Risk Management Analysis of Integrated Utility Network Infrastructure Development in Denpasar City

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Abstract. The construction of Integrated Utility Network Facilities in Denpasar City is an effective solution to overcome the clutter of aerial cables that reduce the aesthetic value of the city. To realize the plan is very difficult because this project in its implementation method has complicated and complex work characteristics, making it vulnerable to risks in its implementation. Risks can arise at every stage of construction both at the project implementation level and at the external level. To be able to minimize the risks that occur in this project, identification, analysis, and mitigation of possible risks that will occur are required**.** Risk management can be defined as an approach to risk and uncertainty by conducting an identification, analysis, and mitigation as a basis for action to minimize the impact of these risks. This research aims to identify risks in construction projects comprehensively by brainstorming methods, interviews using questionnaires given to competent parties in construction projects. Risk assessment is carried out to determine the dominant risks that are controlled through mitigation actions. Qualitative analysis was used in this study. The results showed 213 risks identified at the planning and implementation stages. According to activities, the most risks occurred in construction activities, namely 127 risks or 59.62%, while according to the risk source category, the most risks were construction implementation risks, namely 24 risks or 11.27% of all identified risks. The dominant risk obtained is 96.71% or 206 risks consisting of 84 unacceptable risks and 122 undesirable risks.

Keywords: Identification, Risk, Utility

1 Introduction

The construction of Integrated Utility Network Facilities in Denpasar City is an effective solution to overcome the clutter of aerial cables that reduce the aesthetic value of the city. To realize the plan, it is very difficult because this construction project needs synergy and the implementation method has complicated and complex work characteristics, making it very vulnerable to risks in the implementation of construction. The pattern of synergy implementation of activity programs can be carried out through four synergistic stages, namely: synergy at the needs identification stage, synergy at the preparation stage, synergy at the implementation stage, and synergy at the evaluation stage (Hasbi, 2016). The synergy of program activities for public services requires

A. A. N. G. Sapteka et al. (eds.), *Proceedings of the International Conference on Sustainable Green Tourism Applied Science - Engineering Applied Science 2024 (ICoSTAS-EAS 2024)*, Advances in Engineering Research 249,
https://doi.org/10.2991/978-94-6463-587-4_17

strong support from stakeholders (Aditya et al., 2014). Risks can arise at every stage of construction both at the project implementation level (planning stage, tender process and work contract, construction implementation), as well as at the external level. To be able to minimize the risks that occur in this project, it is necessary to identify, analyze, and mitigate the possible risks that will occur.

This development can be said to be a high-risk project, this is based on the construction process which usually takes a long time, the location of the project is in the area of roads and dense and complex settlements so it can cause uncertainty that raises various risks.

Research on risk management in the construction industry has been widely conducted. The more complicated a construction will be the increasing risk factors posed as well (Akintoye & MacLeod, 1997).

The purpose of this research is to identify the risks that occur and the magnitude of the influence on the construction project and analyze the risk response that occurs and the allocation of possible risks that will occur in this project. The results of this research in the form of risk modeling are expected to be a consideration in decision-making by the parties involved to overcome the negative consequences that occur in the construction of this project.

Risk is the uncertainty of an event or occurrence. Godfrey (1996) CIRIA defines risk as the possibility of an adverse event or event that depends on the situation. Risk is a condition that is possible for the occurrence of a loss, profit, damage as well as delays in the completion of activities as a consequence of the emergence of uncertainty in the implementation of an activity or activity.

Risk management is an activity carried out to identify, analyze, and control risks that may occur in an activity or activities so that higher effectiveness and efficiency will be obtained (Darmawi, 2016). Risk analysis is a process of identification and assessment, while risk management is the response and actions taken to mitigate and control the risks that have been analyzed (Thompson & Perry, 1991).

