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Investment Feasibility Analysis of the Drinking Water Supply System (SPAM) Project by PT. XYZ in Cilacap, Central Java

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Abstract

This research analyzes the investment feasibility of the Drinking Water Supply System (SPAM) project in Cilacap, Central Java, carried out by PT XYZ under a BOT scheme with Perumdam Tirta Wijaya. The research aims to assess financial feasibility using NPV, IRR, PI, and Payback Period indicators, and to identify key risk factors through sensitivity analysis and Monte Carlo simulation. Using a capital budgeting approach with a WACC of 9.93%, the project yields a positive NPV of IDR 10.5 billion, IRR of 12.72% above WACC, PI of 1.19, and Payback Period of 7.32 years, indicating financial feasibility. The project projects cumulative revenue of IDR 278.14 billion and free cash flow of IDR 94.81 billion. However, risk analysis reveals significant uncertainty, with sensitivity analysis identifying bulk water price and production volume as most critical, and Monte Carlo simulation producing a mean NPV of IDR 2.63 billion with a 39% probability of negative NPV. The study concludes that while the project is financially feasible, active risk management in securing revenue realization is essential. Theoretically, it contributes to infrastructure investment literature by integrating capital budgeting with quantitative risk assessment, while practically offering recommendations for PT XYZ and other investors in managing revenue-related risks and making informed decisions on PPP water infrastructure projects.

INTRODUCTION

Water is a vital resource for human life. Although approximately 72% of the Earth's surface is covered by water, only around 2.5% constitutes fresh water, and less than 1% is directly usable by humans (Gleick, 1993). The challenge lies not only in availability but also in quality, as water must undergo treatment processes to meet safe consumption standards set by WHO (2022).

The clean water crisis has become a serious global issue. WHO & UNICEF (2025) reported that in 2024, approximately 2.1 billion people, or 25% of the global population, lacked access to safely managed clean water, with 106 million still relying on untreated surface water. The primary contributing factors include pollution, climate change, and rapid population growth (Li, 2023; Manzoor et al., 2025; Ofremu et al., 2025; Rehman et al., 2022; Saxena, 2025).

Indonesia faces similar challenges. Although access to safe drinking water reached 91.72% of households in 2023 (BPS, 2024), the Household Drinking Water Quality Study (SKAM RT) revealed that only 11.8% of the population truly accessed safe drinking water (Bappenas & UNICEF, 2024). Piped water services cover only 20.69% of the population (SUSENAS, 2020). To achieve SDG 6.1 universal access to safe drinking water by 2030 the government has set a target of 45% through the 2020–2030 Safe Drinking Water Master Roadmap, requiring an estimated investment of IDR 367.45 trillion (Bappenas & UNICEF, 2024). Given limited government funding, the Public-Private Partnership (PPP) scheme has become a key financing strategy (Akomea-Frimpong et al., 2024; Alamu et al., 2024; Han & Guo, 2024; Mirzaee & Sardroud, 2022; Oyegbade et al., 2022).

In this context, Perumdam Tirta Wijaya of Cilacap Regency initiated the development of a Drinking Water Supply System (SPAM) through a Build, Operate, and Transfer (BOT) scheme. Domestic and non-domestic clean water demand in Cilacap is projected to reach 140,918.4 m^3/day in 2023 and nearly double to 284,774.4 m^3/day by 2038, while piped water service coverage currently reaches only approximately 54% of the total population (SPAM Feasibility Study of Cilacap Regency, 2020). PT XYZ, a State-Owned Enterprise (BUMN) with over 50 years of experience in construction and water infrastructure including its involvement in the Jatiluhur I Regional SPAM transmission network with a capacity of up to 4,000 liters per second has expressed interest in participating as both implementer and investor in this project.

As the basis for its investment decision, PT XYZ conducted a preliminary feasibility study yielding an NPV of IDR 5.9 billion, IRR of 12.10%, PI of 1.11, and a Payback Period of 7.85 years at a WACC of 10.14%. This study updates those findings using more current macroeconomic assumptions and extends the analysis through quantitative risk management approaches specifically sensitivity analysis and Monte Carlo simulation to produce a more comprehensive and realistic investment evaluation.

Several previous studies have examined investment feasibility in water infrastructure projects. Nabila et al. (2021) analyzed the investment feasibility of the SPAM project in Bandar Lampung City using NPV, IRR, and Payback Period indicators, concluding that the project was financially feasible. Diasa et al. (2022) evaluated the SPAM investment in Wanagiri Village, Buleleng Regency, and found positive NPV and IRR exceeding WACC. Nurhalizah et al. (2022) conducted a feasibility analysis and financial risk assessment for an AMDK company's business, emphasizing the importance of risk analysis in investment decisions. However, despite these findings, several research gaps remain. Most previous studies focused on basic capital budgeting indicators without comprehensive risk analysis (Ambarwati et al., 2024; Darmansyah et al., 2025; Farran, 2023; Nurgaliyeva et al., 2022). The integration of sensitivity analysis and Monte Carlo simulation to assess investment risk in SPAM projects has not been extensively examined. Moreover, research specifically analyzing the Cilacap SPAM project with updated macroeconomic assumptions and quantitative risk management approaches has not been previously conducted. This study addresses these gaps by providing a comprehensive investment feasibility analysis incorporating both capital budgeting indicators and quantitative risk assessment methods. The novelty of this research lies in integrating capital budgeting with quantitative risk assessment (sensitivity analysis and Monte Carlo simulation), updating the feasibility analysis with current 2025–2026 macroeconomic assumptions, quantifying the 39% probability of investment loss, and specifically analyzing the Cilacap SPAM project as a National Strategic Project with a PPP scheme, making it relevant for policymaking and investment decisions in Indonesia's water infrastructure sector.

