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Risk Management in Indonesia Construction Project: A Case Study of a Toll Road Project

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Abstract

While project risks are generally acknowledged merely from owner and contractor perspectives, other parties also play important roles in the project. The aim of this study is to analyze the application of risk management in the toll road project from stakeholders' perception, such as contractor, owner, design consultant, supervisory consultant, and community surrounding the project. Data of risk factors were collected through interviews with each stakeholder, including the probability of occurrence and their impacts. Risk Breakdown Structure (RBS) has been adapted to breakdown project risks from various stakeholders. Risk level of each risk factor is obtained by multiplying the probability and the impact. The overall results of risk analysis show various risks as perceived by each stakeholder due to different roles and interests in the project. This research provides an understanding of how project risks need to be fully comprehended for the success of the project.

Keywords: risk management, construction risk, project stakeholders, risk breakdown structure, toll road project

1. Introduction

Indonesia's economic growth continues showing improvement over the last 9 years (2009–2017 period) with the latest rate of 5.05% in 2017. One of the challenges faced in escalating Indonesia's economic growth and improving economic competitiveness is the development of infrastructure. The rapid infrastructure development has been running in various sectors, from energy systems, road transport, office buildings and schools, telecommunications, and water supply networks, all of which require reliable infrastructure support [1].

Risks are closely linked to infrastructure projects, and toll road projects are no exception. Risk is a consequence of an uncertain condition which quite often cannot be predicted accurately. It is therefore necessary to have risk management from the beginning of the construction project, to reduce the impact of possible risks. PMBOK Guide 5th edition (2013) describes the stages of risk management, that is, risk identification, risk analysis, risk response, risk monitoring, and control.

Risks in construction projects are actually borne by many parties that involved in the project. Generally, risks are identified just from the owner and contractors perspectives; however, some other parties are also involved in the project. The aim of this study is to analyze the application of risk management in the toll road project from stakeholders’ perception, such as contractor, owner, design consultant, supervisory consultant, and community surrounding the project.

2. Reviewing risk management framework

2.1. Risk management at construction project

Risks of the project can be defined as an elaboration of unfortunate consequences, both of finance and structure of project, as a result of decisions taken or due to environmental conditions on the project location. Risks in construction projects are the matter that cannot be eliminated, but their impact can be minimized [2].

A construction project is unique, specific, and dynamic, and therefore projects have different levels and combinations of risks, hence different responses are taken to minimize those risks and different consequences affect the project performance. Risk categories in building projects

