Implementation of Risk Management in Water Quality Management Infrastructure Projects

Yogi Irmas Pratama* and Sylviana Maya Damayanti

School of Business and Management, Institut Teknologi Bandung, Indonesia

E-mail address: yogi_irmas@sbm-itb.ac.id

Water quality management is an obligation that must be carried out by every mining business actor. The construction of settling ponds as water quality processing infrastructure is one of the efforts made in order to meet the water quality standards.

The iron triangle consisting of timeliness, cost suitability and quality meets standards is a parameter commonly used to determine the success of a project. The absence of a risk analysis at the beginning of infrastructure development resulted in not being successful in the project. The different landscape conditions for each project location became one of the reasons for the difficulty of learning from the previous project. In addition, technical aspects related to infrastructure specifications and unexpected non-technical aspects are factors that often arise in a development process and become a contributor to the failure of a project.

Risk analysis prior to project commencement will explore all potential risks that occur during the development process. The implementation of risk management is expected to be able to improve the previous work process and achieve all parameters of success.

Keywords : Risk management, construction, water quality

I. INTRODUCTION

Water quality management is a legal requirement for mining company, and it is one of the ways to avoid water pollution. The requirement is established in the Minister of the Environment's Decree on wastewater quality criteria for coal mining firms and related activities. Settling ponds construction shall be completed prior mining operation commencement for pollution prevention pollution prevention. The pond must be constructed, operable, and licensed before accepting runoff water from mining activities. If this is not accomplished, there is a chance that mining work will be slowed or that additional costs will be incurred to manage water in the pond so that it does not spill into the environment.

Pond construction has a history of experiencing delays with varied lengths of additional time. Aside from delays, certain projects also necessitate additional. Differences in data in the field, with the idea that one of the variables generating delays and additional expenses is the initial data utilized for planning. The main activity in the construction of the pond is earthworks; this work accounts for the majority of the total costs, accounting for more than half of the total. Land clearance, stripping of topsoil and inappropriate layers, and the construction of pond bodies are all part of the earthworks process.

The various risks that may arise throughout the infrastructure development process were not fully examined before the project began. The current risk assessment is more concerned with issues of safety, security, and a few environmental concerns.

The objective of this study is to present the various risks that arise throughout the settling pond construction process, identify the root causes, and define sollution to eliminate the risk-causing variables. The study question is how risk management can address all of risk that may develop during the construction.

Project management is known as the application of information, skills, tools, and procedures to project activities in order to achieve project requirements. [7] The main goal of project management is to keep the budget under control and to execute the project within a specified budgetary constraint. 12]

Project risk management encompasses risk management, identification, analysis, reaction planning, and risk control processes for a project. Project risk management comprises the project risk management objectives include increasing the likelihood and consequences of good events and decreasing the possibility and effect of unfavorable project events. [7]

Risk management consists of six major steps: establishment of relationship, risk identification, risk analysis, risk assessment, risk management implementation, and monitoring. Risk attitude has a significant impact on how we approach risks. Acceptable risk is mostly decided by risk attitude, which is far from objective. [9]

There are numerous definitions available for risk in general and project risk in particular. Each concept emphasizes one or two specific aspects of risks. Some emphasize the significance of uncertainty, while others emphasize the impact of conditions. There are five different Types of Uncertainty: Uncertainty of occurrence, impact, favorability, manageability and uncertainty of identification. [11]

Risk identification usually begins before the project is launched and the risk is discovered. As the project evolves over the entire life cycle, its first hazards increase. The impact assessment must also consider: cost, scope, schedule, and performance/ quality for each risk category [4]

Risk analysis is intended to forecast future occurrences and actions without regarding for the intentions of people involved. Risk attitude plays a critical part in risk

***ISBN**: 978-623-92201-2-9*

evaluation because, despite involving objectively quantifiable criteria such as assets and income, it is mostly determined by subjective factors that must be understood in order to impact individuals' attitudes toward the risk at concern. [9]

The estimation of risk attributes is the next phase in the project risk management process after identifying the risks. There is no certainty that these analytical methodologies will provide the best reaction to mitigate possible risks; hence, there is no guarantee that they will be the best solution.[12]

Risk could be classified as social risks, technical risks, economic risks, environmental risks, political risks, commercial risks, organizational risks, information technology risks and legal risks. [3]