Based on this background, this study aims to assess the investment feasibility of the Cilacap SPAM project using NPV, IRR, PI, and Payback Period indicators, while also identifying the key factors that most significantly influence the project's investment feasibility. This research offers significant benefits both theoretically and practically. Theoretically, it contributes to the literature on infrastructure investment feasibility by integrating capital budgeting with quantitative risk assessment methods, enriches the understanding of PPP project evaluation in the water sector, provides empirical evidence on the application of sensitivity analysis and Monte Carlo simulation in infrastructure investment, and serves as a reference for future researchers. Practically, this research provides an objective investment evaluation for PT XYZ's decision-making, offers actionable recommendations for managing revenue-related risks, provides insights for investors and policymakers in structuring PPP schemes for water infrastructure, and serves as a foundation for developing risk mitigation strategies in similar infrastructure projects.

METHOD

Unit of Analysis

The object of this study was the investment feasibility analysis of the SPAM (Drinking Water Supply System) project in Cilacap, Central Java, conducted by PT XYZ. PT XYZ is a State-Owned Enterprise (BUMN) engaged in the construction sector in Indonesia that has contributed to a number of strategic projects in the clean water sector, including the SPAM project, which is a National Strategic Project with a KPBU (Government-Private Partnership) scheme.

This study uses a combination of qualitative and quantitative research methods with a descriptive approach. The quantitative approach was used because the research was conducted by processing numerical data in the form of initial investment, operational costs, revenue, and project cash flow to assess investment feasibility using the capital budgeting method . The descriptive approach is used to describe the conditions of the investment project being analyzed, while the evaluative approach is used to evaluate whether the project is feasible based on financial indicators.

Data collection technique

The data used in this research are primary data and secondary data. Data collection techniques used include:

1) Documentation

   Primary data was collected through documentation methods by collecting project financial data such as economic assumptions, initial investment value, operational costs, revenue, and production projections from the SPAM Project feasibility study document in Cilacap prepared by PT XYZ and related sources. Secondary data collection in the form of historical data and economic data was carried out through literature studies of books, scientific journals, company reports, and other references related to SPAM investment in Cilacap.

2) Interview

   Primary data was collected through interview methods by communicating directly with the Vice President of the Business Development Division of PT XYZ to collect information related to the feasibility study of the SPAM Project in Cilacap which had been carried out by PT XYZ.

The data was collected from January to May 2026 as shown in Table 1.

Table 1. Schedule of data collection stages

	2026				
	January	February	March	April	May
Documentation					
Interview					

Source: Data processed by the author (2026)

Operationalization of Variables

The variables used in this study are variables in the financial aspect in the form of:

1. Income
   The revenue source for the Drinking Water System (SPAM) project in Cilacap uses the Availability Payment (AP) scheme. The volume of bulk water required (m3) is determined by the Cilacap Government, and then the volume of bulk water (m3) is multiplied by the bulk water tariff (Rp/m3) which is used as the annual revenue for PT XYZ. This bulk water tariff will increase annually based on an agreement with the Cilacap Government.
2. Capital Expenditure (CAPEX)
   Capital Expenditure (CAPEX) costs on The Drinking Water System (SPAM) project in Cilacap covers the costs of SPAM installation, development costs, and building construction. SPAM installation costs include the installation of intake subsystems, pre-sedimentation, pre-treatment, ultra-filtration, WTP buildings, generator sets, and other costs. Development costs include permitting fees, road construction, drainage, office building construction, and street lighting.
3. Operational Expenditure (OPEX)
   Operational Expenditure (OPEX) costs on The Drinking Water System (SPAM) project in Cilacap is funded by land lease costs, chemical consumption, energy costs, maintenance costs, insurance costs, surface water taxes, and Business as Usual costs. These Business-as-Usual costs include personnel costs and office expenses.
4. Inflation
   Inflation is the increase in prices of goods and services over a specific period. This inflation will affect tariff increases, operational expenditure (OPEX), and capital expenditure (CAPEX), which can significantly impact project cash flow. This inflation is then factored into each cost and revenue variable to produce a nominal value. This nominal value will then determine the free cash flow in the SPAM project. The inflation value is obtained based on published data, such as data from the Central Statistics Agency (BPS) and other relevant sources.
5. The Weighted Average Cost of Capital (WACC) is an assumption used as the minimum rate of return required by a company for project investments. This WACC is influenced by the loan interest rate, which is related to the Cost of Debt in calculating the WACC value of a project investment. The interest rate value is obtained based on public data on corporate loan rates. In addition to the Cost of Debt, the Cost of Equity is also calculated using data

such as beta, risk-free rate, and market risk obtained from public data. The beta value is calculated based on the average beta value of companies with the same type of business as PT XYZ. Meanwhile, the risk-free rate value is obtained from Indonesian government bonds and ERP and CRP values. obtained from public data. After the Cost of Debt and Cost of Equity have been obtained, the WACC is calculated using the formula:

$$\mathrm{WACC} = \left(\frac{\mathrm{D}}{\mathrm{V}} \times \mathrm{K_d}(1 - \mathrm{T})\right) + \left(\frac{\mathrm{E}}{\mathrm{V}} \times \mathrm{K_e}\right)$$

Where:

D = Total Debt
E = Total Equity
V = Total value/assets of the company
Kd = Cost of Debt
Ke = Cost of Equity
T = Tax Rate

These variables are then calculated to obtain general indicators used in investment feasibility methods (NPV, IRR, PI, PP) as well as sensitivity and Monte Carlo analysis in assessing investment feasibility comprehensively.

Analysis Techniques

The data analysis method used in this research is capital budgeting. This method was used to assess the feasibility of an investment plan by considering initial investment requirements, financing sources, revenue projections, cash flow, and investment feasibility indicators. Through this approach, companies can determine whether the planned investment will provide adequate financial benefits and is feasible to implement.