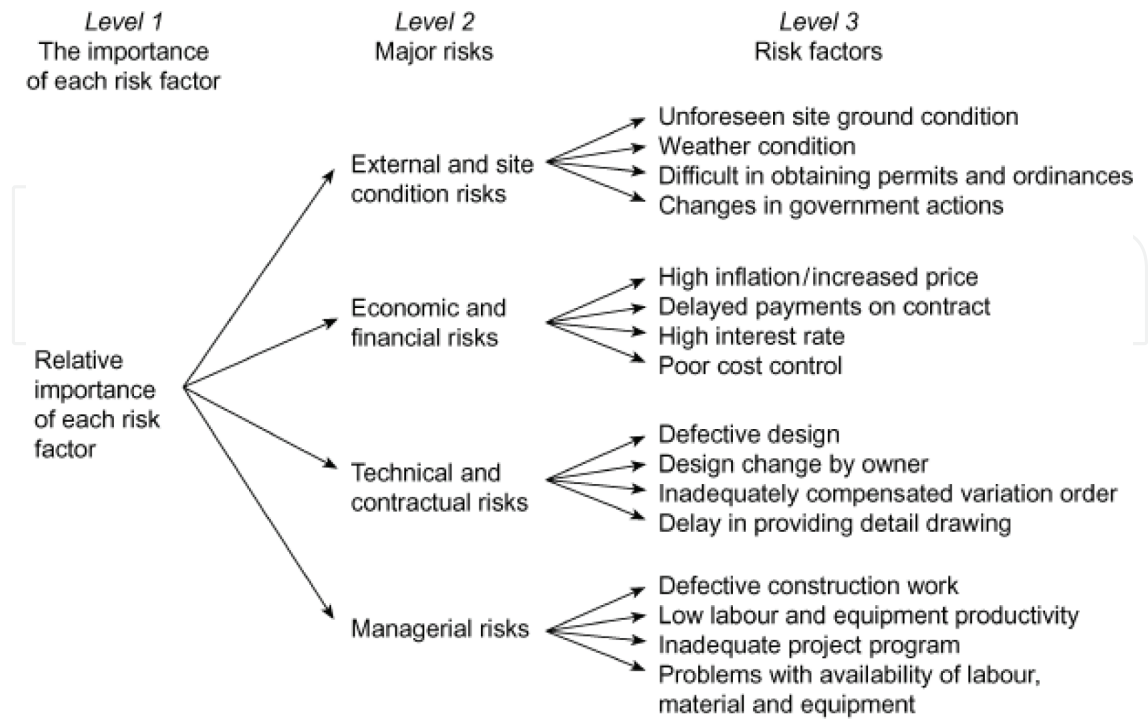


Figure 1. Hierarchy of risk at building project in Indonesia. Source: Wiguna and Scott [3].

are external risks, economic and financial risks, technical and contractual risks, and managerial risk [3]. This risk identification can be seen in **Figure 1**.

It is important to manage the multifaceted risks associated with international construction projects, in particular in developing countries, not only to secure work but also to make profit [4]. To effectively manage risks in construction projects, it is crucial to correctly identify the important risks and properly allocate them to the contractual parties. Stakeholders' perceptions of risk vary due to different interests in the project [5].

Figure 1 shows risk category and risk identification on a construction project. Risks are identified in each risk category. The risk category in the construction project can be within the scope of financial risk, time risk, physical risk, personnel risk, design and technical risk, contractual risk, political and regulation risk, and safety risk [6]. The risk categories for construction projects are determined based on several considerations, including the types of construction works, the parties involved, the construction methods, the project resources, the construction issues, and others.

2.2. Risk management of toll road projects

Basically, risk management of toll road projects goes through several stages such as risk identification, risk analysis, and risk response. What distinguishes toll road projects from other projects is the identified risks. Risks will vary depending on the stakeholders' perceptions on the project.

The identified risk on toll road construction projects was [7]:

2.2.1. Major risk

- Traffic risk: traffic during the construction process. Inconvenience for the commuters to travel.
- Toll risk: due to the lower traffic density, the collection of toll reduced. Toll risk lead to the failure in recovery of construction cost. Total construction cost increased.
- Constructional risk: the project is to be completed in certain costs and time, hence the risk in the increase of material cost increased.
- Operational and maintenance risk: due to the delays of the project, the operational and maintenance cost increased which affected the commencement of operation to cover the estimated maintenance expenditure.
- Land acquisition: delay in the project due to land acquisition lead to increase in the estimated construction cost.

2.2.2. Minor risks

- Utilities: nonavailability of fuel, electricity, and utilities not relocated on time causing delays to some works.

- Noise: repetitive, excessive noise causes long-term hearing problems in labour and can be a dangerous distraction.
- Material and manual handling: materials and equipment are being constantly lifted and moved around on a construction site, whether manually or by the use of lifting equipment. Different trades will involve greater demands, but all may involve some degree of risks.

The risks of toll road projects in Indonesia from the perception of owners are categorized into seven categories as below [8]:

- a. Political risks, such as discontinuation of concession, tax increase, inappropriate tariff implementation, inappropriate tariff increase, new government policy enforcement, etc.
- b. Construction risks, such as inappropriate design, land acquisition, project delay, project site condition, contractor's failure, etc.
- c. Operation and maintenance risks, such as toll network condition, operator's incompetence, construction quality, etc.
- d. Legal and contractual risks, such as concession time warranty, flawed/inconsistent contract document, etc.
- e. Income risks, such as inaccurate traffic volume estimate, inaccurate toll tariff estimate, construction of a competing alternative road, etc.
- f. Financial risks, such as inflation, devaluation, interest rate, changes in monetary policies, limited capital, etc.
- g. Force major, such as weather condition, war, natural disasters, etc.

Risks of toll road projects will be different when viewed from different stakeholder perspectives. From the investor point of view, the most risk in toll road projects is related to land acquisition. Other major risks are related to government policy [9].