Stakeholder analysis is critical in the risk assessment process for the majority of activities. Stakeholder management success is contingent upon excellent communication with all stakeholder groups and quite frequently, effective communication with essential stakeholders will become critical to maintaining an acceptable amount of project uncertainty. Stakeholders may have a direct or indirect relationship with the project or its outcome. Stakeholders also include organizations that are impacted by the project but may not always have the opportunity to influence the outcome. [8]

The management of a project must deal with accuracy and attention to the completion dates of a project, the costs of the project, and the quality of the work, while avoiding risks and having knowledge of what was asked by the project's beneficiaries. Perfection of these knowledge and skills by a project manager is an indicator of the project's success or failure. [14]

A project manager's essential qualities include listening to team feedback, making the right choice of people, establishing trust and confidence, knowing what is required, and negotiating with project teams. A project manager's style should be task and people oriented, and it is understood that a project manager should understand people in everyday relationships in organizations in addition to these qualities.[10]

The iron triangle concept can be used to define project success parameters. The concept is a practical demonstration of the most fundamental criteria for project success: if the project is completed on time, within budget, and to an agreed-upon degree of quality, performance, or scope. The Iron Triangle has become the de facto standard for evaluating project performance on a routine basis. [1]

The Iron Triangle concept is a powerful tool for expressing the interrelationships between these critical success criteria. During the early stages of a project, schedule takes precedence above cost and quality. Later in the project's lifecycle, cost becomes the primary worry, followed by scheduling. After the project is completed, scheduling and financial concerns become irrelevant, and quality becomes the primary consideration. [1]

Throughout the planning and execution phases of a project, various types of decisions will be made with varying degrees of uncertainty. The initial focus is on deciding on the best concept and defining the project goals. Rolstads et al. (2011) highlight the difficulties associated with predictability of Capital Expenditure (CAPEX). The CAPEX predictability challenge entails two critical decisions. On the one hand, CAPEX decision-makers require a certain level of confidence in their forecasts of the cost and duration of the proposed production asset's revenue stream. On the other hand, CAPEX decision-makers must acknowledge the harsh reality that, when all risks associated with a project's outcome are considered, this desired level of confidence may diminish.[5]

Each project is unique in terms of complexity and scope. It takes a systematic approach to resolve all relevant uncertainty. The project's strategy, risk, and uncertainty all interact and have an effect on the project. Since no project is risk-free, effective risk management is critical to a successful project. It's worth noting that there are various uncertainties throughout the project's lifecycle, which must be considered beginning with the conceptual stage. [6]

Risk mitigation strategies are intended to avoid or significantly mitigate the impact of risk events that have a negative or detrimental effect on the project. Risk identification is both a creative and systematic process. There are basic strategies for managing project risks: Risk Avoidance, Risk Reduction, Risk Transfer, Risk Sharing, Risk Retention. [13] The strategies for responding to risks are dependent on the type and magnitude of the risk; nevertheless, the project's risk management team must be aware that there is no single strategy that is ideal for dealing with all risks. [14] Obviously, an unidentified risk cannot be managed. [11]

II. METHODOLOGY

The study was carried out using qualitative and quantitative methodologies. The current reality tree (CRT) technique was used to conduct root cause analysis. By identifying the main causes or core problems, the CRT applies cause and effect logic to determine what has to be changed. Another goal of a CRT, whether created by an individual or a group, is to reach agreement among individuals concerned in a situation.[2]

CRT was the most appropriate root cause analysis method to apply in this infrastructure development case particularly due to the cause-effect flow that can be applied at any stage of development. The PMBOK framework, which separates project management into five categories: initiating, planning, executing, monitoring, controlling, and closing is used in this research.

Interviews with key persons who were actively involved in and responsible for infrastructure development activities provided primary data. The information gathered from these interviews was mostly qualitative. Respondents came from a variety of departments, each with its own set of duties and responsibilities.

The study focuses on the company's internal factors; external factors had no direct impact on activities. The environmental department, which engages directly with

***ISBN**: 978-623-92201-2-9*

external parties, had interpreted considerations and requests from external stakeholders. A more detailed analysis was carried out at the planning stage with consideration, out of all the stages of development. When the beginning process was completed correctly and thoroughly, the risks that may occur during the project's implementation, completion, and closing stages were considerably reduced.

Secondary data was derived through a study of the development plan initiation document, which contained information such as the reasons for undertaking the project, the time required to finish it, the required budget, and construction criteria. When doing the interview process, data was useful as reinforcement and consideration. The secondary data facts provided grounds for respondents to be more aware of the threats that may develop.

