



Risk Analyses for Riau Regional Water Supply Projects (SPAM), Indonesia

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Abstract. This paper investigated to what extent risk analyses may play its role in the development of feasibility study of Riau regional water supply projects (regional SPAM). This SPAM services coverage area may cover 4 (four) regions in Riau province such as; Rokan Hulu regency, Rokan Hilir, Bengkalis and Dumai. The capacity of this SPAM is 500 l/second. Total financing required for development of this SPAM was approximately Rp. 344 billion. Project finance will be obtained from budget sharing scheme from APBN (Rp. 140 billion or 41%), APBD (Rp. 62 billion or 18%), and the private sector (Rp. 141 billion or 41%). Three stages of risk analyses have been applied in this paper, such as; (i) risk identification, (ii) risk assessment, and (iii) risk mitigation. Based on the simulation result, it was identified that the initial project NPV was in the range of -Rp. 6.68 billion up to Rp. 18.01 billion. The mean value of the projected NPV was Rp. 6.27 billion. This project is considered to be risky to proceed, as there is 90% probability the projected NPV < Rp. 0. After risk mitigation procedure will be applied, there is a mean value of the project NPV is Rp. 9.9 billion (increase by 30% from the initial NPV). Four significant risk variables affected NPV performance are identified as follow; (i) engineering cost for constructing water treatment plant and facilities, (ii) cost of pipelines installation and accessories, (ii) electricity costs, and (iv) chemical cost expenditure. A reduction of technical uncertainties including design changes; redundant of engineering risk costs, introduction of energy efficient technology during project operation may reduce electricity and chemical costs. Hence, based on the simulation results, it is confirmed that, the risk analyses procedure may improve regional SPAM regional technical and economy performances (e.i. NPV parameters).

Introduction

The purpose of this paper is to identify; (i) investment magnitude for the project, (ii) identification of risks related to the project lifecycle, (iii) sensitivity analyses, and (iv) risk mitigation and control

for the project. This regional water supply project (regional SPAM) focused in 4 (four) regions in Riau province, e.i. Rokan Hulu regency, Rokan Hilir, Bengkalis and Dumai (Figure 1).

What is a Regional Water Supply Project?

A Regional Water Supply Project (Regional SPAM) is a water supply system dedicated to (i) treating, and (ii) supplying and selling bulk of water to several designated regions. This SPAM service coverage area is beyond regency/municipality/ provincial administration boundaries. The bulk of treated water will



Fig. 1. Scoping area for Regional SPAM, Riau.

be distributed throughout a pipe line (Figure 2). The regional SPAM scope area is mainly at the

The provision of water services in urban areas is the responsibility of PDAMs (Perusahaan Daerah Air Minum), Local Government Owned Water Utilities. There are 319 PDAMs in Indonesia. Most of PDAMs are operated at local governments' level, such as at the level of a regency (349 PDAMs), and a city (91 PDAMs). Hence, the existence of regional SPAM is expected to assist the existing local water companies (PDAMs) in treating water and supplying bulk water to the PDAMs water mains. The local PDAMs distribute this water directly via pipe line to house connections (SR). The operation of the SPAM is directed to be under provincial institutions. This complies with the government regulation PP. No. 66/2005.

The location of water intake was designed at Tanjung Berembun (Rokan River). The length of transmission pipe line was estimated 80.3 kms. The regional SPAM service areas would cover some villages and cities such as; Simpang Bangko, Dumai, Duri and Ujung Tanjung with the total population > 2 million people. Water intake capacity was designed to be 500 l/second. This capacity is able to cover 200.000 people (40.000 house connections).

The existing condition regions will be covered by the SPAM services are as follow; (i) Dumai city. This city has a total population of 220,035 people (2012), with the population density of 178 people / km² and the population growth rate of 3.51% per year; (ii) Bengkalis regency. It consists of 8 sub-districts with total populations of 561,303 people. The average population growth rate was 2.8% per year; (iii) Rokan Hulu regency. This regency has population 565,353 people (2012); and (iv) Rokan Hilir. This regency has population of 726,369 people (2012), with population growth rate of 4.22% per year.