The research was conducted systematically through several interrelated stages. These stages were structured to provide a comprehensive overview of the investment feasibility analysis and recommendations that can be used as a basis for investment decision-making. Figure 3.1 illustrates the following research stages:

3) Problem Identification Stages

This stage is the initial stage of the research, namely identifying a problem that is the reason for conducting this research. The main problem that is the basis of this research is the need to evaluate the investment feasibility of the Drinking Water Supply System (SPAM) project to determine whether the project is able to provide financial benefits to PT XYZ and meet expectations in terms of the ability to return on investment. At this stage, a review is carried out on the need for SPAM in Cilacap, the project conditions, investment needs, impacts on the Cilacap community and challenges that have the potential to affect the project's success.

2) Data Collection Stages

After identifying the problem, data was collected through literature studies and project documentation. The purpose of this literature study was to obtain theories related to investment, capital budgeting, investment feasibility analysis, and risk analysis. The literature was obtained from books, journals, and other data. publicly accountable information. Project documentation aims to obtain data such as technical, operational, and financial data, as well as macroeconomic assumptions, needed to develop a cash flow model for the Drinking Water Supply System (SPAM) project in Cilacap. This data was obtained from data and reports from PT XYZ and other sources related to the SPAM project in Cilacap. Documented data include:

a) Capital Expenditure (CAPEX)

Capital Expenditure (CAPEX) data is the initial investment data for a project, the value of which is based on market analysis and expert judgment. The CAPEX data for the Cilacap SPAM project includes:

such as determining the amount of initial investment or initial investment costs for purchasing intake subsystems, pre-sedimentation, pre-treatment, generators, Water Treatment Plant (IPA) buildings, operational offices, and other supporting facilities.

b) Revenue

Revenue data is obtained from SPAM productivity projections, which include water sales volume and bulk water tariffs. Revenue serves as the primary source of cash inflow, determining whether the project is profitable during its operational period. The revenue data was obtained based on a market analysis conducted by PT XYZ, which included data on population growth and the economic status of the Cilacap region, which the company needed. This analysis served as a reference in determining projected tariffs and the volume of water to be sold.

c) Operating Expenditure (OPEX)

Operating Expenditure (OPEX) data is used to estimate operational costs throughout the concession period. Cost components include office operations, chemical use, building and infrastructure maintenance, energy costs, land rent, and various other operational expenses. In the context of project investment feasibility analysis, OPEX is a key determinant that significantly influences profitability.

d) Macroeconomic Assumptions

This study also integrates several key assumptions in developing a cash flow model, including parameters for tax rates, inflation, depreciation methods and rates, projected rate escalations, and the Weighted Average Cost of Capital (WACC), which functions as a discount rate. These assumptions are calibrated to reflect projected macroeconomic conditions and financial parameters expected to apply throughout the project's life cycle.

3) Data Processing and Analysis Stages

The collected data was then processed into a cash flow model that shows all revenues and expenditures of the Cilacap SPAM project during the investment period. Cash flow consists of cash inflows from water sales revenue and cash outflows consisting of CAPEX, depreciation, OPEX, taxes, and other expenses during the project's investment period. These cash flows will form free cash flow during the investment period, which is then analyzed using the capital budgeting method. The capital budgeting analysis will produce several indicators, namely:

a) Net Present Value (NPV)

Net Present Value (NPV) is used as an analytical tool to measure the difference between the present value of all cash inflows and the present value of all cash outflows arising from a project. NPV is calculated by adding the present value of free cash flow for each annual period within the investment period. The NPV formula is

$$NPV = \sum_{t=1}^{n} \frac{CF_t}{(1+r)^t} - C_0$$

Where:

CFt = cash flow in period t

r = Discount rate or cost of capital

n = project age

C_0 = initial investment

Within the framework of investment feasibility evaluation, a project is declared financially feasible if it produces a positive NPV value, which indicates that the project is capable of creating net added value to the invested capital.

b) Internal Rate of Return (IRR)

The Internal Rate of Return (IRR) is defined as the discount rate that causes the Net Present Value (NPV) to equal zero. The IRR formula is:

$$0 = \sum_{t=1}^{n} \frac{CF_t}{(1+IRR)^t} - C_0$$

Where:

CFt = Cash flow in period t

n = Project age

C_0 = Initial investment

IRR = Internal Rate of Return

In the context of investment feasibility analysis, a project is declared financially feasible if the IRR value exceeds the cost of capital represented by the Weighted Average Cost of Capital (WACC), which indicates that the project's internal rate of return is above the minimum rate of return required by the fund provider.

c) Profitability Index (PI)

The Profitability Index (PI) represents the ratio between the present value of a project's benefits or cash inflows and the initial investment. Within the framework of a financial feasibility evaluation, a project is considered feasible if the PI is greater than one, indicating that the benefits generated exceed the investment.

d) Payback Period (PP)

The Payback Period (PP) is an indicator used to measure the length of time required to recover the initial investment through the cash inflows generated by the project. In the context of financial evaluation, this indicator provides an overview of the speed of return on invested capital.

After obtaining the results of the investment feasibility indicators, a sensitivity analysis was conducted to measure the influence of the uncertainty of the main variables on the value of the investment feasibility indicators. In addition, a Monte Carlo analysis was also conducted to obtain a more detailed picture of the uncertainty of the variables that will be shown in statistical conclusions such as Mean, Min, Max, standard deviation, VaR, Probability of Loss on the investment feasibility indicators. The Monte Carlo analysis was conducted by creating random scenarios regarding the uncertainty of the variables that make up the cash flow, which were then iterated and simulated, resulting in 5,000 samples. The results of the iterations and simulations were then subjected to statistical analysis, to obtain conclusions from the investment feasibility analysis of the SPAM project in Cilacap.

4) Conclusion and Recommendation Stage
This is the final stage of the research, drawing conclusions based on the results of the capital budgeting and risk analysis, including sensitivity and Monte Carlo analyses. These conclusions are used to determine whether the Cilacap SPAM project is feasible from an investment perspective. Recommendations are then developed to inform company management's considerations in future investment decisions and project risk management.

