

# **A Systemic Framework Analysis for Designing Financial Model in Replace Water Meter Analog to Smart Meter**

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## **Abstract**

Investment analysis needs to be conducted for determining whether investment projections are feasible to run. In order to reduce water loss, provide bills accurately, provide a quick solution for identifying pipe leaks, monitor water quality, read water usage in real time, and reduce potential errors in customer water meters, it is necessary for customers to replace their analog meters with smart meters. Therefore, this study aims to identify the important factors, actors, goals and the connection by using a systematic framework based on Soft System Methodology (SSM). This identification is used for decision making in the model field problem, with approaching of new technology and topics in Regional Drinking Water Companies (PDAMs).

## **Keywords**

Soft System Methodology (SSM), Smart Meter, Non-Revenue Water (NRW), Financial Modeling and Decision Making.

## **1. Introduction**

Water is a basic need and an important element used in every human life (Rahardjo 2008). This issues bring out the companies that provide and serve clean water. One of the clean water providers for regional areas in Indonesia is the Drinking Water Companies (PAM). The problems faced by Drinking Water Companies (PAM) in providing clean water services are the lack of water sources and water loss. The water loss reaches 33% and it is mainly caused by the damage of customer's water meter (Hidayat 2011).

In 2021, PT DEF has achieved a KPI (Key performance indicator) of Water Sales 154,120,000 m<sup>3</sup> (Rp 1,116,785,909,620) while the percentage of water loss is 48.76% (Rp 89,020,864,636). This percentage of water loss exceeds the average of national water loss that is 20% according to Minister of Public Works Regulation No 20/PRT/M/2006.

There are several solutions to increase Water Sales and reduce Non-Revenue Water (NRW), in a Physical and Commercial way. In 2021, Physical activities have a target of 6,185 m<sup>3</sup> with an actual achievement of 6,925 m<sup>3</sup>. Physical activity is an activity of detecting physical water leaks. Besides physical activities, an active leak detecting is carried out by establishing a District Meter Area (DMA). DMA is a NRW management which is carried out by dividing networks in certain areas into smaller or more specific areas.

Whereas for Commercial activities such as illegal connection and by pass has a target of 64,700 m<sup>3</sup> with an achievement of 60,680 m<sup>3</sup>, Illegal Use activities has a target of 79,198 m<sup>3</sup> with an achievement of 649,061 m<sup>3</sup>, Meter Anomaly Activities has a target of 250,420 m<sup>3</sup> with an achievement of 147,305 m<sup>3</sup>, Meterization Activities has a target of 67,398 m<sup>3</sup> an achievement of 94,506 m<sup>3</sup> and for the achievement of Improve meter access activities of 94,238 m<sup>3</sup> and a target of 98,716 m<sup>3</sup>.

Based on the achievement of Physical and Commercial activities, the Commercial has an impact towards the failure of water sales and NRW achievement. This is because commercial activities have a direct impact on the company. In commercial Gap activities, the biggest achievement was in Illegal Use (IU) activities of 12% and Meter Anomaly of 59%. The activities such as Meter Anomaly, Meterization and Improving meter access had a largest portion of

Commercial Losses handling. Commercial Losses activities such as Meter Anomaly, Meterization and Improved access meters can reduce water loss by 335,599 m<sup>3</sup> (Rp 2,431,748,035). However, these activities are not an optimal solution in reducing water loss as long as the consumers using analog water meter. PT DEF has a plan to replace the current water meter from the analog system to a smart meter. Smart Meters have advantages such as billing accurately, providing a quick solution for identifying pipe leaks, monitoring water quality, reading the amount of water usage in real time, and reducing the potential errors in the customer's water meter.

This replacement plan needs an additional investment, hence an economic study is needed to determine the investment feasibility in replacing analog meter system to a smart meter. It is important to identify risks in order to anticipate adverse impacts of investment. In this study, an analysis of the impact of possible risks on Smart Meter investments will be carried out using the Value at Risk (VaR) approach