It was obtained from the laboratory test that the raw water quality from the Tanjung Berembun (Rokan River) was as follow; pH levels of 6.33 (acceptable pH range of water is 6-9). BOD levels 4.405 mg / L to 5.999 mg / L. While COD was 28.22 mg / L to 68.99 mg / L. However BOD and COD values contained in the raw water of this river is beyond permissible limits, the water is still able to treated to become drinking water (the Regulation of the Ministry of Health and Presidential regulation No. 82 of 2001 concerning raw water quality standards).

Raw water will be extracted from the Rokan River, and it will be pumped to the water treatment plant located approximately 70-100 m from the river. Two types of water pumps in the intake facilities such as centrifugal pumps and submersible pumps will be installed.

In the water treatment plan (WTP) facility, the raw water will be purified to become drinking water. Water purification process may include physical processes and biological one. Physical processes encompass filtration, sedimentation, and distillation. Biological processes encompass slow sand filters or biologically active carbon, chemical processes such as flocculation and chlorination and the use of electromagnetic radiation such as ultraviolet light. After passing purification process the water then stored in reservoir. This water is ready to distribute through a network pipe line to the local PDAM companies.

Capital expenditure for this project is as follow:

Projected project investment for the procurement of HDPE pipe line (PE 100 Ø630 mm S8-SDR17 / PN10 with the total length of 80.3 km) is Rp. 200,750,000,000, -.

- Installation fees for pipe lines and accessories cost of Rp. 12,915,890,960, - (including preparation works, soil excavations, pipeline installation, and pipeline pressure tests).

Project investment required to construct water intake (with a capacity of 500 l /second) was Rp.2,500,000,000, -. Water treatment plant cost was approximately Rp. 100,000,000,000, -. Meanwhile, the cost required for the construction of office buildings and other support facilities including laboratory was Rp.2,500,000,000, -.

Consultant fees would be Rp. 15,933,294,548,- and supervision fees would be Rp. 9,559,976,729,. Hence, the total investment cost would be Rp. 344,159,162,237,-

The projected inflation rate was set up to 6%. Total project life span would be 10 years period. Loan interest was estimated 12%, with the loan grace period for 2 years. Taxes were 11.5%.

Water tariffs was divided into two types; household connection (Rp. 5,000,-) and the industrial sector (Rp. 8,000,-). Tariffs adjustment would be regulated increase 6% per year (similar to inflation rate).

The investment required for development of the regional SPAM was approximately Rp. 344,159,162,236,-.

Investment outlays for constructing water intake, transmission pipe line (15 km),and water treatment plants are expected from APBN (Rp. 140,000,000,000 or 41%).

Land accusation and resettlement scheme, consultant fees, and construction of transmission pipe line (15 km) are from APBD (Rp. 62,993,271,276 or 18%).

The remaining water supply facilities such as transmission pipe line 50.3 km, office buildings, valves and accessories (Rp. 141,389,740,960 or 41%) are expected from the private sector.

Approximately 70% of the private sector investment is financed from Bank borrowing (Rp. 98,972,818,672).

This paper illustrated cash-flow of the project during 10 years project duration. An interest rate was estimated to 12% per year The projected cash flow of the project as follow; (i) Total revenue (10 years) = Rp. 603,262,169,843, (ii) Annual Cost (10 years) = Rp. 587,737,835,279. (iii) NPV= Rp. 6,70,018,355, (iv) BCR = 1.026, and (v) Capital payback time (CPBT)=9.5 years