III. RESULTS

The pond construction is a sequence of actions involving multiple parties, with Civil and Environmental Planning (CEP) personnel or engineers serving as project manager. The development objective is to conduct environmental friendly mining operations.

The mining process is heavily reliant on the settling pond readiness. Mining cannot occur in the absence of ready-to-use supporting infrastructure, or if additional treatment is required to keep the mining process running, which incurs additional expenditures.

Construction of a settling pond is a series of several stages and involves numerous parties. The detail of construction stage is as follows:

- The first step in the feasibility process is to determine why the project should take place and to gain approval to begin the project in the budget book. The proposed project is based on the Five-Year Plan (5YP) team's mine progress plan. The pond requirements are determined at this point, and the project value is calculated based on the preliminary design
- Step 2: Planning and design. CEP creates a detailed design for each project (detail cost, detail schedule, scope of work, detailed engineering design and drawing, and all requirements needed for tender). The pond plan is meticulously designed by CEP. The design was designed with the intention of managing runoff water from the catchment region. The Geotechnical (GT) conducted an evaluation after the design had been completed. If the design fulfills the criteria, it can proceed to the next stage; however, if it does not, the CEP team will alter it. Design adjustments to fulfill the needs of the GT team are typically associated with increased work volumes and expenditures.
- Step 3: The pond construction is carried out by a contractor or a third party who is selected by the company after winning the bidding. The contractor will be monitored by the custodian of the company, which will vary depending on the project area.
- Step 4. Monitoring and controlling. The company's custodian is in charge of monitoring and managing the project implementation.
- Step 5. The closing process is comprised of all operations that are performed in order to formally conclude a project or contract obligation. Commissioning is carried out at this stage in order to determine whether or not the project end product fits the requirements. When the project is created in accordance with the design, commissioning can arise.

The CEP section conducts and analyzes pond specification requirements as part of the pond development planning process. The analysis is conducted to determine the pond capability and performance, as well as the desired treatment results. Specification will affect the cost of completing the pond. The costs associated with the pond construction are included in the capital expenditure.

The capital value is calculated using the engineer's or project manager's assumptions. Assumption data is based on information that has been utilized as a foundation for work on a nearby pond that has been constructed and is in operation. Furthermore, data from drilling or mining activities near the targeted location can be used to generate assumption data.

The cost of the project to construct settling pond ranges between USD 1 million and USD 5 million or more, with the time of work varied depending on the volume of work. The volume of work is majorly affected by topographic circumstances and the demand for pond requirements. The volume is divided into numerous categories, with the majority is allocated to earthworks for the development of pond bodies. Construction is performed by contractors who are bound by contractual obligations regarding the time and value of the work. If the duration and value of the job exceed those specified in the preset contract, an administrative process is required to renew the contract.

The construction of settling ponds requires the collaboration of multiple interconnected parties, each with their own roles and responsibilities. The stakeholders involved are:

- 5YP; is a mining planner who creates five-year plans that will be modified annually.
- CEP functions as the planning party, with the design of the pond as the product, as well as the calculation of the construction costs and the completeness of the bidding documents. CEP serves as a project manager throughout the development process.
- GT, before moving on to the detailed and implementation stages, CEP's design must pass a review by the GT team, which serves as an assessor for structural stability issues.
- Environment (ENV): In addition to receiving approval from GT, the design must also receive approval from ENV for the treatment effectiveness, possibility for environmental impact, and mining closure. ENV also

serves as a watchdog for environmental issues that occur during the construction process.

- Mining Service (MS) and Contract Mining (CMD); MS and CMD are two departments that will supervise contractors or third parties who work directly on settling pond construction. The location of the pond construction will define who will be responsible for supervision. MS and CMD have separate regions of responsibility.
- Supply (SPL): Supply is the party that will tender the work to the contractor or will be the direct implementer if a third party is used.
- Contractors (CTR): The executor of pond construction under the supervision and direction of the MS or CMD.

Pond construction is an annual occurrence that coincides with the development of mining activities. Every year, new areas must be developed, requiring the development of settling ponds as supporting infrastructure, in addition to the mining process progressing in existing pits.

Prior to the start of construction activity risk analysis is confined to potential hazards to safety and the environment that may occur during the course of the work. There has been no comprehensive risk assessment addressing all dimensions and types of risk.