2.3. Concepts of risk and risk management

The risk arises because of the uncertainty of an event that has not happened yet. In such an uncertainty, risk will always be inversely proportional to profit. Uncertainty can usually increase the risk factors that can be seen from potential occurrence of an undesirable negative state of an event [10]. In many cases, the greater the likelihood of risk, the greater the likelihood of profit. But there are also some cases where the level of risk is small, but the likelihood of profits is great. The ability to understand one's risks and benefits is not always the same will depend on the experience and knowledge.

Analyzing risk is an important thing in a business. In construction, risks can be seen in every aspect of the job, such as work location, resources, or project execution schedule [11]. Risk analysis aims to determine from the beginning of the possibility of losses and benefits.

Risk management can be defined as the identification, measurement, and control of the economic perspective of the risks that threaten the assets and income. Risk management aims to

identify the source of risk and uncertainty, determine its influence and determine its response appropriately. The goal of risk management is not just to reduce risk. Risk management can be used by a decision maker in estimating risks and benefits that can turn a risk into a large income. The risk management divided into five stages, that is, risk classification, risk identification, data elicitation, risk analysis, and risk response [10].

In the book, A Guide to The Project Management of Body of Knowledge 5th edition, a more detailed description of the risk management process consists of more than five steps as shown in **Figure 2**. In the following diagram, it is shown that the risk management process consists of six stages, that is, risk management planning, risk identification, risk analysis that divided into