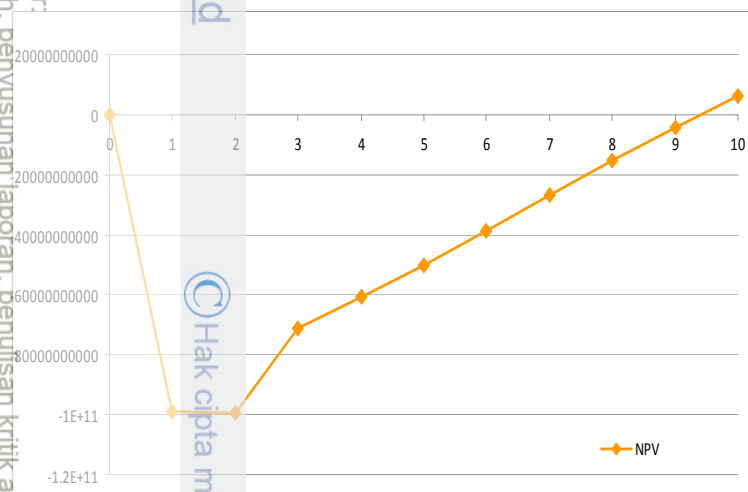


Fig. 2. A Projected of Cash in-out Flow of SPAM

Project capacity of 500 l/second

Source: Data Analyses, 2014

The cumulative cash flow (Figure 2) shows that the project is relatively unattractive to investors in a commercial sense as the BCR 1.26 (relatively low), and CPBT is relatively long (9.5 years).

Risk Analysis

Risk analysis quantifies the effects of identified risks on economic parameters. After risk analysis has been applied projects may appear more risky. This is because the identified negative risks have not been mitigated. Thus, the negative risks often outweigh the positive risks (Merna, 2000).

Sensitivity and Probability Analysis

Sensitivity analysis is used to assess the sensitivity of the economic outcome of the project to the occurrence of any risk or uncertainty (Raftery, J., 1994). This also measures the impacts on the project outcome as a result of changes in the values of input variables (risks). The main goal of this sensitivity analysis is to gain insight into which assumptions affects choice (CIRIA, 1994).

Based on the previous SPAM performance 2012, it was identified that three significant factors affecting SPAM Operation and Maintenance (O&M) performance, they were; (i) chemical materials (31%), (ii) electricity costs (36%), and staff payment (21%). These factors are the largest portions contributing to the cost expenditure for SPAM O&M (Figure 3).

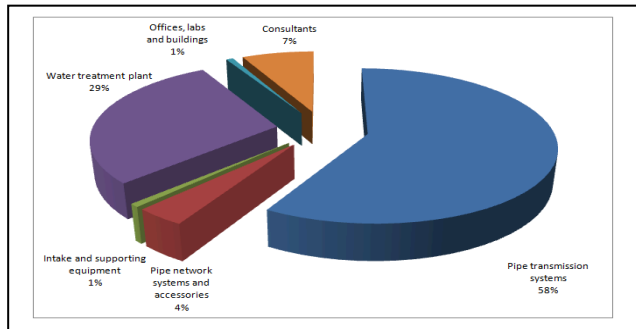


Fig. 3. Investment expenditures by construction plants (Without debt)
Source: Data Analyses, 2014

The highest investment cost was to construct pipe transmission lines (Rp. 200.7 billion), and water treatment plant facilities (Rp. 100 billion).

The sensitivity analysis of risk variables (Figure 4) shows that an increase of O&M cost such as chemical costs (15%) will affect to a reduction of the NPV by 33%. In fact an increase of chemical expenditure affects to decline NPV by double. An increase electricity tariffs by 15% reduces NPV by 28%. An increase of staff expenditures affects to fall NPV by 21%. On the other hand, an increase of water tariffs by 15%, will increase NPV up to 126%.

