order signing	3&4	3.25
17	Change on work schedule	3	3.00
18	Change on work scope	4	3.33
19	Different measurement scale between work design and field condition	3	3.00
20	Different elevation on excavation to that in work design	2	2.33
21	Lack of supervision during project implementation	2&3	2.50
22	Fault time frame for material order	2&3	2.83
23	Delay of material delivery	4	3.67
24	Lack of material during project	3	3.17
25	Availability of material used	4	3.67
26	Material placement during project	2	2.92
27	Inadequate number of equipment	1	2.17
28	Damage on equipment	2	2.67
29	Wrong specification of equipment	2	2.50
30	Incompetent manpower	4	3.33
31	Carelessness of manpower	3	3.08
32	Inadequate number of manpower	3	2.92
33	Culture of manpower	2	2.83
34	Fatigue on the part of manpower due to extra work	3	3.17
35	Noncurrent cash flow	2	2.67
36	Payment Delay to supplier	1	1.83
37	High operational cost and overhead	2	2.00
38	Payment delay from owner	3	3.17
39	Rain fall	3	3.00
40	Landslide	2	2.08
41	Tax increase	2	2.67
42	Fuel price increase	2	2.58
43	Price escalation during project implementation	3	3.00
44	Theft	1	2.42
45	Lack of project security	2	2.75
46	Damage	1	2.17
47	Lack of safety equipment use	4	3.00
48	Lack of Self-safety equipment	4	3.00
49	Manpower awareness to apply safety procedures	3	3.17
50	Dangerous substance	1	2.50
51	Structure collapse	1	1.92

The next step is to calculate matrix by matching result of scoring for rick occurrence and risk impact. The result is presented below

TABLE 5. Matched Matrix on Possibility and Occurrence of Risk

No	Very Low	Low	Moderate	High	Very High
Very small	1	2	3	4	5
Small	0.8	1	2	3	4
Moderate	0.6	0.8	1	2	3
Big	0.4	0.6	0.8	1	2
Very Big	0.2	0.4	0.6	0.8	1
Total	**3**	**4.8**	**7.4**	**10.8**	**15**

The matrix above is used to obtain percentage of possibility and occurrence of risk. The result is as follows

TABLE 6. Percentage on Possibility and Occurrence of Risk

No	Very Low	Low	Moderate	High	Very High	Total	Average	Percentage (%)
Very small	0.33	0.42	0.41	0.37	0.33	1.86	0.37	100.00
Small	0.27	0.21	0.27	0.28	0.27	1.29	0.26	69.37
Moderate	0.20	0.17	0.14	0.19	0.20	0.89	0.18	47.71
Big	0.13	0.13	0.11	0.09	0.13	0.59	0.12	31.86
Very Big	0.07	0.08	0.08	0.07	0.07	0.37	0.07	20.00
Total	**1**	**1**	**1**	**1**	**1**			

Matrix of possibility and occurrence of risk results in the following

TABLE 7. Result of Risk Weight Calculation

Risk Level	Very Small	Small	Moderate	Big	Very Big
Weight	0.2	0.32	0.48	0.69	1

Then, each risk weight is multiplied by risk levels from all respondents. The result is presented in following table

TABLE 8. Average Score of Possibility of Risk

Variable	Very Low	Low	Moderate	High	Very High	Average
	0.2	0.32	0.48	0.69	1	
1	0	2	7	2	1	0.32
2	8	2	2	0	0	0.16
3	0	6	4	2	0	0.26
4	0	1	5	5	1	0.36
5	1	2	6	2	1	0.31
6	1	7	3	1	0	0.23
7	0	2	5	5	0	0.32
8	0	1	4	6	1	0.37
9	0	2	8	2	0	0.29
10	0	3	7	2	0	0.29
11	0	3	4	5	0	0.32
12	2	5	3	2	0	0.24
13	0	6	5	1	0	0.25
14	0	3	4	4	1	0.33
15	0	1	4	6	1	0.37
16	0	2	5	5	0	0.32
17	1	2	6	2	1	0.31
18	1	2	3	4	2	0.35
19	1	2	6	2	1	0.31
20	1	7	3	1	0	0.23
21	1	5	5	1	0	0.24
22	1	4	4	2	1	0.29
23	0	1	1	4	6	0.48
24	0	2	5	5	0	0.32
25	0	1	2	8	1	0.39
26	0	2	3	7	0	0.35
27	1	2	2	6	1	0.35
28	1	5	3	2	1	0.28
29	2	6	2	1	1	0.25
30	1	7	2	2	0	0.24
31	1	2	6	2	1	0.31
32	0	2	8	2	0	0.29
33	1	1	3	6	1	0.36
34	0	2	5	5	0	0.32
35	1	1	3	4	1	0.29
36	1	2	5	3	1	0.32
37	1	1	2	6	2	0.38
38	1	2	4	4	1	0.33
39	1	2	6	2	1	0.31
40	4	3	3	2	0	0.23
41	1	6	2	2	1	0.27
42	1	5	5	1	0	0.24
43	1	2	6	3	0	0.29
44	1	2	5	3	1	0.32