RESULTS AND DISCUSSION

Cash Flow Component Assumptions and Projections

1. Income

Revenue from the Cilacap SPAM project comes from the sale of raw water to Perumdam Tirta Wijaya. The maximum installed capacity of the SPAM is 400 ^{m3} /hour of produced water (9,600 m3 $^{/ \text{ day}}$). In the first year, the installed capacity was 29%, resulting in approximately 115 m3 /hour of produced water . Furthermore, in the second year, until the end of the investment period, the installed capacity of the SPAM reached 100%.

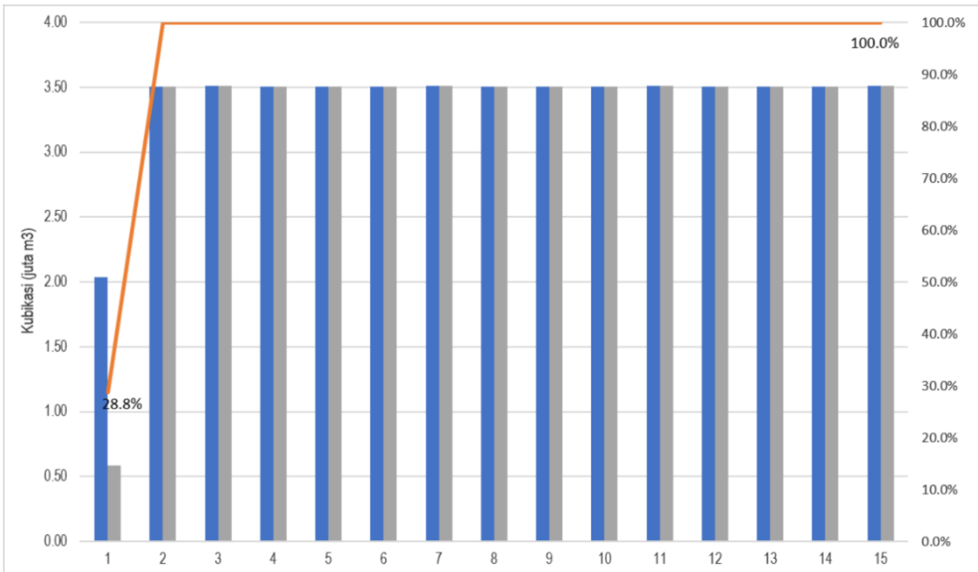

Figure 1. Production capacity and installed SPAM
Source: Feasibility Study of SPAM Development in Cilacap Regency (2020)

The bulk water tariff produced by SPAM in Cilacap is Rp 3,900/m ^{3} with a 5% annual rate increase. This rate increase percentage has been agreed upon by PT XYZ and Perumdam Tirta Wijaya so that the bulk water tariff at the end of the contract can reach Rp 7,722/m ^{3} . The total gross revenue from the SPAM project is Rp 278,142,726,000. The details of the SPAM project revenue are as follows:

Table 2. Gross revenue of Cilacap SPAM

Year	Total income (Thousand Rupiah)	Year	Total income (Thousands of Rupiah)
1	2,281,968	9	19,789,714
2	14,064,180	10	20,779,199
3	14,807,848	11	21,877,935
4	15,505,758	12	22,909,067
5	16,281,046	13	24,054,521
6	17,095,099	14	25,257,247
7	17,999,031	15	26,592,767
8	18,847,346	**Total**	**278,142,726**

2. CAPEX

CAPEX costs are the costs associated with investing in SPAM development. These costs consist of two components: SPAM installation costs and development and construction costs. CAPEX costs can be seen in the following table:

Table 3. CAPEX Costs

No	Description	Total Cost (Rp)
SPAM Installation		
1	Intake Unit Subsystem	2,023,560,000
2	Pretreatment Unit	444,000,000
3	Ultra Filtration Unit	31,455,375,000
4	Science building	990,000,000
5	Substation and Generator Set	1,877,242,069
6	Etc	11,521,000,000
Development cost & building construction		
1	Development cost	5,674,389,931
2	Office building construction	1,204,225,000
Total		**55,189,792,000**

Source: Feasibility Study of SPAM Development in Cilacap Regency (2020)

3. OPEX

OPEX costs are costs associated with the operation of the Cilacap SPAM. These OPEX costs are linear with revenue, influencing a project's revenue. For example, if OPEX costs are high in a given period, then the revenue generated in that period will also be high.

In the Cilacap SPAM development plan, OPEX costs are calculated based on market surveys conducted by vendors and others, then projected at the annual inflation rate. The OPEX costs are as follows:

Table 4. OPEX Costs

No	Description	Total Cost (Rp)
1	Business as Usual	36,065,930,353
2	Office operations	7,785,754,068
3	Energy costs	46,218,964,000
4	Chemical material	6,844,939,342
5	Building maintenance	714,022,636
6	ME Maintenance	2,164,205,658

No	Description	Total Cost (Rp)
7	Insurance	850,412,202
8	Water tax	799,438,464
Total		**102,597,759,000**

Source: Feasibility Study of SPAM Development in Cilacap Regency (2020)

4. Depreciation

Depreciation is the process of allocating the acquisition cost of a fixed asset (CAPEX) over its useful life. This depreciation value is a non-cash expense recorded in the cash flow statement (profit and loss) projection. In the SPAM project, CAPEX costs will be allocated over a 15-year period, taking into account the clean water production that generates revenue generated by the new SPAM installation each year. The CAPEX consists of office buildings and infrastructure, as well as a Water Treatment Plant (WTP), with a total investment value of 55 billion rupiah. The annual depreciation value for the SPAM project in Cilacap is as follows:

Table 5. Depreciation allocation

Year	Cost allocation (Rp)	Year	Cost allocation (Rp)
1	650,019,386	9	3,892,650,959
2	3,892,650,959	10	3,892,650,959
3	3,903,315,756	11	3,903,315,756
4	3,892,650,959	12	3,892,650,959
5	3,892,650,959	13	3,892,650,959
6	3,892,650,959	14	3,892,650,959
7	3,903,315,756	15	3,903,315,756
8	3,892,650,959	**Total**	**(55,189,792,000)**

Source: Feasibility Study of SPAM Development in Cilacap Regency (2020)

5. Inflation

Inflation is a crucial macroeconomic component in the cash flow planning of the Cilacap SPAM project. The inflation rate will affect the nominal value of operational expenditure (OPEX) components, such as WTP maintenance costs, office operating costs, energy costs, chemical costs, and other costs associated with the Cilacap SPAM operation.