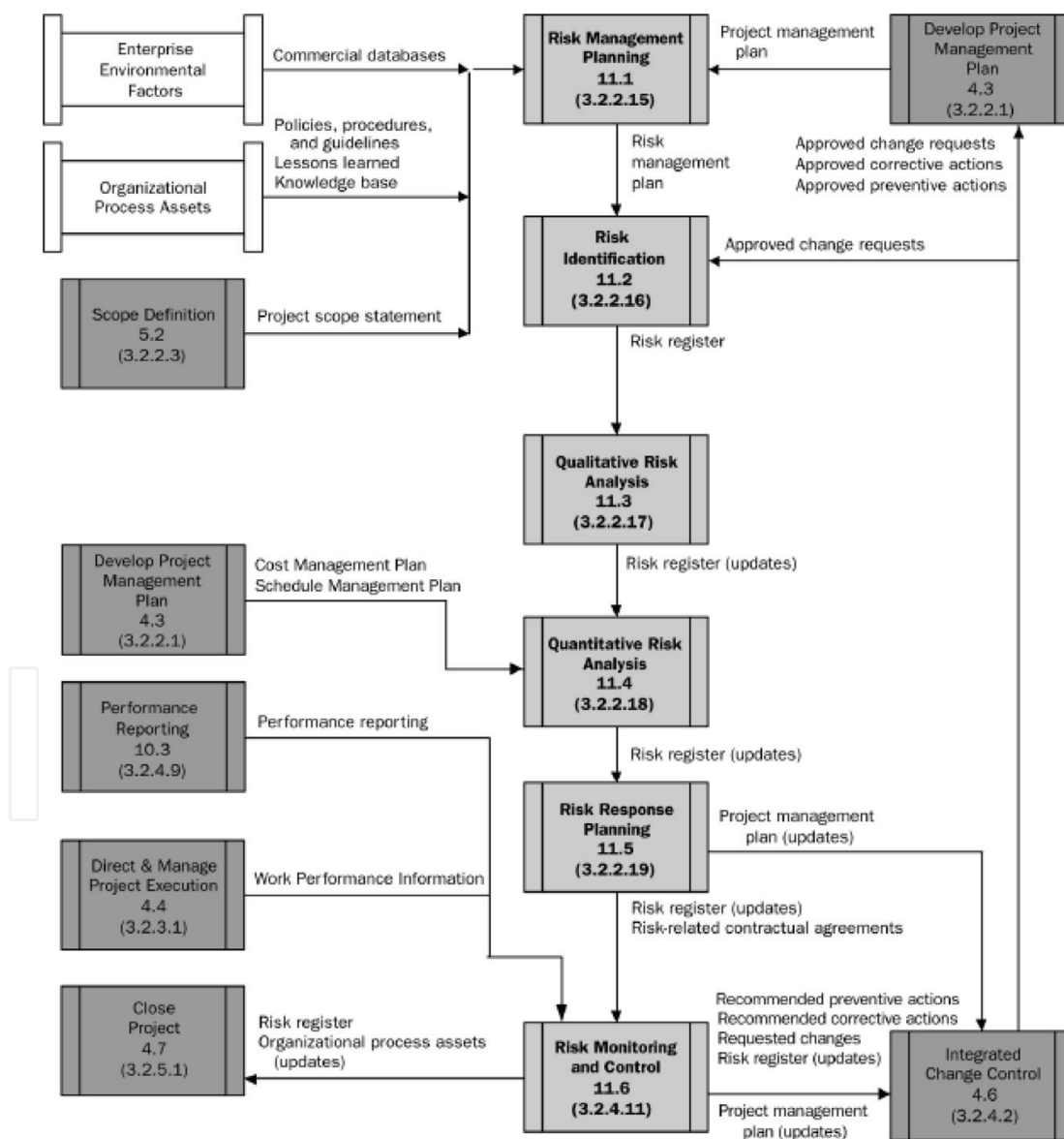


Figure 2. Step of risk management. Source: PMBOK 5th edition, 2013.

two: quantitative analysis and qualitative analysis, risk management action planning, and supervision and control.

Another simple, common and systematic approach to risk management is suggested by Berkely and others [11]. Risk management has four distinct stages: (a) risk classification, (b) risk identification, (c) risk assessment, and (d) risk response. In the first stage, risks should be classified into different groups with certain criteria in order to clarify the relationships between them. The second stage entails the identification of the risks pertaining to risk management. The third stage is to assess and evaluate the effects of these risks. In the final stage, appropriate risk response policies should be developed to reduce and control the risks.

3. Research method

The object of this research is Semarang-Solo toll road Section I in Indonesia. In this case, the risk perceptions of the stakeholders are from contractors, owners, design consultant, supervisory consultants, and community surrounding the project. Differences in stakeholders' perspective on the project and the different interests in the project lead to differing views on project risks.

Primary data were collected by interviews and questionnaire surveys. Primary data were the identification risk and also the impact and probability risk from all stakeholders. The questionnaires were distributed to all five stakeholders. From contractor side, the respondents were the general superintendent, deputy project manager, construction manager, and project engineering manager of the project. From owner side, the respondents were the chairman of the control section 1, the chairman of the control section 2, and the chairman of the control section 3. From design consultant side, the respondents were the team leader project and the expert in the case study project (two person). From the supervisory consultant, the respondents were resident engineer, quantity engineer, soil material engineer, and chief inspector. From the community around the project, the respondents were the urban village heads (two persons) and the proxy of community (two persons). All respondents are decision makers who are directly involved in this case study project and have a lot of work experience.

Secondary data were obtained from the data collection conducted by other study, for example, reference books, magazine articles, and journals related to the topic of study. The secondary data were the toll road technical document, project document, and risk management that will generate output risk and its response to the construction of toll road development.

The method of data processing used risk breakdown structure as described in **Figure 3**.

3.1. Risk management model

A Management Model is simply the set of choices made by executives about how the work of management gets done about how they define objectives, motivate effort, coordinate activities, and allocate resources [7]:

Level 1: planning.

Level 2: risk identification.

Level 3: risk analysis.

Level 4: mitigation.

3.2. Planning

Planning is the first step of any project which includes planning, organizing and controlling, and execution of the project. Project planning is the function in which project and construction managers and their key staff members prepare the master plan. Then this master plan is put into time schedule by scheduling people which is later called project scheduling. Project planning and project scheduling are two separate and distinct functions of the project management. A project planning is mostly responsible for the success or failure of the project, therefore planning of the project should be done very carefully and under expert advice [7].

3.3. Risk identification

The most important step in risk management is to identify the risks involved. The overall risks must be identified to be able to analyze and know the risk response that will be taken. Decision