Control risks that may occur in an activity or activity so that higher effectiveness and efficiency will be obtained (Darmawi, 2016). The importance of risk management is to map the risks on a project and how to develop optimal strategies to handle and mitigate the chances of these risks occurring (Wideman, 1992). Flanagan and Norman (1993) suggest the stages that must be carried out in carrying out risk management starting from risk identification (identifying sources and types of risk), risk classification (determining the type of risk to be accepted or not), risk analysis (analysis of the consequences and impact of risk), addressing risk (determining attitudes or things to do to the source of risk that has been analyzed), and responses to risk (selection of ways to manage risks that have been analyzed) (Norken et al., 2015). Godfrey (1996) mentions the sources of risk include political, environmental, planning, marketing, economic, financial, natural, project, technical, human, criminal and safety, human, criminal, and safety.

2 Methodology

This research method uses a qualitative descriptive analysis method. Data sources are divided into two, namely primary data sources and secondary data (Pertiwi et al., 2016). This research uses data collection techniques by distributing questionnaires/interviews to competent and experienced respondents (experts), as well as literature studies related to risk management about the Main Network Facilities Development Plan of Denpasar City. Data analysis techniques using validity and reliability tests and using risk analysis.

Table 1. Data analysis

Problem formulation	Data	Analysis	Result
What risks were identified at the planning and implementation stages of the construction of the Integrated Utility Network Facilities	Source of risk	Identification of hazards that can become risks in the construction of the Denpasar City Main Network Facilities, through literature studies, brandstroming and interviews with parties who are experts in their fields to obtain initial variables that can later be used as questions in the questionnaire.	Risk identification
What risks are included in the dominant category (major risk) in the construction of Integrated Utility Network Facilities	Risk identification Kuisioner Frequency mode and consequence mode values	Develop a questionnaire based on risk identification Validity and reliability test	1. Questionnaire 2. Valid and reliable questionnaire 3. Risk assessment 4. Risk acceptance
What is the risk management or mitigation model in place to minimise negatives that may occur	Risk acceptance	Analyse risk acceptance according to the risk acceptance indicators, namely: Unacceptable > 12, Undesirable $6 < x \leq 12$, Acceptable $2 < x \leq 6$, Negligible ≤ 2	

3 Result and Discussion

3.1 Result

Results of Validity and Reliability Test of Research Instruments. From the results of the analysis of the research instrument both on the validity test and the reliability

test, it turns out that it is valid and reliable because the correlation coefficient of the question items is greater than 0.300 on the total question items or the significance value of the correlation of the question items to the total question items is less than 0.05. Analysis of the reliability test obtained alpha coefficient (Cronbach's Alpha)> 0.6 then the research instrument is declared reliable.

Respondent Data. Primary data in this study was obtained by conducting interviews regarding risk identification and assessment to obtain respondents' opinions or opinions regarding the likelihood of occurrence (likelihood to assurance) and the effect of risk (potential consequences). The parties to be used as respondents in this study are parties involved in the project, totaling 115 respondents. The position of respondents in this case study is grouped into 4 categories, namely, Contractors, Consultants, ASN/ Policymakers, and experts who have the capacity and experience in similar projects.

Risk Identification Analysis. The identification of risks that occur in the construction of the Denpasar City Main Network Facilities is obtained by referring to several similar studies and making direct observations in the field. In addition, brainstorming and interviews with related parties or project stakeholders as well as those who have the competence to provide input on the risks that occur in the Development of the Denpasar City Main Network Facilities starting from the planning and implementation stages.

Table 2. Percentage of total risk

No	Activities	ID	Source of risk	Total risk	%	%
A	Technical Planning Stage					27.23
1	External	A1	Economics	4	1.88	
		A2	Technology Change	1	0.47	
		A3	Politics and Social	9	4.22	
		A4	Policy	7	3.29	
2	Internal	B1	Site	10	4.69	
		B2	Owner	2	0.94	
		B3	Field Investigation	3	1.41	
		B4	Design	11	5.16	
		B5	Environment	2	0.94	
		B6	Financial	5	2.35	
		B7	Management	4	1.88	
B	Bidding process and contract stage					13.15
1	Internal	C1	Auction	10	4.69	
		C2	Pre-Contract	8	3.76	
		C3	Contractual	10	4.69	
C	Construction Implementation Stage					59.62
1	Internal	D1	Labour	6	2.82	
		D2	Plant	9	4.23	
		D3	Sub-contractors	5	2.35	
		D4	Material	11	5.16	
		D5	Work location	10	4.69	
		D6	contractor	3	1.41	
		D7	Construction	24	11.27	

