Analysis the MCA method as a basis decision making value engineering in determining choice of clean water house connection to the house

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Abstract. Non-Revenue Water (NRW) or Loss of Water is a term for water that has been produced but does not reach consumers. In Indonesia, NRW is also often referred to as Unbilled Water or ATR. Non-renewable water loss (NRW) is a known quantity that cannot be accounted for but can be monitored.The effects of NRW are increasing operation costs, water leaks, and impaired performance of PDAM. The purpose of this research is to analyze the MCA method as a basis for decision-making value engineering in determining the choice of clean water house connection to the house. The single case study is water treatment in Manado, North Sulawesi. The result of the research is that the new design is a lockable valve, ferrule pursuit fan push-fit elbow has a higher MCA value at 3. The research result is valuable for the government, stakeholders in water treatment, and academicians.

1 Introduction

The 2020-2024 development policy directions include strengthening Sulawesi's role as an entry point for international trade and Eastern Indonesia. The development strategy for Sulawesi will predict equity, growth, implementation of regional autonomy, strengthening connectivity, and disaster risk mitigation and reduction, one of which is by increasing the need for water through safeguarding land and sustainable raw water. Manado-Likupang is one of the ten priority tourist destinations that the government has determined, so it requires infrastructure support, including clean water supply facilities.

The need for clean water is to be addressed to meet their raw water needs through adequate infrastructure. The problem of distributing clean water to the house is Non-Revenue Water (NRW) or Loss of Water. NRW is a term for water that has been produced but does not reach consumers. In Indonesia, NRW is also often referred to as Unbilled Water or ATR. That is, Non-renewable water loss (NRW) is a known quantity that cannot be accounted for, but it can be monitored.

Currently, the NRW level in Regional Drinking Water Companies (abbreviated as PDAM) varies greatly. Out of 380 PDAMs, some PDAMs have a water loss rate of only 20 percent or less, but several also reach 60 percent or more. According to official data from the

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Ministry of Public Works for the 2018 financial statement, the average water loss for PDAMs in Indonesia is around 32.75 percent. With a total connection of 11,951,927 SR and a National Real Cost of Goods Sold (COGS) of NRW is Rp. 4,874.20 / m3, the volume lost is equivalent to 1.51 billion m3 of water per year and lost opportunities to earn Rp. 7.8 trillion per year [1].

The government will construct the water treatment infrastructure in North Sulawesi in 2023-2024. Value Engineering is implemented in this project to obtain the value and the function. Value engineering is helpful for the project value of money so the project will run well. One of the causes of the delayed project is financial adversity [2]. The Multi Criteria Analysis (MCA) will help in making decisions in value engineering. Thus, this research will analyze the MCA method as a basis for decision-making value engineering in determining the choice of clean water house connection to the house. The research question of the study is: How does the MCA method affect value engineering in Manado North Sulawesi water treatment?

NRW is a term for water that has been produced but does not reach consumers. There were no trustworthy and uniform techniques for accounting for water losses before the early 1990s. The performance of leak management was evaluated in terms of "unaccounted-for water." NRW comprises three components as follows: (1) Leaks from every system component and overflows at the utility's reservoirs are examples of physical (or actual) losses ; (2) Inadequate operations and maintenance ; (3) Errors in data management, water theft in many forms, and under-registration of customer meters are the reasons for apparent or commercial losses; (4) Water utilized for firefighting, operational utility use, and free water given to specific customer groups are examples of unbilled approved consumption [3].

The MCDA technique focuses on compiling and determining which decisions are more appropriate to a condition faced by the organization. The purpose of this technique is to support decision-makers in making the right decisions in the conditions being experienced. Basically, every decision taken is unique. The same decision in different situations will produce different results. Because there is no optimal solution for all conditions, the decision maker must be able to assess which decision alternative is more appropriate and appropriate to apply to the conditions being experienced [4-7].

Multi-Criteria Analysis (MCA) was developed in the 1960s to assist decision-makers in dealing with four problems (communities and local government, 2009): (a) Identify alternative choices closest to preferences (election cases); (b) Classify alternative choices according to certain aspects (classification case); (c) Ranking alternative options (case ranking); (d) Identify appropriate alternative options; (e)description of its receipt (case description).