In the Cilacap SPAM project, inflation is determined based on Consumer Price Index (CPI) data for Cilacap Regency, published by the Central Statistics Agency (BPS). This index indicates changes in economic conditions, commodity prices, and consumer spending. Based on collected historical data, Cilacap Regency's inflation rate ranges from 1.68% to 6.81% per year (BPS, 2025).

Table 6. Historical inflation data for Cilacap Regency

Year	Inflation Rate (%)	Year	Inflation Rate (%)
2015	3.1	2021	1.91
2016	2.32	2022	6.81
2017	3.73	2023	2.49
2018	2.65	2024	1.77
2019	2.44	2025	2.79
2020	1.68	**Average**	**2.49**

Source: Central Statistics Agency of Cilacap Regency (2025)

The spike in the inflation rate in 2022, reaching 6.81% from the previous 1.91%, is an anomaly due to the COVID-19 pandemic, which caused a significant increase in inflation. Therefore, the 6.81% figure was not included in the average inflation rate calculation. From this data, the inflation rate in Cilacap Regency is 2.49%, which will then be used in calculating the cash flow for the Cilacap SPAM project.

6. Tax Rates

The general rate of Corporate Income Tax (PPh Badan) in Indonesia is 22% of taxable income. This taxable income is the income from the project's operational cash flow minus operating costs, depreciation, and interest expense, also known as Earnings Before Tax (EBT). If the cash flow projection for a given period shows negative taxable income, no tax will be paid for that period.

The legal basis for imposing tax rates stems from Law Number 7 of 2001 concerning the Harmonization of Tax Regulations (HPP Law). Under this law, the rate for domestic corporate taxpayers and Permanent Establishments (PE) is set at 22%.

7. Funding Sources

The funding sources used in the Cilacap SPAM project come from loan debt and equity capital of PT XYZ. The debt portion used in funding is 70% (Rp 38.6 billion) of the CAPEX value while equity capital is 30% (Rp 16.5 billion). Equity funding is funding derived from PT XYZ's capital injection while debt funding comes from a bank loan with an interest rate of 9.75% for a 5-year term in accordance with PT XYZ's corporate loan interest rate. The details of the principal and interest payments arising from the loan are as follows:

Table 7. Details of principal and interest costs of loans

Year	Disbursement of Funds (Thousands of Rupiah)	Main Point (Thousands of Rupiah)	Flower (Thousands of Rupiah)
0	38,632,854		1,883,352
1		7,188,909	3,451,081
2		7,922,014	2,717,976
3		8,729,879	1,910,111
4		9,620,127	1,019,862
5		5,171,926	148,068
Total		**38,632,854**	**11,130,449**

Source: Feasibility Study of SPAM Development in Cilacap Regency (2020)

8. Weighted Average Cost of Capital (WACC)

Weighted Average Cost of Capital represents the weighted average cost of capital derived from the cost of debt and the cost of equity. The formula for determining the WACC value is as follows:

$$\mathrm{WACC} = \left(\frac{D}{V} \times K_d(1 - T)\right) + \left(\frac{E}{V} \times K_e\right)$$

Where:

D = Total Debt

E = Total Equity

V = Total value/assets of the company

Kd = Cost of Debt
Ke = Cost of Equity
T = Tax Rate

Capital structure describes the proportion of project funding derived from debt and equity. For the Cilacap SPAM project, PT XYZ's funding comes from 70% debt and 30% equity. The use of debt can provide tax benefits by reducing taxable income due to interest expenses. Therefore, the weighting for the cost of debt is 30%, while the weighting for the cost of equity is 70%.

Cost of equity is the rate of return required by shareholders or the company. Cost of equity is calculated using the Capital Asset Pricing Model (CAPM) approach, with the following formula:

$$Ke = Rf + \beta \times ERP + CRP$$

Where:
Ke = Cost of Equity
β = Beta
ERP = Expected Risk Premium
CRP = Country Risk Premium

The risk-free rate is determined based on Indonesian government bonds with a 10-year tenor for the 2020-2025 period, taken from OECD data (2025). The annual yield of Indonesian government bonds from 2020-2025 ranged from 6.36% to 7.47%. Based on this data, the risk-free rate is 6.93%, the average of the data.

Table 8. Indonesian Government Bond Data 10 Y per year

Year	Indonesia Government Bond 10Y
2017	3.1
2018	7.46
2019	2.32
2020	6.9
2021	6.36
2022	3.73
2023	2.65
2024	2.44
2025	1.68
Average	**6.93%**

Source: Organization for Economic Co-operation and Development (2025)

Beta value is a value that reflects the level of investment risk against market risk. PT XYZ is a company engaged in infrastructure and clean water processing; therefore, the determination of the beta value uses a bottom-up beta approach (Damodaran, 2012) in the form of a comparison of beta values with companies in similar fields listed on the Indonesia Stock Exchange (IDX) and carries out the unlevering and relevered beta process. The companies engaged in infrastructure and clean water processing listed on the IDX are PT Alamtri Resources Indonesia Tbk (ADRO), PT Adhi Karya (Persero) Tbk (ADHI), and PT PP (P, ersero) Tbk (PTPP). The company's financial data was collected through Reuters public data (2025) with beta values ranging from 0.87-1.94.