IV. DISCUSSION

The process of constructing a pond can be summarized as illustrated in Figure 1.

Risk analysis should be carried out at the beginning of the development plan and continue throughout the entire process, from planning to closure. There are two kind of risk that can develop during pond construction: technical risk and economic risk. Technical risk is associated with the quality, which includes its safety and capacity. Economic risk is the risk that occurs when the plan does not correspond to the real field conditions. During this time period, technical risk is intolerable and must be eliminated through risk management.

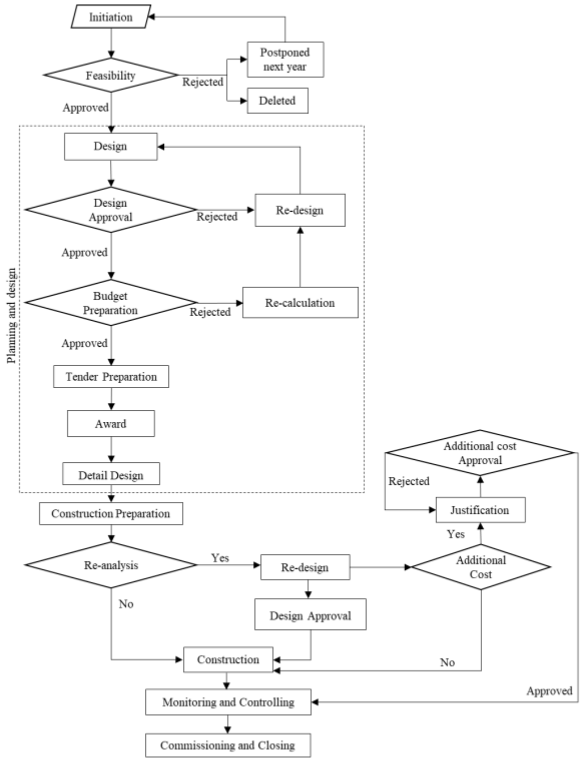

Fig. 1. Pond construction stageflow

The risk of additional time and cost arises at each stage that is not appropriate and must be repeated or requires additional procedures. Based on the flow of the pond construction, these risks will appear on work preparation process.

Earthworks are the primary activity in constructing the pond. The materials used to build the pond must meet the requirements of the standard. At the planning stage, without knowing the factual conditions, location of the source material is planned. The assumption of topographic conditions is a consideration for the location of the source material to be used.

Site inspections, sampling, and analysis of material samples in specific regions can be conducted prior to the start of pond construction activities, so that the data is ready before the development activity begins. However, in specific areas, checking can be performed after the contractor is hired, allowing more time for material assessment.

The condition of the material can be established only once the contractor has been confirmed as the implementing party. This is because no resources other than those provided by the contractor can be utilized. When the planned location assumption yields the desired results, the project will proceed normally. However, when the factual circumstances are much different from those expected in the comprehensive work plan, numerous more consequences are possible. There is more time required for re-analysis, and if there is a considerable deviation from the initial planning, the overall cost to perform the work could increase.

The distance is one of the input parameters used to calculate the unit price of work. The greater the distance necessary, the more expensive the job per unit. If the additional cost exceeds 10% of the basic plan, an administrative procedure is necessary.

In the iron triangle concept, stakeholders have varied interpretations of the parameters of project success. Quality is the only non-negotiable of the three requirements, therefore when things don’t go according to plan, it results in additional expenses and time. The strength of the pond construction is a concern in terms of quality factors. There is a reference value that must be satisfied, and the GT team is in charge of the assessment. In addition, the reference for expenses is the value or cost of the work that was estimated and defined at the outset and is stated in capital expenditure. Finally, the work must be done before the mining activity begins for the time parameter.

The risk of incurring additional costs that have occurred is up to 100% of the initial cost; the task takes twice as long to finish as planned. In this instance, the cause is a weakness in the original data gathered during planning. Additionally, this is exacerbated by the large disparities between the data utilized as planning assumptions and the actual field conditions. Associated to the company's risk matrix, the risk is already factored into the high criteria. The cost of the consequences is more than a million dollars, and it happens at least once a year.

Coordination between involved parties and the decision-making process both contribute to the lengthening of the project's completion time. The disparity in competency among employees, each decision is largely reliant on the issues that arise and the persons who will analyze and make decisions.