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45	1	2	5	3	1	0.32
46	5	3	2	1	1	0.23
47	2	5	2	2	1	0.27
48	2	5	2	2	1	0.27
49	0	3	4	4	1	0.33
50	1	5	3	2	1	0.28
51	6	4	1	1	0	0.18

Based on the above table, we found that dominant risks and their sub risks to occur are as follows

- For political risk, Lack of coordination among related parties is the most likely to occur whose weight is 0,36.
- For environmental risk, Permission from local people is the most likely to occur whose weight is 0,37.
- For Planning risk, Selection of road solidification type is the most likely and its weight is 0,37.
- For Project risk, Change on work scope is the most likely whose weight is 0,35.
- For material risk, the most likely to occur is Availability of Material whose weight is 0,39.
- Concerning Equipment, Damage on Equipment is the most likely to occur whose weight is 0,28.
- For manpower, Culture of Manpower is the most likely to occur and its weight is 0,36.
- For financial risk, High operational and overhead cost is the most likely with weight of 0,36.
- For Nature risk, Rain Fall is the most likely to occur and its weight is 0,31.
- For economic risk, price escalation during project turns to be the most likely to occur whose weight is 0.29.
- Concerning criminal risk, Lack of Project security is the most likely one and its weight is 0,32.
- The last is safety risk. The most likely to occur is Manpower awareness to apply safety procedures and its weight is 0, 33.

C. Calculating Risk Impact by Using Severity Index

By using formula stated in previous section, then Severity Index is calculated. Then, scoring scale of risk occurrence based on AS/NZS4360:1999 Risk Management is used in which

- SI = < 20 = 1 = very rarely
- SI = 20 - < 40 = 2 = rarely
- SI = 40 - < 60 = 3 = occasionally
- SI = 60 - < 80 = 4 = often
- SI = 80 - < 100 = 5 = very often

The result is presented in following table

TABLE 9. Severity Index for Risk Possibility

No	Risk Indicators	SI	Scale
1	Regional government Policy	63.33	4
2	Change on design and work technical aspects	30.00	2
3	Problems concerning conflict resolution with other parties	53.33	3
4	Lack of coordination among related parties	70.00	4
5	Substitution on person in charge in government	60.00	3
6	Noise due to the use of heavy equipment	46.67	3
7	Insecure environment of project	65.00	4
8	Permission from local people	71.67	4
9	Difficult access to project site	60.00	3
10	Change on site usage	58.33	3
11	Design change	63.33	4
12	Fault design by engineer	48.33	3
13	Incomplete design data	51.67	3
14	Vagueness of information on project scope	65.00	4
15	Selection of road solidification type	71.67	4
16	Contract and work order signing	65.00	4
17	Change on work schedule	60.00	3
18	Change on work scope	66.67	4
19	Different measurement scale between work design and field condition	60.00	3
20	Different elevation on excavation to that in work design	46.67	3
21	Lack of supervision during project implementation	50.00	3
22	Fault time frame for material order	56.67	3
23	Delay of material delivery	85.00	5
24	Lack of material during project	65.00	4
25	Availability of material used	75.00	4
26	Material placement during project	68.33	4
27	Inadequate number of equipment	66.67	4
28	Damage on equipment	55.00	3
29	Wrong specification of equipment	48.33	3
30	Incompetent manpower	48.33	3
31	Carelessness of manpower	60.00	3
32	Inadequate number of manpower	60.00	3
33	Culture of manpower	68.33	3
34	Fatigue on the part of manpower due to extra work	65.00	4
35	Noncurrent cash flow	55.00	3
36	Payment Delay to supplier	61.67	4
37	High operational cost and overhead	71.67	4
38	Payment delay from owner	63.33	4
39	Rain fall	60.00	3
40	Landslide	45.00	3
41	Tax increase	53.33	3
42	Fuel price increase	50.00	3
43	Price escalation during project implementation	58.33	3
44	Theft	61.67	4
45	Lack of project security	61.67	4
46	Damage	43.33	3
47	Lack of safety equipment use	51.67	3
48	Lack of Self-safety equipment	51.67	3
49	Manpower awareness to apply safety procedures	65.00	4
50	Dangerous substance	55.00	3
51	Structure collapse	35.00	3