D8	Environment	10	4.69	
D9	Financial	17	7.98	
D10	Management	16	7.51	
D11	Social community	5	2.35	
D12	Time frame	4	1.88	
D13	Force Majeur	3	1.41	
D14	K3	4	1.88	
		213	100	100

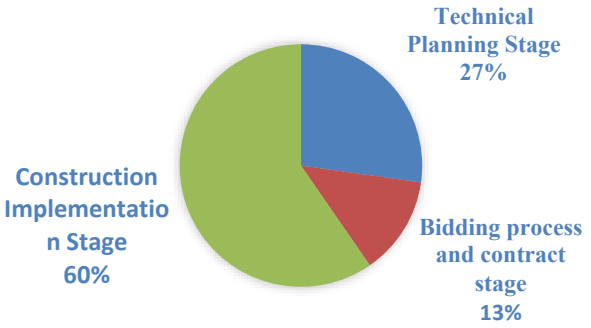

Figure 1. Percentage of total risk based on risk source

Based on Table 2 above. there are 213 (two hundred and thirteen) risks identified in the Development of Main Network Facilities in Denpasar City. According to activities. the most risks occur in construction activities. namely 127 risks or 59.61%. while according to the risk source category. the most risks are construction implementation risks. namely 24 (twenty-four) risks or 11.27% of all identified risks.

Risk Assessment Analysis. Data analysis to determine significant risks in the construction of Denpasar City Main Network Facilities was carried out by statistical analysis based on the likelihood and consequences identified from respondents' assessments through questionnaires. The frequency of respondents' assessment of the likelihood of risk occurrence (likehood) is shown in Figure 2**.**

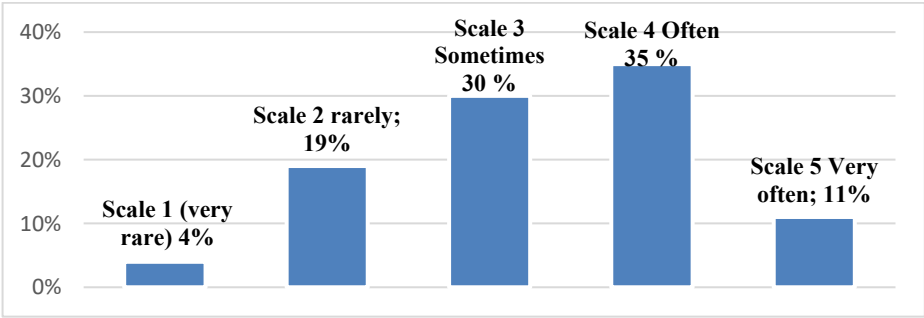

Figure 2. Frequency diagram of respondents' assessment

The results of data processing regarding the mode of respondents' answers to the likelihood (likelihood) of risk are as follows: a. Frequency scale 1 (very rare): 9 risks (4%); b. Frequency of scale 2 (rare): 40 risks (19 %); c. Frequency of scale 3 (sometimes): 65 risks (30%); d. Frequency of scale 4 (often): 75 risk (35%); e. Frequency of scale 5 (very often): 24 risks (11%).

Based on the data above. Respondents' answers to the possibility of occurrence of risks tend to be on a frequency scale of 4 (often) as many as 75 risks. This shows that the identified risks often occur both at the planning. implementation and operational stages. For scale 1 (very rare). respondents thought there were 9 risks identified that rarely occurred. Likewise. with a scale 5 (very frequent) which shows the respondents' answers there are 24 risks identified as very frequent.