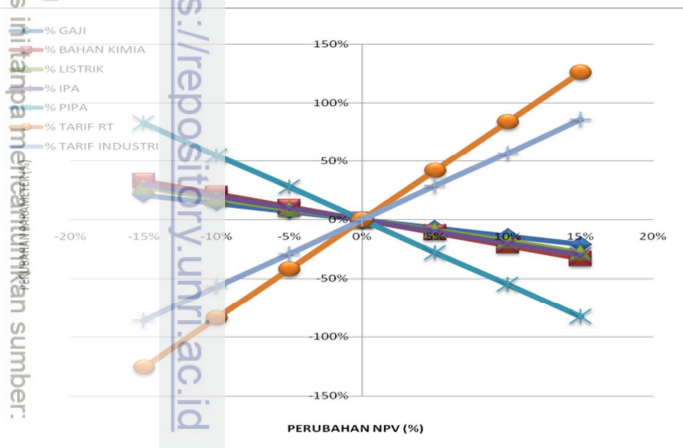


Fig. 4. Sensitivity of O&M and the construction investment parameters versus project NPV
Source: Data Analyses, 2014.

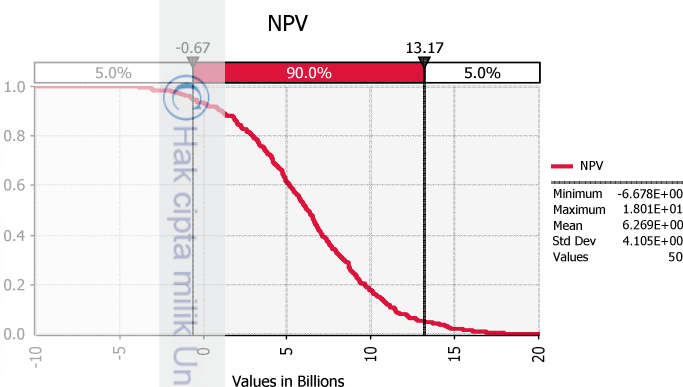


Fig. 5. The ranges for the identified risk parameters indicated the sensitivity of risks to project's NPV before Risk Mitigation.
Source: Data Analyses, 2014

The sensitivity analyses also simulate risk variables for the project construction costs. An increase of pipe transmission construction cost by 15% will affect to decline the project NPV by 80%; and an increase of water treatment cost by 15% will fall the project NPV by 30% (Figure 4).

Probability Analyses

Probability analysis is used to analyze the combined effect of different risk variables on the economic parameters of the project (i.e. using Monte Carlo simulation). The frequency of occurrence of a particular value of any one of the variables is determined by defining the probability distribution to be applied across the given range of values (Cooper, D. F. and Chapman, C. B., 1986). The ranges for the selected risk variables are indicated in the sensitivity of risks to project's NPV (Figure 5).

It was identified that project NPV was in the range of -Rp. 6.68 billion up to Rp. 18.01 billion. The average of projected NPV was Rp. 6.27 billion. Hence, there is a 90% probability of this project will yield NPV Rp.0 (no profits). But there is also 5% probability of this project will raise NPV Rp. 13 billion (Figure 5).



The average value of NPV over the 10-year of the project operation is relative low 6.27 billion (however this project is quite risky, but this is still good enough to proceed as long as risk mitigation procedure will be put into account and the recommendations will be implemented).

Risk Mitigation

Risk analysis in this paper is divided in 2 (two) stages namely; (i) preparation stage, and (ii) O&M stage. Here is the implementation and operation phase is discussed as follows:

Risk Mitigation during Project Planning Stage. Various risks may occur during project planning stages have been identified and discussed qualitatively, such as: Lack of stakeholders' commitments, poor coordination among stakeholders to achieve project successes, poor institutional and building capacity in understanding the project objectives as well as project characteristics, will also cause project to become failure. Strengthening coordination and capacity building programs in the forms of technical assistance programs, trainings, workshops and seminars should be in place before project commencement. Establishing SPAM Regional institution (UPT) is also necessary. Inadequate administrative documents prepared for project planning and design including development of FS, master plan, MoU among local governments as well as with the Central Government, environmental impact assessment (Amdal) documents, DED, and procurement plans. Conflict of interest. SPAM Regional service coverage beyond regency even provincial administrative boundaries. Uncertainty of financial access. This is the most crucial aspect to justify project to go or not to go is financial access prior to project commenced. Sharing budget among Central Government and local governments may alleviate this financial obstacle.