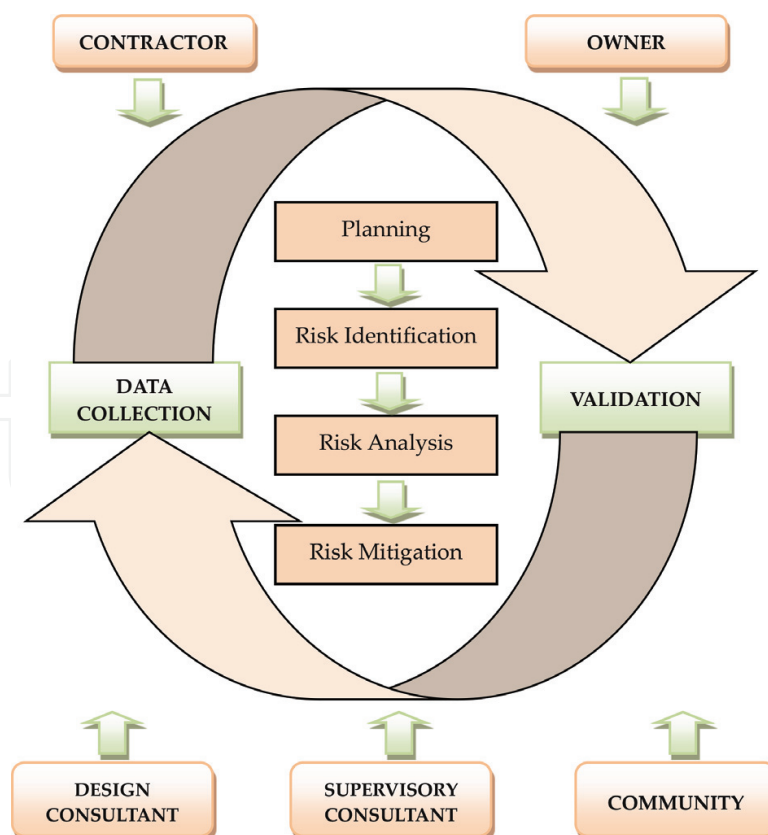


Figure 3. Data processing methods.

makers believe that the most important advantage in risk management is to identify it rather than analyzing it [10]. According to the book, A Guide to the Project Management Body of Knowledge (PMBOK), the steps in the risk identification are document review, information gathering technique, checklist analysis, assumption analysis, and diagram engineering.

3.4. Risk analysis

PMBOK (2013) mentions that in the risk analysis, there are often used methods such as risk probability and risk impact assessment. Estimating possible risk investigates the possibility of occurrence of some specific risk, and estimating the risk impact investigates the potential effects of a project that may affect the project's objectives such as time, quality, price, and scope of work which include both negative and positive impacts. Risk probability and risk impact are used to calculate the risk level of risks. Risk level is calculated using Eq. (1) [11].

$$\text{Risk level} = \text{Risk probability} \times \text{Risk impact} \quad (1)$$

Risks are ordered based on the multiplication of frequency and impact scales, composed from the largest to the smallest. To quantify the values of the risk probability and risk impact, a scale of 1–5 representing low to high probability and impact is used.

3.5. Risk mitigation

Risk response planning is a process of developing options and determining the most effective actions to increase the opportunity and reduce the risk from the negative effect. The types of response to risk can be divided into four, that is, risk avoidance, by altering the project plan to eliminate risks or conditions or to protect the project objectives from the effects/consequences; risk transfer, by seeking the exchange of consequences or risk effects to third parties together with the ownership of the response; risk mitigation, conducting investigations to reduce the probability and/or consequences of adverse risk events to acceptable levels; and risk acceptance, shows that the project team decides not to change the project plan or is unable to identify other appropriate response strategies.

4. Risk identification

The case study in this study is the Semarang-Solo Section I toll road project in Indonesia with the following project details:

- Rigid pavement 4/2 along 3.525 m
- Three main bridges
- Six box culverts
- Four overpass
- Toll facilities and plaza toll