The results of data processing regarding the mode of respondents' answers to risk consequences are as follows: a. Consequence scale 1 (very small): 2 risks (1%); b. Consequences of scale 2 (small): 18 risks (8%); c. Consequences of scale 3 (medium): 58 risks (27%); d. Consequences of scale 4 (large): 110 risks (52%); e. Consequence scale 5 (very large): 25 risks (12%).

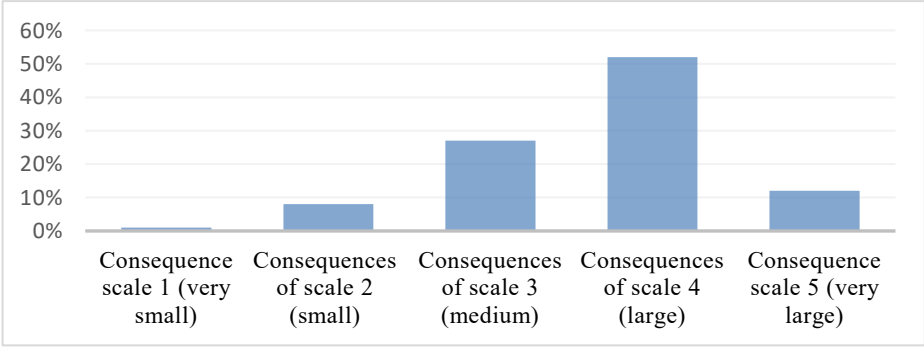

Figure 3. Mode of respondents' answers to risk consequences

Based on the data above. it can be concluded that all risks have an influence or consequence on the Development of Main Network Facilities Denpasar City From the

respondents' answers to the effect of the occurrence of the most risks on the frequency of scale 4 (large) as many as 110 risks. This shows that the identified risks have a major influence on the Denpasar City Main Network Facilities Development project. For scale 1 (very small). respondents argued that only 2 risks had a very small influence. namely changes in the organisational structure of the user/owner and the lack of local workers. As for answers with a scale of 5 (very large). respondents assessed that there were 25 (twenty-five) risks that had a very large influence on the project where the most frequent occurred at the construction stage. management and social aspects of the community.

3.2 Discussion

Dominant Risks. Major risks are risks that are categorized as unacceptable and risks that are categorized as undesirable. These risks are risks with a risk acceptability value of the multiplication of likelihood and consequences equal to or above 5 (five). The existence of dominant risks (major risks) will have a major effect on the development of the Denpasar City Main Network Facilities at the planning. implementation and operational stages. In the level of risk acceptance. it can be seen that the dominant risk is 96.71% or 206 risks. The percentage of dominant risks is quite large. indicating that there are many unacceptable risks in the project at the planning and implementation stages that can hinder and harm the development of the Denpasar City Main Network Facilities. These dominant risks must receive special attention from competent parties who have responsibility for the occurrence of risks to be able to take mitigation actions to reduce the negative impact caused by the risks that occur.

Based on the multiplication results. the risk value is obtained to determine the level of acceptability of risk. The results of risk acceptance can be explained as follows: unacceptable: 84 risks, undesirable: 122 risks, acceptable: 7 risks, negligible: 0 risk of the 213 risks identified. it can be seen based on the results of the study that the planning and implementation of the Denpasar City Main Network Facilities Development is a high-risk development project because more than half of the identified risks are dominant risks that must get special attention.

Distribution of Risk Acceptance for Each Risk Source. Based on the mode analysis of respondents' assessment of risk based on risk sources. the distribution of risk acceptability can be described as in Table 3.

Table 3. Percentage of total risk.