By using the same procedure, we calculate severity index for risk impact

TABLE 10. Severity Index for Risk Impact

No	Risk Indicators	SI	Scale
1	Regional government Policy	63.33	4
2	Change on design and work technical aspects	55.00	3
3	Problems concerning conflict resolution with other parties	56.67	3
4	Lack of coordination among related parties	70.00	4
5	Substitution on person in charge in government	55.00	3

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6	Noise due to the use of heavy equipment	41.67	3
7	Insecure environment of project	65.00	4
8	Permission from local people	63.33	4
9	Difficult access to project site	73.33	3
10	Change on site usage	60.00	3
11	Design change	65.00	4
12	Fault design by engineer	50.00	3
13	Incomplete design data	46.67	3
14	Vagueness of information on project scope	65.00	4
15	Selection of road solidification type	63.33	4
16	Contract and work order signing	65.00	4
17	Change on work schedule	60.00	3
18	Change on work scope	66.67	4
19	Different measurement scale between work design and field condition	60.00	3
20	Different elevation on excavation to that in work design	46.67	3
21	Lack of supervision during project implementation	50.00	3
22	Fault time frame for material order	56.67	3
23	Delay of material delivery	73.33	4
24	Lack of material during project	63.33	4
25	Availability of material used	73.33	4
26	Material placement during project	58.33	3
27	Inadequate number of equipment	43.33	3
28	Damage on equipment	53.33	3
29	Wrong specification of equipment	50.00	3
30	Incompetent manpower	66.67	4
31	Carelessness of manpower	61.67	4
32	Inadequate number of manpower	58.33	3
33	Culture of manpower	56.33	3
34	Fatigue on the part of manpower due to extra work	36.67	2
35	Noncurrent cash flow	40.00	2
36	Payment Delay to supplier	63.33	4
37	High operational cost and overhead	60.00	3
38	Payment delay from owner	41.67	3
39	Rain fall	53.33	3
40	Landslide	45.00	3
41	Tax increase	53.33	3
42	Fuel price increase	51.67	3
43	Price escalation during project implementation	60.00	3
44	Theft	48.33	3
45	Lack of project security	60.00	3
46	Damage	43.33	3
47	Lack of safety equipment use	60.00	3
48	Lack of Self-safety equipment	60.00	3
49	Manpower awareness to apply safety procedures	63.33	4
50	Dangerous substance	55.00	3
51	Structure collapse	38.33	2

D. *Ranking Risk*

Based on the above calculation, then risk ranking is formulated

TABLE 11. Risk Ranking

No	Risk Indicators	Possibility of occurrence	Impact	Risk Level	Risk Ranking
23	Delay of material delivery	5	4	20	1
1	Regional government Policy	4	4	16	2
4	Lack of coordination among related parties	4	4	16	3
7	Insecure environment of project	4	4	16	4
8	Permission from local people	4	4	16	5
11	Design change	4	4	16	6
14	Vagueness of information on project scope	4	4	16	7
15	Selection of road solidification type	4	4	16	8
16	Contract and work order signing	4	4	16	9
18	Change on work scope	4	4	16	10
24	Lack of material during project	4	4	16	11
25	Availability of material used	4	4	16	12
30	Incompetent manpower	3	4	12	13
31	Carelessness of manpower	3	4	12	14
36	Payment Delay to supplier	3	3	9	15
49	Manpower awareness to apply safety procedures	3	3	9	16