## **2. Literature Review**

### **2.1 Related Research**

This study focuses on analyzing the feasibility of replacing analog meters with smart water meters. Regards on the literature review that has been conducted, many studies related to feasibility analysis and risk identification have been carried out. However, most of the research that has been discussed different objects and methods. Discusses the reliability of smart meters using the monte carlo method (Tobias Altenburg 2022). Discusses smart grid applications using the Monte Carlo method [(Zafar A Khan et al.2017), (I. C. Figueiró et al.2013), (W. Du 2011)]. Discusses the identification of economic risks using the VaR method [(Chebbi, A., and Hedhli, A. 2022), (Taeyoung Doh and A. Lee Smith.2022), (Yonggu Kim and Eul Bum Lee 2018), (Allan W et al.2017), (Yun Hsing Cheung and Robert Powell 2012), (Bluford H. Putnam et al. 2002)]. Discusses financial efficiency using NPV (Carlo Alberto Magni and Andrea Marchioni 2020). Discusses the determination of the replacement period for analog water meters using the Net Present Value Chain method (Aluta Moahloli et al.2019). Discusses risk and investment evaluation using NPV at Risk (Ye, S., and Tiong, R. L. K 2000). And Discusses the Sensitivity Analysis of Power Plants using the method *Levelized Cost of electricity (LCOE) and NPV* ((Suzan Abdelhady 2020)

### **2.2 Financial Model and Risk Identification For Investment Decision Making**

The financial model is a quantitative representation of the past, present and future business operations of the company (Proctor 2010). The Financial Model is a mandatory component of every investment (Proctor 2010). The financial model aims to analyze risk factors that have not been counted and calculate the feasibility study of a project or investment from a company (Joerg Kienitz 2012). One of the basic factors that influence investment decision making is the risk factor. Investment decision making must be decided appropriately without having to confirm the risk or not (Virlics Agnes 2013). There are several parameters used in selecting investment evaluations, namely Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period (Proctor 2010).

In order to anticipate adverse impacts, it is necessary to identify risks in investment project. Value at Risk is a method used to estimate the maximum loss that can occur on an investment under normal market conditions at a certain period and confidence level (Rosadi 2009). Value at Risk (VaR) has a function as a risk management tool to measure and control market risk (Sime 2011).

## **3. Methods**

This study uses a soft system methodology approach. This method aims to arrange or describe complex activities in problem solving in general, by describing and understanding situations to intellectual processes that contribute to understanding (Wilson 2001).

Soft system methodology seven step is Problem situations considered problematic, problem situation expressed, root definitions of relevant purposeful activity system, conceptual model of the system named in the root definitions, comparisons of models and real world (compare step two vs four), changes: systematically desirable and culturally feasible, and action to improve the problem situation (Wilson 2001). This study implements the four stages of the SSM approach.

## 4. Results and Discussion

### 4.1 Understanding Problem Situations

The aim of this stage is to define the problem and identify the relevant stakeholders related to the problem. In order to support the formulation of the problem, this research uses actor analysis with the form (Enserink 2010) shown in (Table 1).

Table 1. Actor Analysis

Actors	Interest	Desired Situation/Objective	Existing or Expected Situations	Causes	Possible Solutions
PDAM	Water Sales achieved more than 162.8 Mm <sup>3</sup>	Reduce the potential error in reading the customer's water meter	Water usage billing is not read accurately (taxation)	Added sales are not achieved optimally	Converts analog system reading to smart meters
	NRW 6 MMA reduction less than 42.97 %	Provides a quick methods to identify pipe leaks	Some illegal activities and commercial losses	NRW is increasing by 48.76%	
DKI Regional Government	Improving existing water services and adding water distribution pipelines for all citizens, in accordance with international standards	Increasing clean water access more than 408 thousand connections for more than 3 million residents in the western region of DKI Jakarta	Many customers who complain about the water service	Many water leaks in PDAM pipes	Investment and risk impact on replacing analog to digital meters
customers	Customers get a meter recording schedule according to a predetermined period	Customers get exact bills according to the usage	Incorrect water billing (unmatched bill with the usage) and poor water quality	The meter reading system is operated manually (door to door). And still there is a pipe leak	Replacement of analog system meters to smart meters

### 4.2 Root Definition

The main problem in this system is the water meters still use an analog system that cause inaccuracies in recording invoices which impact company revenue. For this reason, a replacement is needed from analog meters to smart meters. In the replacement process, an analysis of economic feasibility and risk impact is required. The CATWOE analysis developed from the system root definition can be seen in (Table 2)

Table 2. The CATWOE Analysis

Root Definition	CATWOE	Elements
Decision making regarding the replacement of analog meters to smart meters requires an analysis of economic feasibility and risk impact	customers	Water use in the western region of Jakarta
	Actors	Regional Drinking Water Company (PDAM), Government (PEMDA DKI), Customer
	transformation	Replacement of analog meters to smart meters