Source of Risk	Risk identification		Risk acceptance level							
	total	%	Unacceptable		Undesirable		Acceptable		Negligible	
			Total	%	Total	%	Total	%	Total	%
Economics	4	1.88	0	0.00	4	3.27	0	0.00	0	0.00
Technology Change	1	0.47	0	0.00	1	0.82	0	0.00	0	0.00
Politics and Social	9	4.22	2	2.38	7	5.74	0	0.00	0	0.00

Policy	7	3.29	1	1.19	6	4.92	0	0.00	0	0.00
Site	10	4.69	0	0.00	9	7.38	1	14.3	0	0.00
Owner	2	0.94	0	0.00	2	1.64	0	0.00	0	0.00
Field Investigation	3	1.41	1	1.19	2	1.64	0	0.00	0	0.00
Design	11	5.16	4	4.76	7	5.74	0	0.00	0	0.00
Environment	2	0.94	0	0.00	2	1.64	0	0.00	0	0.00
Financial	5	2.35	2	2.38	3	2.46	0	0.00	0	0.00
Management	4	1.88	1	1.19	3	2.46	0	0.00	0	0.00
Auction	10	4.69	0	0.00	9	7.38	1	14.3	0	0.00
Pre-Contract	8	3.76	2	2.38	5	4.10	1	14.3	0	0.00
Contractual	10	4.69	5	5.95	5	4.10	0	0.00	0	0.00
Labour	6	2.82	1	1.19	4	3.28	1	14.3	0	0.00
Plant	9	4.23	5	5.95	4	3.28	0	0.00	0	0.00
Sub-contractors	5	2.35	2	2.38	3	2.46	0	0.00	0	0.00
Material	11	5.16	5	5.95	6	4.92	0	0.00	0	0.00
Work location	10	4.69	4	4.76	6	4.92	0	0.00	0	0.00
Contractor	3	1.41	1	1.19	2	1.64	0	0.00	0	0.00
Construction	24	11.3	14	16.6	9	7.38	1	14.3	0	0.00
Environment	10	4.69	3	3.57	6	4.92	1	14.3	0	0.00
Financial	17	7.98	9	10.7	7	5.74	1	14.3	0	0.00
Management	16	7.51	12	14.3	4	3.28	0	0.00	0	0.00
Social community	5	2.35	5	5.95	0	0.00	0	0.00	0	0.00
Time frame	4	1.88	4	4.76	0	0.00	0	0.00	0	0.00
Force Majeur	3	1.41	1	1.19	2	1.64	0	0.00	0	0.00
K3	4	1.88	0	0.00	4	3.28	0	0.00	0	0.00
	213	100	84	39.4	122	57.3	7	3.32	0	0.00

From Table 3. it can be seen that the risks that fall into the unacceptable category are 84 risks (39.437%). Risks with high-risk acceptance values include:

Construction/Project Risk: The contractor does not conduct a soil investigation to verify the design. improper implementation method. misapplication of field working drawings. quality of installation work not according to specifications. damage to one utility network can disrupt other utility services. there will be traffic congestion around the planned construction of Integrated Utility Network Facilities. immature design. actual conditions that are not known for sure or the absence of soil investigations on unstable locations. building elevations. and other existing data

Management Risk: Lack of control and coordination within the team. inability of project management planning. low evaluation and decision-making system. *n*ot following work phasing procedures. *l*ack of effective coordination and communication between utility providers such as electricity. water. gas. telecommunications. can lead to conflicts and overlapping work.

Financial Risk: Unstable cash flow. potential cost overruns due to delays. design changes. or technical problems. risks arising from uncertainty in terms of the continuity of the source of financing funds (the following year) it can lead to the risk of delays and overhead costs. community social risk. *p*ublic opinion on the lack of socialization

regarding the construction of Integrated Utility Network Facilities. The existence of rejection from Indigenous peoples regarding the development plan of the Integrated Utility Network Facilities. There will be complaints from the surrounding community due to the disruption of their activities including the congestion that occurs, while risks with undesirable categories are 122 risks (57.277%) and acceptable risks are 7 risks (3.286%).

Risk Mitigation. After obtaining the most dominant risk variables that cause cost and time deviations. the last stage is to determine the mitigation actions against the dominant risks obtained from journal references and direct interviews by stakeholders in the project concerned.

Action in handling risk (risk mitigation) is carried out after knowing the identified risks that have a major impact on an activity. Risk handling can be done by retaining risk. reducing risk. transferring risk and avoiding risk.

