



The Analysis of Identification and Risk Mitigation in Irrigation Work Contractors

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Abstract. The construction of irrigation projects carries a relatively high risk potential compared to other project work. In Indonesia, the use of new methods and technologies and the increasing number of parties involved reflect the development of construction projects. Rehabilitation of the Progomanggis irrigation network is more complicated due to its vast area and location in a hard-to-reach place, rendering it vulnerable to risks. The analysis conducted indicates that the project's schedule for opening and closing river water poses a very high risk to project performance. The risk's impact on the project is time delays in work completion, and other risks include weather conditions; changes in work methods; materials shortage; and cropping patterns of water-using communities. To control risks, regular coordination meetings with stakeholders and adjustments to work methods are necessary.

Keywords: Risk management, Irrigation project, Construction Project, Mitigation

INTRODUCTION

Construction projects have a relatively high potential risk compared to other project work. The development of potential construction projects in Indonesia can be seen from the use of new methods and technologies as well as an increase in the number of parties involved. According to Kurniawan & Wibowo, the construction industry is more complicated and difficult to manage than other industries as it requires special skills and techniques [1]. Goldratt & Cox states that TOC (Theory of Constraints) is an approach towards process improvement that focuses on restricted elements to increase output [2]. According to the TOC, to improve the overall performance of the project, managers need to identify existing constraints, exploit them in the short term and in the long-term, find ways how to overcome these obstacles. In general, project performance is limited in cost, time and quality. These three boundaries, known as project management triangles, can be interpreted as project objectives, which are defined as cost, time, and quality [1]. The successful implementation of a project by a construction services company is associated with the extent to which the three goals can be met.

Rehabilitation projects are slightly different from development projects, and many contractors avoid taking them due to fluctuating and unpredictable volumes. In addition, rehabilitation projects are complex and involve risks that must be borne by the contractor. The first rehabilitation project was the DI Irrigation Network. Progomanggis. DI. Progomanggis is one of the many legacy infrastructure facilities from the Dutch colonial era which is still in use today, supporting the economy and lives of the people of Temanggung Regency, Magelang City and Magelang Regency. DI Irrigation Network. Progomanggis was built in 1870 and began to function as an irrigation network in the Kedoe Residency area, currently known as Temanggung Regency, Magelang City and Regency Magelang, in 1887. Until now, the community still really requires this Dutch colonial infrastructure as a source of water that flows through the rice fields of the surrounding area. As time passes, the infrastructure facilities of the DI Irrigation Network. Progomanggis began to deteriorate, therefore improvements are necessary to maintain the function and strength of the structure.

Progomanggis Irrigation network rehabilitation work, DI. Progomanggis, is more complex than other rehabilitation projects because it covers a large area and is located in a place with difficult access, which makes it vulnerable to potential risks. The high water utilization in DI irrigation streams makes it necessary to pay special attention to Progomanggis from both the private sector and the community. The irrigation network work requires special attention not only from the technical aspects of the work, but also from other non-technical sources of risks that may arise during the implementation of the project. For example, the low quality work in irrigation projects often leads to a risk of loss for job owners, consultants, the public as well as the contractor. Constructed Wetlands is an efficient green technology to reduce pollutant levels in treating domestic liquid waste, as well as industrial and mining waste. Constructed Wetlands (CWs) are typically applied to settlements that have sufficient yards [3].

The potential risks that may occur and need to be considered by stakeholders of the DI irrigation network rehabilitation project in Progomanggis, including: location risks such as damage to protected areas, land acquisition, relocation of affected residents. There are also design, construction and operation risks to consider, including the strength of building structures, submergence of physical buildings and the environment; as well as operating risks like sedimentation management, malfunctions of raw water and irrigation services, and the impact of possible runoff. Other risks to consider include income risk, network connectivity risks, political risks, and *Force Majeure* Risk due to natural events at the project construction site.

The second rehabilitation project is D.I. Secondary Channel Rehabilitation Sedadi. The worksite for the D.I Secondary Channel Rehabilitation in Sedadi is located in Penawangan Godong District, Karangrayung, Grobogan District and Dempet District, Grobogan Regency PT. PP Persero is responsible for improving the irrigation services in Grobogan and Demak Regencies by repairing a 22.8 km main channel, while PT. SAC Nusantara has been tasked with repairing the 39.8 km secondary channel. The total contract value for the DI Sedadi project reached Rp 300.83 billion. Prior to rehabilitation, DI Sedadi was only able to irrigate a rice field area of 13,282 Ha, falling short of its service target of 16,055 Ha.