Risk Mitigation during Project Construction and O&M Stages. The mitigation measures were applied for 4 (four) significant risks during Project Construction (2 risks) and O&M Stages (2 risks). This is briefly described bellows:

Changes in engineering costs of water treatment plants and reservoirs. Engineering costs often increase as a result of technical uncertainties such as: design changes; redundant work; human error; unforeseen ground conditions; and increased rates of inflation. Adequate site investigations may reduce risks associated with ground conditions; recruitment of skilled and professional staff may reduce human error, as will procurement of equipment and materials from accredited suppliers at fixed prices. It is also essential to select appropriate contract strategies such as fixed price, lump sum, and Turnkey contract. The probability change in engineering cost was expected +/- 10%.

Changes in engineering costs of pipeline and connections. Adequate site investigations may reduce risks associated with pipe installation; staff training may reduce human error; as will procurement of equipment and materials from accredited suppliers with possible discounts. The probability change in pipeline cost was estimated to be +/- 10%.

Direct costs of electricity. These costs can be reduced by contracting power at a fixed rate bases; and improving efficiency through low-watt equipment and apparatus, such as eco office buildings, energy saving water treatment plant systems, low watt bulbs/lamps, and low watt air conditioning equipment. Staff training programs concerning energy efficiency and sustainable development may reduce energy consumptions as consequence reduction of electricity cost by 5%, 2 years after project operation.

Direct cost of chemical material. Chemical material for treating water may include chlorine (chloramines) as disinfectants, alkaline or acidic, lime, soda ash, or sodium hydroxide as pH adjustment, and aluminum sulfate or alum or iron as coagulants, etc. In order to reduce fluctuation of chemical prices, implementing contract strategy based on fix rate contract for a certain period may be applied (for 1 year for instance).

Probability Analyses After Risk Mitigation

For the model project, the new results after risk mitigation shows that there is a mean value of the NPV is Rp. 9.9 billion (**Figure 6**). The value of NPV (after risk mitigation) is greater than the initial value (before risk mitigation processed) is Rp. 6.27 billion.

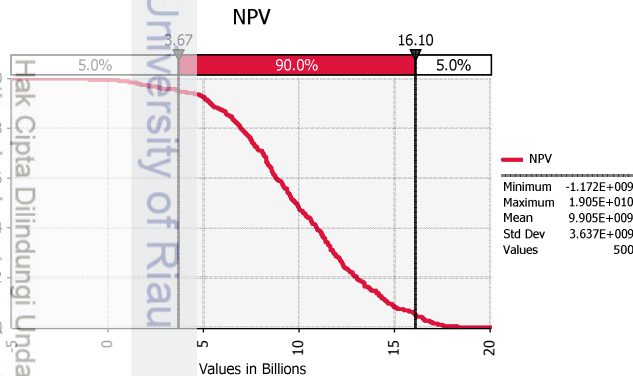


Fig. 6. The ranges for the identified risk parameters indicated the sensitivity of risks to project's NPV After Risk Mitigation. Source: Data Analyses, 2014

It was also identified that the minimum project NPV was -Rp.1.17 billion (less than the initial result of -Rp. 6.68 billion). The maximum NPV was Rp. 19,01 billion (> Rp. 18.01 billion). This figures show that, the NPV values after risk mitigation are more attractive to the project financiers compared to those before mitigating.

Summary

The use of the risk analyses within the regional water supply projects in Riau has demonstrated that both financial and technical performances of a project should be put into consideration.

The application of risk analyses enhances predicted economic performance, as the identified risks have been partially or fully mitigated and controlled. The cost of risk mitigation and control measures should be included in project accounts, and should assist in the generation of best value for money for the stakeholders. Four risks parameter have been mitigated as the follow; ; (i) engineering cost for constructing water treatment plant and facilities, (ii) cost of pipelines installation and accessories, (ii) electricity costs, and (iv) chemical expenditure. It is concluded that the results of these risk analyses for case study have satisfied the main objectives of this research in mitigating and control of the engineering and operation risks of the Regional SPAM in Riau Province.

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