The mitigation measures taken in this project are preparation of soil investigation plans. careful planning and preparation of methods. preparation and verification of working drawings. preparation of clear specifications. resilient network planning and design. coordination with traffic authorities. flexible planning and design. making cash flow projections. careful project planning. diversification of financing sources. effective communication. use of proven project management methodologies. training and development of decision-making skills. socialisation and training of work procedures. establishing a coordination team among utility providers. early consultation and involvement of indigenous villagers. comprehensive early socialization.

Ownership of Risk. At the risk allocation stage. all risks that fall into the category of dominant risk (major risk). are allocated ownership to the parties involved in the construction project. namely the planning consultant. the government and the contractor implementing the construction project. The allocation of risk ownership aims to ensure that all identified risks. especially risks in the unacceptable category. can be handled properly by each party. so that risks that cause the Denpasar City Main Network Facilities Development project to be problematic can be avoided.

The results of the risk ownership allocation are as follows: Government: 5 risks. Planning Consultant: 2 risks. Supervisory Consultant: 3 risks and contractors: 10 risks.

4 Conclusion

Based on the results and discussion above. it can be concluded that a. The risks of the Denpasar City Main Network Facilities Development project based on the identified sources are 213 (two hundred and thirteen) risks at the planning and implementation stages. According to activities. the most risks occur in construction activities. namely 127 risks or 59.62%. while according to the risk source category. the biggest risks are construction implementation risks. namely 24 (twenty-four) risks or 11.27% of all identified risks; b. For the dominant risk (major risk). the amount obtained is 96.71%

or 206 risks. consisting of 84 unacceptable risks and 122 undesirable risks; c. Risk management can be done by retention risk. reduction risk. risk transfer and risk avoidance. while the result of risk ownership allocation is the Government: 5 risks. planning consultant: 2 risks. supervisory consultants: 3 risks and contractors: 10 risks.

The results of this study are expected to serve as guidelines for further research in identifying risks and carrying out mitigation measures of development to reduce the negative impacts caused. as well as input or consideration for parties involved in the Development of the Denpasar City Main Network Facilities and similar development activities in the Denpasar City Government in the future.

Acknowledgment

The author expresses his deepest gratitude to the leadership of the Bali State Polytechnic. especially P3M and the management of the Civil Engineering Department. who have supported this research from the start of its implementation to the realization of this report.

References

Aditya, B. R., Sarwono, & Rozikin, M. (2014). Sinergitas stakeholders dalam pengelolaan sampah terpadu yang demokratis dalam perspektif teori governance. *Jurnal Administrasi Publik (JAP)*, *2(3)*, 407–413.

Akintoye, A. S., & MacLeod, M. J. (1997). Risk analysis and management in construction. *International Journal of Project Management*, *15(1)*, 31–38.

Darmawi, H. (2016). *Manajemen Risiko Edisi 2*.

Flanagan, R., Norman, G. (1993). *Risk managem ent and contruction*. University Press.

Godfrey, P. S. (1996). *Control of Risk. A Guide to The Systematic Management of Risk from Construction.*

Norken, I.N., Purbawijaya, I.B.N dan Suputra, I. G. N. . (2015). *Pengantar Analisis dan Manajemen Risiko pada Proyek Konstruksi*. Udayana University Press.

Pertiwi, I. G. A. I. M., Kristinayanti, W. S., & Aryawan, I. G. M. O. (2016). Manajemen risiko proyek pembangunan Underpass Gatot Subroto Denpasar. *Jurnal Akuntansi, Ekonomi Dan Manajemen Bisnis*, *4(1)*, 1–6.

Thompson, P. A., & Perry, J. G. (1991). Engineering construction risk. *London : Thomas Telford Ltd*.

Wideman, M. R. (1992). *Project and program risk management: a guide to managing project risk opportunities.* Project Management Institute.

Hasbi, M. (2016). Aktualisasi sinergitas komponen governance dalam peningkatan pelayanan pendidikan kecakapan hidup di Kota Makassar. *Ad'ministrare*, *3*(1).