The potential risks that may occur and need to be considered by stakeholders of the DI irrigation network rehabilitation project in Progomanggis include location risks such as damage to protected areas, land acquisition, relocation of affected residents; design, construction and operation risks such as the strength of building structures, submergence of physical buildings and the environment; Based on the description above, the author conducts an analysis of risk management of construction projects with the advantages of construction projects. DI Irrigation Network Rehabilitation Project. Progomanggis (MYC) is one of the construction projects under the authority of the Yogyakarta Serayu-Opak River Basin Center and the Rehabilitation of D.I Secondary Channels. Sedadi is located in Penawangan Godong District, Karangrayung, Grobogan District and Dempet District, Grobogan Regency.

TABLE 1. Previous research

Researcher	Tittle	Analysis Result
(Zaccaria & Passarella, 2012)[4]	Irrigation Delivery Performance and Environmental Externalities from a Risk Assessment and Management Perspective	The risk of aquifer salination by means of artificial aquifer recharge will be very effective in reducing pressure on groundwater. In order to reduce the existing effect on aquifer salinity, a strong reduction in groundwater pumping must also be carried out along with artificial aquifer filling
Nurrochmad, 2008 [5]	Analysis of Rehabilitation Priority of Irrigation Infrastrukture	Rehabilitation of semi-technical command areas, including small command areas, needs to be carried out by the government. Transfer of Irrigation Management (PPI) for small command areas needs to be upgraded to technical by rehabilitating a simple weir to a technical weir

Researcher	Title	Analysis Result
Edhisono & Hadihardaja, 2016 [6]	Optimization Budgeting Distribution Model for Maintaining Irrigation Scheme	List of priority irrigation buildings that will be maintained from each irrigation area. Research results Phase 1: From the available costs for Pondok IA. Rp. 749.880.000,-. Dero IA., received IDR 216,715,320; Sambiroto IA., received IDR 207,716,760; Padas IA., received IDR 173,222,280; and Plesungan IA., received IDR 151,475,760
Efendi, et.al, 2019 [7]	Irrigation Maintenance Priority Analysis (Case Study: Irrigation Areas in Salatiga City)	11 irrigation areas are included in irrigation maintenance activities. By setting irrigation maintenance priorities, budget allocations will be more targeted.

MATERIALS AND METHODS

Step I

In this step, start from a literature survey rather than trying to identify even or problems that occur on the project with research questions. After that, make sure with the literature review to formulate the hypothesis and variables, including risk factors, technical risks and duration assumptions for the acceleration of the project. So, primary and secondary data, including general data of runway pavement projects with on-site surveys can be collected. When evaluating the economics of building reuse, there are many factors, such as property value. There is a divide between economic and conservation discourse, with conservation discourse focusing on historical narratives and materials science, while economic discourse emphasizes quantitative expressions and defers to market judgments as an efficient means of decision-making and resource allocation [8]

Step II

At this stage, we start by identifying the risks in the field by using questionnaires, interviews, and observations to gather primary data, and using time scheduling data for projects, project documentation and project reports as secondary data. Next, we analyze these risks so that we can understand their value. Finally, we need to develop responses and map out the risks.

Step III

In this step, we get the result of all the things we've done from step I to step II called Risk Levels that can happen to a runway pavement project. We need to talk about how we can get those data by using formulas, literature as well as theory in step I. Next, the author only needs to compare the primary and secondary data with the formulas and theories in step I.

After obtaining primary and secondary data, conclusions and recommendations are made from the results of calculations and analysis. The author focuses only on how important monetary losses may be between the levels of risk on the acceleration of the assumption project. We must know what the implications are if it happens, how high the risk is and how much money is lost. The last part is the conclusion of step I to step III then provide some recommendations for this research to make it better or can be used as material for future improvements.

RESULTS AND DISCUSSION

Risk Identification

At this stage, the first step is to formulate the problem from the background, followed by determining the research topic. Then, a literature review on a predetermined topic is conducted. Then, research is carried out on the topic. The next step is to prepare the references related to the topic and develop a hypothesis and a methodology flow for the study. For the DI irrigation network rehabilitation projects, Progomanggis and the D.I. Secondary Channel Rehabilitation Project Sedadi, hazard identification is the first step in developing risk management. Identifying these potential hazards can be performed by analyzing every activity in the DI irrigation network rehabilitation project. Direct observations and interviews can be conducted to identify these hazards.