E. *Composing Risk Matrix*

After finding out risk possibility to occur and impact, then risk matrix is composed. It aims at formulating mitigation action. The matrix is presented in following table

TABLE 12. Risk Matrix

	IMPACT				
Possibility for occurence	(1) Very small	(2) Small	(3) Moderate	(4) Big	(5) Very Big
5 (Very often)	M	M	H	23	E
4 (Often)	L	34	7, 8, 26, 27, A37, 38, 44, 45,	1,4,7, 8, 11, 14, 15, 16,18, 24, 25, 36,49	H
3 (Occasionally)	L	35, 51	3, 5, 6, 9, 10, 12, 13, 17, 19, 20, 21, 22, 28, 29, 32, 33, , 39, 40, 41, 42, 43, 46, 47, 48, 50, 51	30, 31	H
2 (rarely)	L	L	A2,	M	H
1 (very rarely)	L	L	L	L	M

High Risk

Moderate Risk

Low Risk

Form the matrix above, there are 16 indicators that fall into high risk category. They are risk no 23, 1, 4, 7, 8, 11, 14, 15, 16, 18, 24, 25, 36, 49, 30 and 31. Those risks are priority tobe mitigated.

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F. Risk Mitigation

After identifying 16 high risks variable for road construction project of Sumbernanas, mitigation actions are formulated. The mitigation actions are presented as follows

TABLE 13. Risk Variable

Risk Variable	Mitigation Action
Regional government Policy f	• Public works office of Bina Marga Malang proposes programs to construct and maintain roads and bridges to Planning and Development Office of Malang Regency
Lack of coordination among related parties	• Public works office of Bina Marga Malang establishes periodical coordination with Planning and Development Office of Malang Regency, Budget Committee of Malang and other related offices.
Insecure environment of project	• Public works office of Bina Marga Malang works together with police department and other related parties
Permission from local people	• Public works office of Bina Marga Malang releases regular information to people around the project.
Design change	• Planning consultant must have experts to make Detail Engineering Design. • Planning consultants invites public works office of Bina Marga to review Detail Engineering Design.
Vagueness of information on project scope	• Public Work Office of Bina Marga gives concept of road construction to Planning Consultant. • Planning consultant conduct field study and obtain input from local peole.
Selection of road solidification type	• Public Works Office of Bina Marga Malang determines types of road solidification used. • Planning consultants formulates alternative design • Public Works Office of Bina Marga reviews design proposed by planning consultants. • Public Works Office of Bina Marga and planning consultants reaches agreement on types of road solidifation.
Contract and work order signing	• Public Works Office of Bina Marga or Commitment Making Officials examines budget availability. • Commitment making officials releases Letter of Provider Appointment. • Commitment Making Officials invites supplier to sign contract. • Service/good provider composes letter of contract guarantee.
Change on work scope	• Commitment making officials delegates its authority to supervisory consultant for field measurement. • Service/good provider and supervisory consultant proposes Change Work Order. • Addendum is formulated
Delay of material delivery	• Good/service provider formulates delivery schedule approved by commitment making officials
Lack of material during project	• Good/service provider assign special staff in logistic department. • Good/service provider makes material stock plans. • Good/service provider formulates work plan for material usage.
Availability of material used	• Good/service provider work together with supplier factory to prepare materials. • Good/service provider selects other material supplier approved by commitment making officials.
Incompetent manpower	• Good/service provider assign competent workers. • Good/service provider conduct short training for less competent worker.
Carelessness of manpower	• There must be clear direction for good/service provider.
Payment Delay to supplier	• Good/service provider proposes payment term to commitment making officials. • Good/service provider proposes loan to bank to fund the project
Manpower awareness to apply safety procedures	• Good/service provider assign workers who are expert in Work Safety procedures. • Good/service provider provides self-protection devices. • Good/service provider registers all workers to health insurance program.

V. CONCLUSION

Every construction project has potentials risk that may affect the project or even lead to project failure. Therefore, risk management in construction project is crucial. It should be taken into serious consideration for construction project to ensure the success of construction project. For road construction project of Sumbernanas, the findings shows that from 51 risk indicators that have been identified, there are 16 variables that are classified as high risk. In addition, there is only one risk having the biggest impact on construction project. The risk variable is Delay of Material Delivery. Then, mitigation actions are formulated to minimize or prevent the impact of risk to construction project.

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