Root Definition	CATWOE	Elements
	Worldview	This replacement has advantages such as providing accurate bills, providing a quick solution to find out pipe leaks, monitoring water quality, being able to read the amount of water usage in real time, and being able to reduce the potential error in the customer's water meter.
	Owner	Regional Drinking Water Company (PDAM)
	Environment	Financial Model and Risk Identification For Investment Decision Making

### 4.3 Conceptual Model of System's Problem

The next stage in this research is to create a conceptual model to support SSM-based analysis of complex organizational situations which will be useful for showing how the expected model is used (Wilson 2001). The conceptual model is depicted in the following system diagram (Figure 1).

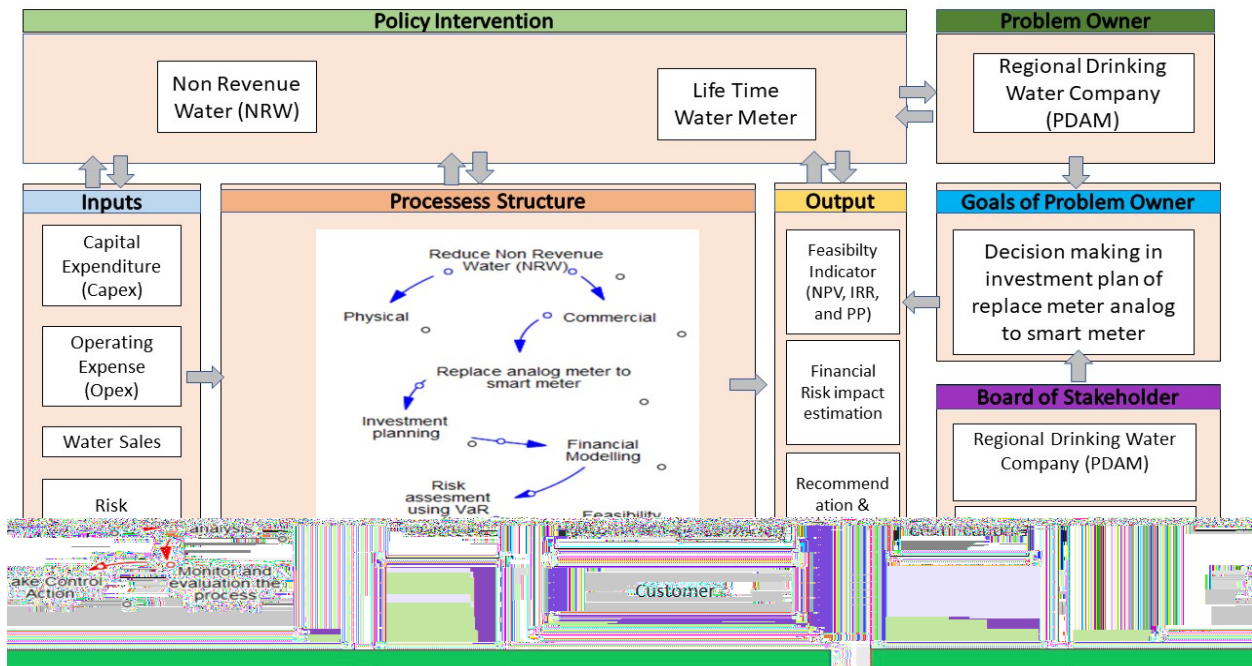


Figure 1. Conceptual Model

The conceptual model shown in Figure 1 explains that the Regional Drinking Water Company (PDAM) as a problem owner has the main goal of making decision in investment plan of replacing analog meters to smart meters. In order to achieve this, there are several policy interventions such as non-revenue water and life time water meters. Moreover, Capital expenditure (Capex), Operating Expense (Opex), Water Sales, and Risk Identification are external factors or inputs that cannot be controlled. Therefore, the output generated by the system is Feasibility Indicator (NPV, IRR, and Payback Period), Financial Risk Impact estimation, and Recommendation and Mitigation.

### 5. Conclusion

It is necessary to develop a financial model for the feasibility of investment planning to replace analog meters to smart meters. Where the financial model can be used as an investment decision making tool for Regional Drinking Water Company (PDAM). In addition, risk identification is used to determine all risks that affect the achievement of the investment. In further research, it is necessary to develop a financial model to obtain analysis and indicators of the feasibility of an investment plan by considering uncertain risk factors.

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## Biography

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