Based on secondary data (journals, literature and previous research), the identified risks were further developed through direct observation in the field and brainstorming with all parties involved in the implementation of the project who have the competence to provide opinions on the risks of irrigation projects. These risks were identified in the implementation of the Rehabilitation of DI Irrigation Areas in Progomanggis and D.I. Sedadi.

TABLE 2. Risks identified In Rehabilitation Projects DI Irrigation Area Progomanggis and DI. Sedadi

No	Sources of Risk	Risk Identification
1	Technical	The existing image does not correspond to the field Selection of Working Method Late Material Low Quality Material Difficult Location Entry Low Worker Productivity Low Quality of Work Damage to Tools and Low tool productivity Weather Water Open-Close Schedule and Planting Pattern
2	Financial	Unit Price Increase Material Order Miscalculation (Advantages/Disadvantages) Late payment of work results Late payment of labor Unexpected Fees

Risk Impact

To place alternative risks, we describe the results of data processing both qualitatively and quantitatively, including the consequences or impacts that will occur if a decision is made. The data results are elaborated and sorted to be placed as an alternative decision. Mapping is the process of measuring, calculating, and depicting spatial data using specific methods to provide a description of geographical phenomena and information of feature types (points, lines, and polygons). The impacts that may arise in the short and long term are comprehensively and systematically expressed to aid decision-making. After identifying the risks, a risk assessment is conducted by considering the possibility of occurrence and the magnitude of consequences to determine the risk's magnitude. Based on the assessment results, risks are sorted into those that have a large impact on the company and those that are mild or negligible, depending on their probability and severity (resulting impact). This helps in determining the magnitude of risk, which can be classified as extreme, high, medium, or low.

TABLE 3. Risks and Impacts on Rehabilitation Implementation Projects DI Irrigation Area Progomanggis and DI Sedadi

No	Sources of Risk	Risk Identification	Risk Impact
1	Technical	The existing image does not correspond to the field Selection of Working Method Late Material Low Quality Material Difficult Location Entry Low Worker Productivity Low Quality of Work Damage to Tools and Low tool productivity Weather Water Open-Close Schedule and Planting Pattern	Adjustment of the method of work with the agreement of the open-close schedule and planting pattern Takes a lot of time to drive the material Retreat of work start time More time Working time following weather conditions Time follows the agreed method More Time due to length of work More Time due to length of work Delay time due to repairs Delay time due to repairs
2	Financial	Unit Price Increase Material Order Miscalculation (Advantages/Disadvantages) Late payment of work results Late payment of labor Unexpected Fees	Delay time due to repairs Delay time due to repairs Delay time due to repairs Delay time due to repairs Delay time due to repairs

Respondents' Answers to the *Likelihood* and Consequences of the Risks of Implementing Irrigation Area Rehabilitation

To determine risk measures, the data collected using a methodological approach, both qualitatively and quantitatively, is processed according to a predetermined scale. The respondents' answers to the frequency (likelihood) of risks are assessed on the predetermined scale. Respondents' answers regarding the frequency (likelihood) of risks are assessed on the established scale. Following the research methodology in Chapter III, risk is determined as the product of frequency and consequences.

TABLE 4 Likelihood and Consequences of Risk of Implementation of Rehabilitation of DI Irrigation Areas .
Progomanggis and DI Sedadi

Risk Factors	Effects/Impacts	Probability	Damage	Value	Information
Technical					
Water Open-Close Schedule and Planting Pattern	Adjustment of the method of work with the agreement of the open-close schedule and planting pattern	5	5	25	Very High
Difficult Location Entry	Takes a lot of time to drive the material	5	4	20	Very High
The existing image does not correspond to the field	Retreat of work start time	4	3	12	High
Late Material	More time	3	4	12	High
Weather	Working time following weather conditions	3	4	12	High
Selection of Working Method	Time follows the agreed method	3	3	9	Keep
Damage to Tools and Low tool productivity	More Time due to length of work	3	3	9	Keep
Low Worker Productivity	More Time due to length of work	2	4	8	Keep
Low Quality Material	Delay time due to repairs	2	3	6	Keep
Low Quality of Work	Delay time due to repairs	2	3	6	Keep
Finance					
Unit Price Increase	Delay time due to repairs	4	5	20	Very High
Unexpected Fees	Delay time due to repairs	4	2	8	Keep
Material Order Miscalculation (Advantages/Disadvantages)	Delay time due to repairs	3	5	15	High
Risk Factors					
Late payment of work results	Delay time due to repairs	3	3	9	Keep
Late payment of labor	Delay time due to repairs	3	2	6	Keep