Risk categories	Risk from contractor's perception	Risk from owner's perception	Risk from society's perception	Risk from design consultant's perception	Risk from supervisory consultant's perception
Economic risk	<ul style="list-style-type: none"> • Loss of costs due to job repairs left by subcontractors • Increase in the price of iron units of concrete 		<ul style="list-style-type: none"> • Payment of land acquisition stagnating • The presence of brokers on land acquisition process • The price of compensation for land acquisition is not suitable • Livelihoods change/disappear • Decrease in value/price of land/house investment due to adjacent to toll road 	<ul style="list-style-type: none"> • Late payment • Changes in interest rates • Monetary policy changes 	<ul style="list-style-type: none"> • Contractor completes the job before the contract expires
Contract and legal risks	<ul style="list-style-type: none"> • Liquidated damages of 1 per mile per day, no maximum limit • Abandonment of funds due to no date of maintenance guarantee returns, maintenance period of 3 years • Extended Performance Guarantee 		<ul style="list-style-type: none"> • The process of socialization of land acquisition is not according to the regulation • No feasibility study of EIA (Environmental Impact Analysis) • Violation of environmental laws and regulations • Violation of legislation on land acquisition 	<ul style="list-style-type: none"> • Inconsistency of contract documents • Late of completion of planning 	
Construction risk	<ul style="list-style-type: none"> • Work is late • Bored Pile meets the bolder layer and instructs the consultant to proceed • Work path collapsed • Theft may occur at the location of the box culvert and overpass 	<ul style="list-style-type: none"> • Land acquisition is late • Increase in land procurement costs • Late of procurement of review design consultants • Inaccuracy and lack of existing utility data 	<ul style="list-style-type: none"> • Road becomes dirty • Pavement in this area becomes damaged • Some walls of the house become cracked • Accidents due to project vehicles and project activities 	<ul style="list-style-type: none"> • Primary data and secondary data are inadequate • The quality of personnel does not meet the standards • Difficult access to location planning 	<ul style="list-style-type: none"> • Improper design from design consultant • Project delays • Conditions in the project do not support

Risk categories	Risk from contractor's perception	Risk from owner's perception	Risk from society's perception	Risk from design consultant's perception	Risk from supervisory consultant's perception
	<ul style="list-style-type: none"> Over material class B2 on ready-mix 	<ul style="list-style-type: none"> The results of the initial study (engineering, environment) is less accurate Procurement of supervisory contractors/consultants is late The quality of the winning supervising contractor/consultant is not as expected Quality of material does not conform to specifications Contractor claims for additional fees beyond the contract Design not in accordance with the conditions and or incomplete Flooding and environmental disturbance due to lack of handling of temporary drainage and construction methods during construction Unavailability of construction material Inaccurate quantity estimates Increase in construction costs The flatness and hardness of the pavement surface does not meet the SPM 	<ul style="list-style-type: none"> Air pollution caused by construction dust (influence on health) Disruption of activity/ accessibility due to project (road closure, route transfer) 	<ul style="list-style-type: none"> Error of price estimates for bidding The results of planning are considered less compatible with conditions in the project The planning completion time is too short 	<ul style="list-style-type: none"> Construction failure Contractor works not in correct procedures Unavailability of PPE (Personal Protective Equipment) Uncooperative owner
Risk of income		<ul style="list-style-type: none"> Not achieving the volume of traffic Delay of tariff increase 			
Risk of operation and maintenance		<ul style="list-style-type: none"> Increased operating and maintenance costs are not appropriate to business plan 			

Risk categories	Risk from contractor's perception	Risk from owner's perception	Risk from society's perception	Risk from design consultant's perception	Risk from supervisory consultant's perception
Political risk		<ul style="list-style-type: none"> Decrease in performance due to changes in government policy 		<ul style="list-style-type: none"> Changes in wisdom Changes in government structure Increase in taxes (related to project cost estimates) 	<ul style="list-style-type: none"> Changes in policies/regulations Changes in government structure Changes in position/organizational structure of owner
Social risk			<ul style="list-style-type: none"> Residence changed/moved Separate/disconnected access road residents due to toll road projects Noise/disruption of life due to vehicles on toll roads during the operation of toll roads 		
Force majeure risk				<ul style="list-style-type: none"> Weather conditions during the survey 	<ul style="list-style-type: none"> Weather conditions during construction

Table 1. Risk identification of Semarang-Solo Section I toll road project.

Particular attention to this project construction is the three major bridges where the land has hilly contours, while the bridge structure has a high pillar (up to 54 m), which in its execution requires special resources (formwork pillar with jump form system and slip form, support system for pier head formwork, and girder launching unit for erection girder job). The geographic and hydrological conditions of Semarang city with high rainfall and unfinished land acquisition conditions are challenges that must be addressed with careful planning and implementation, so that projects can be completed on time, meeting quality requirements, and within the budget.

Risk identification on toll road projects is divided into categories according to stakeholder interests in the project. Risk in the toll road project is divided into four, that is, planning phase, land acquisition phase, operation and maintenance phase, and redelivery phase. The most significant risk is in the phase of land acquisition [12].