Table 10. Beta values of comparative companies

Company	Code	Beta
PT Alamtri Resources Indonesia Tbk	ADRO	0.87
PT Adhi Karya (Persero) Tbk	ADHI	1.75
PT PP (Persero) Tbk	PTPP	1.94

Source: Reuters (2026)

Because the beta value data is a levered beta, an unlevering beta calculation is required to eliminate the influence of the debt structure using the Hamada equation (Hamada, 1972) as follows:

$$\beta U = \beta L / [1 + (1-T)(D/E)]$$

Where:

βU = Beta unlevered

βL = Beta levered

T = Tax Rate

D/E = Debt to equity ratio

Based on the Hamada equation, the company's unlevered beta value ranges from 0.35 to 0.81, with an average of 0.57. The average unlevered beta is calculated using the following relevered beta calculation:

$$\beta L = \beta U \times [1 + (1-T)\ (D/E)]$$

Where:

βU = Beta unlevered

βL = Beta relevered

T = Tax Rate

D/E = Debt to equity ratio

the relevant beta value was 0.89. This value was used as the beta value to calculate the cost of equity for the Cilacap SPAM project.

Table 11. Bottom-up beta calculation

Company	Beta	Unlevered	Unlevered Average	Relevant Beta
ADRO	0.87	0.81	0.57	0.89
ADHI	1.75	0.55		
PTPP	1.94	0.35		

Source: Data processed by the author (2026)

The Rm value in the cost of equity calculation represents the expected market rate of return. The Expected Risk Premium and Country Risk Premium for Indonesia are obtained from published data at approximately 6.69% and 2.46%, respectively (Damodaran, 2026). Based on the risk-free rate, expected risk premium, and country risk premium, the beta value indicates that the cost of equity for the Cilacap SPAM project is 15.34%.

The cost of debt for the SPAM project is based on the estimated interest rate and tax rate. The estimated interest rate is obtained from the credit value of PT XYZ's 5-year corporate loan of 9.75%. The Indonesian corporate income tax (Pph) rate is 22% based on Law Number 7 of 2001. Based on this data, the cost of debt after tax for the SPAM project in Cilacap is 7.61%.

Taking into account the capital structure, country default spread, and company-specific risk, the WACC value for the SPAM project is 9.93%. This WACC value will be used as the discount rate in calculating the Net Present Value and as a reference for PT XYZ's minimum rate of return on the SPAM project investment in Cilacap.

Table 12. WACC of Cilacap SPAM Project

Parameter	Mark%	Portion%	Total (%)
Kd	7.61	70	5.32
To	15.34	30	3.81
WACC (Total Kd + Total Ke)			**9.93**

Source: Data processed by the author (2026)

Project Profit and Loss and Cash Flow Projection

Based on the projections and assumptions for the cash flow components of the Cilacap SPAM project, a profit and loss projection for the SPAM project can be prepared. The profit and loss projection provides PT XYZ with an overview of the project's ability to generate revenue, profit, and free cash flow. The profit and loss projection also takes into account the loan and tax burdens resulting from the Cilacap SPAM project. The profit and loss projection for the Cilacap SPAM project is as follows:

Table 13. Projected profit and loss of the Cilacap SPAM project

Description	Note	Total (Thousand Rupiah)
Income		
Bulk water revenue		278,142,726
Operating costs		
SMELL		(36,065,930)
Office operations		(7,785,754)
Energy Costs - Natural Resources Electricity - Office electricity and infrastructure - Fuel		(47,333,600)
Chemical material		(6,844,939)
Building & infrastructure maintenance		(714,023)
ME Maintenance		(2,164,206)
Insurance		(850,412)
Surface water tax		(838,894)
EBITDA	**63.1%**	**175,544,985**
Depreciation & Amortization		(55,189,792)
EBIT	**43.3%**	**120,355,193**
Flower		(11,130,449)

Description	Note	Total (Thousand Rupiah)
renewable energy	**39.3%**	**109,224,744**
Income tax	22%	(25,543,058)
EAT	**30.1%**	**83,681,685**

Source: Data processed by the author (2026)

Based on the projected profit and loss over the 15-year analysis period, the Cilacap Regency Drinking Water Supply System (SPAM) Project demonstrates relatively strong revenue generation and operational profitability. Cumulatively, the project is projected to generate Rp 278.14 billion in revenue from bulk water sales.

In terms of operational costs, the project's operational expenditure structure consists of business-as-usual costs , office operating costs, energy costs, chemicals, building and infrastructure maintenance, mechanical and electrical maintenance, insurance, and raw water tax. Based on cumulative projections, energy costs are the largest component of operational costs, amounting to approximately IDR 47.33 billion over the investment period.

After accounting for all operating costs, the project generated a cumulative EBITDA of Rp 175.54 billion with an EBITDA margin of 63.1%. Then, after deducting depreciation expenses, the cumulative EBIT was Rp 120.35 billion with an EBIT margin of 54.7%. After accounting for interest expenses, the cumulative EBT value was Rp 109.2 billion with an EBT margin of 39.3%. After accounting for income tax, the cumulative EAT value was Rp 83.6 billion with a net income margin of 30.1%. Although the profit at the beginning of the year showed a negative value, this project showed a consistent profitability trend until the end of the period and had high profitability.

After determining the projected profit and loss, the SPAM project's cash flow projection is calculated to determine the net cash flow or free cash flow (FCF). The cash flow projection is as follows.