Excellence in the Implementation of Rehabilitation of DI Irrigation Areas. Progomanggis and DI Irrigation Area. Sedadi

The implementation of Irrigation Network Rehabilitation DI. Progomanggis (MYC) had a contract period of 887 Days from 2017 to 2019, with a Contract Value of Rp. 129,989,030,000. The employer for this project is the PPK for Irrigation and Swamps II, SNVT Implementation of Serayu Opak Water Utilization Network. The scope of work includes the rehabilitation of DI Irrigation Networks. Progomanggis (MYC) is:

- a. 2 Weirs, i.e. Pleret and Badran
- b. 3 Main Channels, namely Progo, Mangosteen, and Progomanggis
- c. 9 Secondary Channels, namely Banjarnegoro, Bondowoso, Kalinegoro, Jogonegoro, Sumberejo, Bumirejo, Pasuruan, Donorejo, Deyangan

The average Age of Workers involved in the Implementation of Irrigation Network Rehabilitation DI. Progomanggis (MYC) is 22- 30 Years. Regarding the obstacles faced during the process of Rehabilitation of DI Irrigation Network, there were 4 days of dead water and 3 days of running water. The implementation of Secondary Channel Rehabilitation D.I. Sedadi has a contract period of 1135 days from 2015-2018, with a contract value of Rp. 113,065,271,000. The employer in the implementation of Secondary Channel Rehabilitation D.I. Sedadi is PPK Irrigation and Swamp II [SNVT PJPA Pemali Juana]. The scope of work in the rehabilitation of D.I. Secondary Channel Rehabilitation Networks. Sedadi are:

- a. 16 Secondary Channels, namely Pulutan, Nunjungan, Gompeng, Luwuk, Botosiman, Tompe, Brakos, Gempol Denok, Wedean, Ngacir, Genetan, Kampek, Wilalung, Kramat, Truko, Rawoh

The construction industry is one of the industries most at risk for worker safety. Threats to the safety of workers include falling from a height, being trapped in collapsed buildings. An accident is an unplanned and unexpected event that disrupts the work schedule; resulting in lost productivity, personnel injury, damage and eventually disrupt the overall production process[9]. Average Age of Workers in the Implementation of Irrigation Network Rehabilitation DI. Progomanggis (MYC) is 33-50 Years. As for the obstacles in the process of Rehabilitation of DI Irrigation Network. Progomanggis (MYC) between and : 3 Months of Dead Water and 3 Months of Running Water

CONCLUSION

Based on the results of the analysis, it can be concluded that the DI. Progomanggis Irrigation Network Rehabilitation Project has higher risks than the DI Irrigation Network Rehabilitation Project - Sedadi. The former has a very high risk related to the schedule of opening and closing water and planting patterns, as well as moderate and low risks related to unexpected fees/costs and late payment of labor. Regarding the impact of risks, there are several similarities between the two projects, such as delayed start time, delayed work schedule, and work following weather conditions. However, the DI. Progomanggis project also has the risk of molor time. Meanwhile, the DI. Sedadi project has additional risks such as long material shearing time and time delay due to repairs. To control these risks, both projects conduct periodic meetings with stakeholders and adjust work methods accordingly.

Based on the researcher's conclusions, it is suggested that certain steps should be taken before commencing work, such as notifying employees on duty about the risks and impacts associated with the Irrigation Network Rehabilitation Work Project, building a commitment to developing work programs aimed at reducing medium-risk categories to low-risk, applying risk management updates to the work process, and establishing criteria for updating the probability, consequences, and extent of risks and impacts that occur in the project. The development that takes place in a region or city can be identified by various conditions, including physical and non-physical factors related to the social conditions of the community [10]. One form of physical development that can be observed is the expansion of settlements, which is an implication of urban population growth and changes in socioeconomic conditions, as well as the interactions within them.

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