Risk perceptions of each stakeholder will differ due to the different interests within the project. **Table 1** presents the results of interviews in the identification of risks from different stakeholders in this project. The identification of risk from the perception of contractor, owner, community surrounding the project, design consultant, and supervisory consultant are divided into eight risk categories. The risk categories are economic risk, contract and legal risks, construction risk, risk of income, risk of operation and maintenance, political risk, social risk, and force majeure risk. Risk identification was carried out for each risk category. Each stakeholder carries different categories of risk, depending on the interests of stakeholders in the project.

Risks as viewed from contractor’s perception were risk at economic risk, contract and legal risks, and construction risk. Risks from owner’s perception include risk at construction risk, risk of income, risk of operation and maintenance, and political risk. Risks from local community’s perception were economic risk, contract and legal risks, construction risk, and social risk. Risks from design consultant’s perception were economic risk, contract and legal risks, construction risk, political risk, and force majeure risk. Risks from supervisory consultant’s perception were economic risk, construction risk, political risk, and force majeure risk. From this risk identification of each stakeholder, it can be seen that stakeholders have their own risk characteristics, for example, risk of income is only relevant for the owner, and social risk only exist in the community surrounding the project.

5. Risk analysis

Risk analysis was done using risk breakdown structure method. Risk level was obtained by multiplication between the risk probability and risk impacts. The results of the risk analysis suggest that the rank of risks from each stakeholder varies, as shown in **Table 2**.

Table 2 shows the risk priority of each stakeholder. It can be seen that for all stakeholders, the highest rank of risks is within the construction risk. For the contractor, the most significant risk is the job delay. For owner, the most risk is the delay of land acquisition. For local community surrounding the project, the most significant risk is the risk of having pavement in that area

Rank of risk	Risk from contractor's perception		Risk from owner's perception		Risk from society's perception		Risk from design consultant's perception		Risk from supervisory consultant's perception	
	Risk	Risk level	Risk	Risk level	Risk	Risk level	Risk	Risk level	Risk	Risk level
1	Work is late	15	Land acquisition is late	20	Pavement in this area becomes damaged	15	Error of price estimates for bidding	8	Improper design from design consultant	18
2	Liquidated damages of 1 per mile per day, no maximum limit	15	Increase in land procurement costs	20	Air pollution caused by construction dust (influence on health)	14	Changes in interest rates	8	Project delays	15
3	Increase in the price of iron units of concrete	15	Increase in construction costs	16	Road becomes dirty	12	Late of completion of planning	5	Weather conditions during construction	11
4	Bored Pile meets the bolder layer and instructs the consultant to proceed	9	Contractor claims for additional fees beyond the contract	12	Noise/disruption of life due to vehicles on toll roads during the operation of toll roads	11.25	Late payment	5	Conditions in the project do not support	8
5	Work path collapsed	6	Not achieving the volume of traffic	12	No feasibility study of EIA (Environmental Impact Analysis)	11.25	Weather conditions during the survey	5	Contractor works not in correct procedures	6
6	Loss of costs due to job repairs left by subcontractors	6	The results of the initial study (engineering, environment) is less accurate	12	Residence changed/ moved	9	Changes in wisdom	4	Construction failure	5
7	Theft may occur at the location of the box culvert and overpass	5	Delay of tariff increase	9	Disruption of activity/ accessibility due to project (road closure, route transfer)	7.5	Changes in government structure	4	Changes in policies/ regulations	4

Rank of risk	Risk from contractor's perception		Risk from owner's perception		Risk from society's perception		Risk from design consultant's perception		Risk from supervisory consultant's perception	
	Risk	Risk level	Risk	Risk level	Risk	Risk level	Risk	Risk level	Risk	Risk level
8	Over material class B2 on ready-mix concrete	2	The quality of the winning supervising contractor/consultant is not as expected	9	Some walls of the house become cracked	7.5	Monetary policy changes	4	Changes in position/organizational structure of owner	3
9	Abandonment of funds due to no date of maintenance guarantee returns, maintenance period of 3 years	1	Design not in accordance with the conditions and or incomplete	9	Livelihoods change/disappear	7.5	The planning completion time is too short	3	Contractor completes the job before the contract expires	3
10	Extended Performance Guarantee	1	The flatness and hardness of the pavement surface does not meet the SPM	9	Separate/disconnected access road residents due to toll road projects	6.9	Increase in taxes (related to project cost estimates)	3	Uncooperative owner	2.5
11			Increased operating and maintenance costs are not appropriate to business plan	9	Violation of environmental laws and regulations	6.9	Primary data and secondary data are inadequate	2	Unavailability of PPE (Personal Protective Equipment)	2
12			Inaccurate quantity estimates	9	The process of socialization of land acquisition is not according to the regulation	5	Inconsistency of contract documents	2	Changes in government structure	1.5
13			Decrease in performance due to changes in government policy	8	The price of compensation for land acquisition is not suitable	4.4	The quality of personnel does not meet the standards	1		
14			Inaccuracy and lack of existing utility and data	6	Accidents due to project vehicles and project activities	4	Difficult access to location planning	1		