Table 14. Cash flow projection for the Cilacap SPAM project

Description	Note	Total (Thousand Rupiah)
Operating Cash Flow		**150,001,908**
Cash Inflow - Bulk water revenue		278,142,726
Cash Outflow		
- Operating costs		(102,597,759)
- Income tax		(25,543,058)
Investment Cash Flow		**(55,189,792)**
Cash Inflow		-
Cash Outflow		
- SPAM Investment		(55,189,792)
Net Cash Flow (FCF)		**94,812,116**

Source: Data processed by the author (2026)

Feasibility Analysis

1. **Net Present Value (NPV)**

   The Net Present Value (NPV) of the Cilacap SPAM project is calculated based on the free cash flow value. In the previous discussion, the net cash flow value was Rp 94.8 billion. Using a discount rate of 9.93%, or in accordance with the WACC value, the NPV value of the Cilacap SPAM project is Rp 10.5 billion. An NPV value greater than 0 or positive indicates that the SPAM project is feasible.

2. **Internal Rate of Return (IRR)**

   Using cash flow projections, the IRR can be calculated, yielding an IRR of 12.72%. An IRR greater than the WACC indicates that the Cilacap SPAM project is feasible.

3. **Profitability Index (PI)**

   In calculating the Profitability Index (PI), the project's NPV is divided by the initial investment value or CAPEX of the SPAM project. The PI value for this SPAM project is 1.19, indicating a value greater than 1, making this project feasible.

4. **Payback Period (PP)**

   The total time or length of the investment payback period is approximately 7.32 years. This period indicates that PT XYZ can be said to have returned the initial capital used for the SPAM investment in 7 years, or half the investment period. This means that in the 8th year and beyond, PT XYZ will profit from its investment.

Risk Analysis

1. **Sensitivity Analysis**

A sensitivity analysis was conducted to determine the effect of changing one parameter variable on the investment feasibility results of the SPAM Project in Cilacap. The variables tested include:

a. Bulk Water Production

   The volumetric water production is based on the clean water output of the BWRO and UF systems. Based on their capacities, the combination of BWRO and UF systems can produce 360 ^{m3} /hour, or 10% of the desired production. Therefore, the assumed values in the sensitivity analysis are -10% and +10%.

b. CAPEX

   The CAPEX value estimate is based on market surveys and expert judgment. The CAPEX value assumption is estimated during the procurement phase, where the maturity is class 2 (AACE, 2020). Due to its maturity, the CAPEX value estimate has an accuracy of 5%-15% with a median of 10%. Therefore, the accuracy value is used as an assumption in the sensitivity analysis, namely -10% and +10%.

c. OPEX

   The OPEX value estimate is based on market surveys and expert judgment. The OPEX value assumption is estimated during the procurement phase, with maturity level 2 (AACE, 2020). Due to its maturity, the OPEX value estimate has an accuracy of 5%-15%, with a median of 10%. Therefore, the accuracy values are assumed in the sensitivity analysis, namely -10% and +10%.

d. Inflation

The inflation rate assumption is based on the Consumer Price Index (CPI) for Cilacap Regency from 2015 to 2025. The CPI value is then normally distributed, resulting in P90 and P10 values. These values are used as assumptions in the sensitivity analysis, at 1.67% (P90) and 3.67% (P10).

e. WACC

The WACC assumption is based on calculations of the cost of debt and cost of equity. This WACC value is used as the discount rate in calculating the present value. The assumed values in the sensitivity analysis are -10% and +10%.

f. Bulk water prices

The bulk price of SPAM product water varies. The set bulk price is Rp 3,900/m^3. The assumed values in the sensitivity analysis are 10% and +10%.

The sensitivity analysis was based on the Net Present Value (NPV), an indicator of investment feasibility. Other indicators were not subjected to sensitivity analysis because they have the same relationship with NPV. The sensitivity analysis results indicated that bulk water prices and water production were the most influential factors in determining the investment feasibility of the Cilacap SPAM project.

2. Monte Carlo Analysis

A Monte Carlo simulation uses random variables assumed to influence the value of an investment feasibility indicator. This simulation is repeated 7,500 times to generate a probability distribution. The investment feasibility indicator calculated in this simulation is the Net Present Value (NPV).

The variables used are the same as those in sensitivity analysis. While sensitivity analysis only changes one variable, Monte Carlo analysis randomly changes all variables to obtain the NPV value. The following is the random number generator used in Monte Carlo analysis.

Table 15. Random number generator

RNG	Downside	Upside	Information
Water Production	-10.0%	1.0%	Based on the combined output capacity of BWRO and UF (-10%) and no loss (+1%)
CAPEX	-2.0%	10.0%	Based on contingency (2%) and class 2 data accuracy (10%)
OPEX	-2.0%	10.0%	Based on contingency (2%) and class 2 data accuracy (10%)
WACC	-23.4%	23.4%	WACC is the cost of debt (23.4% of the WACC used).
Inflation Rate	-32.0%	47.0%	Distribution of P90 inflation rate of 1.67% (-32% of base inflation) and P10 of 3.67% (47% of base inflation)
Bulk Water Price	-5.0%	5.0%	Based on a rate increase of 5%

Source: Data processed by the author (2026)

Based on the results of the Monte Carlo simulation with 7,500 randomizations for 6 variables, 7,500 NPV values were generated with the following statistical explanations.

Table 16. Monte Carlo simulation results

Parameter	NPV Value (Million Rupiah)
Mean	2,626
Median	2,273

Parameter	NPV Value (Million Rupiah)
Min	(15,475)
Max	26,651
Standard deviation	7,035
Probability of Loss	39%
VaR 95%	8,059

Source: Data processed by the author (2026)

The simulation results show an average NPV of Rp 2.6 billion, with a minimum negative value of Rp 15.4 billion and a maximum negative value of Rp 26.6 billion. The standard deviation indicates that the statistics are still far from the average value. The probability of a negative NPV is 38%, and the potential loss will not exceed Rp 8 billion with a 95% confidence level.