When factual situations differ from the initial plan, the decision-making process for determining the next step is critical. The decision is made by the CEP as the initiating planner with the most appropriate expertise to analyze each proposed change's impact. If analysis and decision-making can be made immediately by the department that supervises the direct contractor, this will accelerate the process more than submitting it to the CEP first.

Implementing risk management in pond construction projects, particularly during the planning stage, enables future improvements and avoidance of repeating project failures. Based on the analysis and discussion, it is possible to reduce potential risks by doing preliminary data checks prior to the pond construction process, ensuring that the pond construction process is based on accurate data.

V. CONCLUSION

The process of constructing a pond is multi-staged and involves numerous parties at each stage until the project is completed and closed. The purpose of pond construction is to achieve an environmentally friendly mining process.

There are two types of risks that are most likely to occur throughout the pond construction process: technical and financial risks. Technical risk is related to quality, which includes its safety and capacity. Financial risk happens when the plan does not match the actual field conditions.

The use of risk management in pond construction projects can help to optimize the amount of time and money spent on the project. A thorough risk analysis at the planning stage can allow all parties concerned to determine how to handle risks and make judgments about any residual concerns.

The fundamental causes of the risk of project failure are a lack of data at the start of the planning stage and a disagreement between the assumed data and the actual data in the field. Dedicated resources for investigation and initial data collection, which will be utilized as a foundation for design and planning, is a vital strategy.

REFERENCES

[1] Pollack, J., Helm, J., & Adler, D. (2018). What is the Iron Triangle, and how has it changed? International Journal of Managing Projects in Business, 11(2), 527–547. https://doi.org/10.1108/IJMPB-09-2017-0107

[2] Fredendall, L. D., Patterson, J. W., Lenhartz, C., & Mitchell, B. C. (2002). What should be changed? Quality Progress, 35(1), 50–59.

[3] Caron, F. (2013). Introduction to project risk. SpringerBriefs in Applied Sciences and Technology, 9788847052437, 51–56. https://doi.org/10.1007/978-88-470-5244-4_11

[4] Ssempebwa, R. K. (2013). PROJECT SCHEDULE MANAGEMENT BY Eng Ssempebwa Kibuuka Ronald. Atlantic International UniversityAt: U.S.A, August 2013.

[5] Johansen, A., Halvorsen, S. B., Haddadic, A., & Langlo, J. A. (2014). Uncertainty Management – A Methodological Framework Beyond “The Six W’s.” Procedia - Social and Behavioral Sciences, 119, 566–575. https://doi.org/10.1016/j.sbspro.2014.03.063

[6] Yang, Q. (2021). Understanding of An ‘Enlightened Planning’ Approach In Project Risk Management. Journal of Management Science & Engineering Research, 4(1), 25–29. https://doi.org/10.30564/jmser.v4i1.2854

[7] Rose, K. H., & Indelicato, G. (2009). Book Review: A Guide to the Project Management Body of Knowledge (PMBOK® Guide), Fourth Edition. In Project Management Journal (Vol. 40, Issue 2). https://doi.org/10.1002/pmj.20125

[8] Johansen, A., Eik-Andresen, P., & Ekambaram, A. (2014). Stakeholder Benefit Assessment – Project Success through Management of Stakeholders. Procedia - Social and Behavioral Sciences, 119(1877), 581–590. https://doi.org/10.1016/j.sbspro.2014.03.065

[9] Cantino, V., Vincentiis, P. De, & Racca, G. (2016). Risk management : Risk management : 51(4), 1–12.

[10] Panchumarthi, D. sree. (2020). Project Management in Enterprise Risk Management. SSRN Electronic Journal, December. https://doi.org/10.2139/ssrn.3737165

[11] Raydugin, Y. (2016). Project risk management: Popular fallacies and overlooked best practices. In Handbook of Research on Leveraging Risk and Uncertainties for Effective Project Management (Issue January 2017). https://doi.org/10.4018/978-1-5225-1790-0.ch001

[12] halife, M. A. (2015). Optimization modeling in construction project risk mitigation , literature review. September 2015.

[13] Ibe, J. G. (2018). Effective Project Risk Assessment and Optimal Mitigation Strategies. July.

[14] Keshk, A. M., Maarouf, I., & Annany, Y. (2018). Special studies in management of construction project risks, risk concept, plan

building, risk quantitative and qualitative analysis, risk response strategies. Alexandria Engineering Journal, 57(4), 3179–3187. https://doi.org/10.1016/j.aej.2017.12.003