Rank of risk	Risk from contractor's perception		Risk from owner's perception		Risk from society's perception		Risk from design consultant's perception		Risk from supervisory consultant's perception	
	Risk	Risk level	Risk	Risk level	Risk	Risk level	Risk	Risk level	Risk	Risk level
15			Procurement of supervisory contractors/consultants is late	6	Payment of land acquisition stagnating	4	The results of planning are considered less compatible with conditions in the project	1		
16			Quality of material does not conform to specifications	6	The presence of brokers on land acquisition process	4				
17			Late of procurement of review design consultants	4	Violation of legislation on land acquisition	4				
18			Flooding and environmental disturbance due to lack of handling of temporary drainage and construction methods during construction	4	Decrease in value/price of land/house investment due to adjacent to toll road	4				
19			Unavailability of construction material	4						

Table 2. Risk analysis of Semarang-Solo Section I toll road project.

damaged by construction activities. For design consultant, the highest risk is the error of price estimates for bidding. For supervisory consultant, the top risk is the improper design from design consultant.

6. Risk mitigation

Risk responses are divided into three according to the level of risks, as follows:

- Low risk → risk acceptance
- Moderate risk → risk mitigation
- High risk → risk avoidance

Based on the results of analysis and interviews with stakeholders, the risk response obtained is shown in **Table 3**.

Risk response	Risk percentage (%)				
	Contractor	Owner	Society	Design consultant	Supervisory consultant
Risk acceptance	30	15.79	5.55	62.5	38.46
Risk mitigation	40	57.89	77.78	37.5	30.77
Risk avoidance	30	26.32	16.67	—	30.77

Table 3. Risk responses of Semarang-Solo Section I toll road project.

7. Discussion

For Semarang-Solo toll road project Section I, risks as perceived by stakeholders are categorized as: construction risk, economic and political risks, legal and contractual risks. These three risk categories are presented in each stakeholder risk analysis with several assumptions and conditions. For the owner, the economic risk is the risk of income. The economic risks refer to macroeconomic risks, related to economic policies such as inflation and devaluation, as well as the micro-economic risks associated with financial stakeholders. The categories of political, legal, and contractual risks are made into one category, because these three risks are considered to be related.

Table 4 shows the top risk levels for these three risk categories. It can be seen that based on the risk analysis, the biggest construction risks are on the owner side, while the biggest economic risks are on the contractor side. For political, legal, and contractual risks, the biggest risk level is also on the contractor side. Compared to previous studies, where the highest risks are in the categories of construction risk, legal and contractual risk, income risk, and financial risk [7, 8], this study found that the top risks are in the categories of construction risk, economic risk, and political, legal, and contractual risk, and the degree of importance differs between stakeholders.

No	Risk category	The top risk level				
		Contractor	Owner	Society	Design consultant	Supervisory consultant
1	Construction risks	15	20	15	8	18
2	Economic risks	15	12	7.5	8	3
3	Political, legal, and contractual risks	15	8	11.25	4	4

Table 4. The top risk level of each stakeholders with risk breakdown structure method.

8. Conclusion

From the application of risk management at Semarang-Solo Section I toll road project, it can be seen that each stakeholder has different perceptions of risks. It is mainly because each stakeholder has different interests in project. The risk categories in this project are economic risk, contract and legal risks, construction risk, risk of income, risk of operation and maintenance, political risk, social risk, and force majeure risk. Each stakeholder carries different categories of risks. The top risks as perceived by all stakeholders are construction risks.

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