CONCLUSION

The Cilacap Regency SPAM project, under a BOT scheme between Perumdam Tirta Wijaya and PT XYZ, has been declared feasible for development. Over 15 years, the project is projected to generate cumulative revenue of IDR 278.14 billion with free cash flow of IDR 94.81 billion. This feasibility is supported by positive financial indicators, including an NPV of IDR 10.5 billion (discount rate of 9.93%), an IRR of 12.72% above the WACC, a PI of 1.19, and a Payback Period of 7.32 years. However, the project faces significant risks, particularly revenue uncertainty due to fluctuations in water prices and production volume. Monte Carlo simulations indicate an average NPV of IDR 2.63 billion, with a negative NPV probability of approximately 39%. Therefore, active risk management and mitigation are key to the project's success.

REFERENCES

AACE International. (2020). *Cost estimate classification system—As applied in engineering, procurement, and construction for the process industries* (Recommended Practice No. 18R-97, Rev. August 7, 2020).

Akomea-Frimpong, I., Jin, X., & Osei-Kyei, R. (2024). Mitigating financial risks in sustainable public–private partnership infrastructure projects: A quantitative analysis. *Systems, 12*(7), 239.

Alamu, O. I., Hassan, A. O., Asa, K. J., & Odunayo, H. A. (2024). Addressing infrastructure deficits through public-private partnership funding of public projects in Nigeria: A review. *TWIST, 19*(3), 130–138.

Ambarwati, R., Dijaya, R., & Anshory, I. (2024). A multi-method study of risk assessment and human risk control for power plant business continuity in Indonesia. *Results in Engineering, 21*, 101863.

Badan Pusat Statistik Kabupaten Cilacap. (2025). *Kabupaten Cilacap dalam angka 2025*.

Bappenas, & UNICEF Indonesia. (2024). *Indonesia's master roadmap for safe drinking water 2020–2030*. Ministry of National Development Planning/Bappenas.

Damodaran, A. (2012). *Applied corporate finance* (3rd ed.). Wiley.

Damodaran, A. (2026). *Country default spreads and risk premiums*. New York University Stern School of Business. Retrieved July 5, 2026, from https://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/ctryprem.html

Darmansyah, A., Ali, Q., & Parveen, S. (2025). Sophisticated capital budgeting decisions for financial performance and risk management—A tale of two business entities. *Journal of Risk and Financial Management, 18*(6), 297.

Diasa, I. W., Ardana, P. D. H., Widarmawa, I. K., & Pamungkas, T. H. (2022). Feasibility analysis of drinking water supply system (SPAM) investment in Wanagiri Village, Sukasada District, Buleleng Regency. *Jurnal Ilmiah Kurva Teknik, 11*(2), 1–9. https://doi.org/10.36733/jikt.v11i2.5354

Farran, I. H. (2023). *Risk analysis and capital budgeting usage in small and medium-sized enterprises in Lebanon* [Master's thesis, University of Nicosia].

Gleick, P. H. (Ed.). (1993). *Water in crisis: A guide to the world's freshwater resources*. Oxford University Press.

Han, Y., & Guo, H. (2024). Governmental support strategies and their effects on private capital engagement in public–private partnerships. *Public Management Review, 26*(4), 908–926.

Li, C. (2023). Ranking of factors affecting environmental pollution. *International Journal of Industrial Engineering and Operational Research, 5*(3), 1–11.

Manzoor, S., Din, M. M. U., Gamal, M., Toor, M. D., & Basit, A. (2025). Increased population is a source of environmental pollution and climate change. In *Bioremediation and nanotechnology for climate change mitigation* (pp. 27–54). Springer.

Mirzaee, A. M., & Sardroud, J. M. (2022). Public–private partnerships (PPP)-enabled smart city funding and financing. In *Smart cities policies and financing* (pp. 117–131). Elsevier.

Nabila, A. A., Kustiani, I., & Siregar, A. M. (2021). Investment analysis of the development of the SPAM (Drinking Water Supply System) project in Bandar Lampung City. *JRSDD (Journal of Civil Engineering and Design), 9*(2), 241–250.

Nurgaliyeva, A., Ismailova, D., & Sarybayeva, I. (2022). Regarding the prospects for the introduction of the budgeting system of international financial organizations of the future (Kazakhstan). *Futurity Economics & Law, 2*(3), 77–94.

Nurhalizah, U., Gunarta, I. K., & Trisunarno, L. (2022). Feasibility analysis and financial risk to determine cooperation decisions with partners (Case study: AMDK Company X's business). *Jurnal Teknik ITS, 11*(1), C1–C8. https://doi.org/10.12962/j23373539.v11i1.71385

Ofremu, G. O., Raimi, B. Y., Yusuf, S. O., Dziwornu, B. A., Nnabuife, S. G., Eze, A. M., & Nnajiofor, C. A. (2025). Exploring the relationship between climate change, air pollutants and human health: Impacts, adaptation, and mitigation strategies. *Green Energy and Resources, 3*(2), 100074.

Organisation for Economic Co-operation and Development. (2025). *Long-term interest rates*. Retrieved July 5, 2026, from https://www.oecd.org/en/data/indicators/long-term-interest-rates

Oyegbade, I. K., Igwe, A. N., Ofodile, O. C., & Azubuike, C. (2022). Advancing SME financing through public-private partnerships and low-cost lending: A framework for inclusive growth. *Iconic Research and Engineering Journals, 6*(2), 289–302.

Reuters. (2025). *ADHI.JK financials: Balance sheet*. Retrieved July 5, 2026, from https://www.reuters.com/markets/companies/ADHI.JK/financials/balance-sheet-annual/

Rehman, A., Ma, H., Ozturk, I., & Ulucak, R. (2022). Sustainable development and pollution: The effects of CO_2 emission on population growth, food production, economic development, and energy consumption in Pakistan. *Environmental Science and Pollution Research, 29*(12), 17319–17330.

Saxena, V. (2025). Water quality, air pollution, and climate change: Investigating the environmental impacts of industrialization and urbanization. *Water, Air, & Soil Pollution, 236*(2), 73.