The water loss rate is the ratio between water loss and the amount of water distributed in the piped water network, while the water balance is calculated based on the amount of incoming water flow, consumption meter-revenue, customer meter inaccuracies, water loss, and physical loss [8-10] .

As a problem-solving system, value engineering aims to identify and eliminate unnecessary costs, such as those that do not contribute to product quality, useful life, or consumer appeal. Value engineering is implemented through specific techniques, knowledge, expert teams, and creative, organized approaches. The main concept of the Value Engineering methodology lies in value with the relationship between function and cost as follows: $(Value) = \frac{Function}{Cost}$ [11-12].

Value Engineering (VE) is a technique that examines a project's issues in an orderly and methodical manner by cutting superfluous expenses without sacrificing the project's functionality, attractiveness, quality, or dependability [13].

Therefore, Value Engineering can be applied at any time throughout the life of the project, from the beginning of planning to the final stages of project development. With a slight increase in project cost or value, which is around 2.5%, a more optimal function and performance of the reservoir is obtained in reservoir Semarang City [14].

In VE, analysis was carried out based on the items analysed using the Pareto distribution, and then further analysis was carried out with several stages/phases, namely the information stage, the creative stage, the analysis stage, and the recommendation stage. For the Budget Plan, it is grouped more concisely into several groups, then Pareto distribution is carried out so that Value Engineering items are obtained, namely Structural Work, Wall, Floor and Ceiling Works as well as Channel and Road Section Works [15-16].

2 Methodology

It is necessary to have stages of research tailored to the research framework that has been compiled in the form of a flowchart. Flow diagrams are prepared based on the research's formulation and objectives to be achieved by referring to the project study. The research method is qualitative. The research design is a study case. The data collection obtains from project data.

3 Results and discussion

3.1 Information stage

A house connection is a type of customer connection that supplies water directly to houses, usually in the form of a water distribution pipe connection through a water meter, and the pipe is installed inside the house.

3.2 Function analysis stage

Activities at the function analysis stage determine the scope of the VE study problem followed by identifying functions based on existing conditions. Figure 1 shows the diagram fast alternative 1. The house connections to be made by VE cover the City of Manado with the specification: House connection material; HDPE with accessories; clamp saddle, knee, stop kran; tap kran

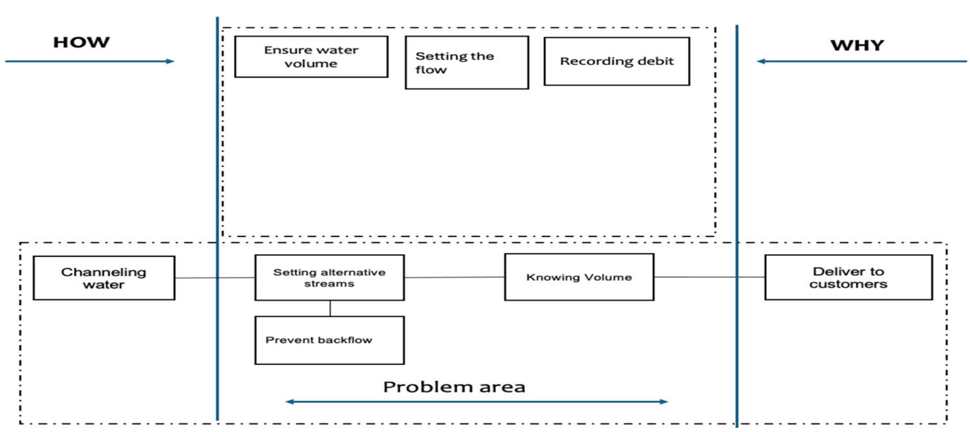

Fig. 1. Fast diagram alternative 1.

3.3 Creative stage

Activities at the creative stage are generating creative ideas for existing conditions. The problem with the existing water connection is the high-water leakage. Based on this, a new connection hose design is needed. The new design is lockable valve, ferulle pursuit fan push fit elbow. The fast diagram alternative 2 is displayed in Figure 2.

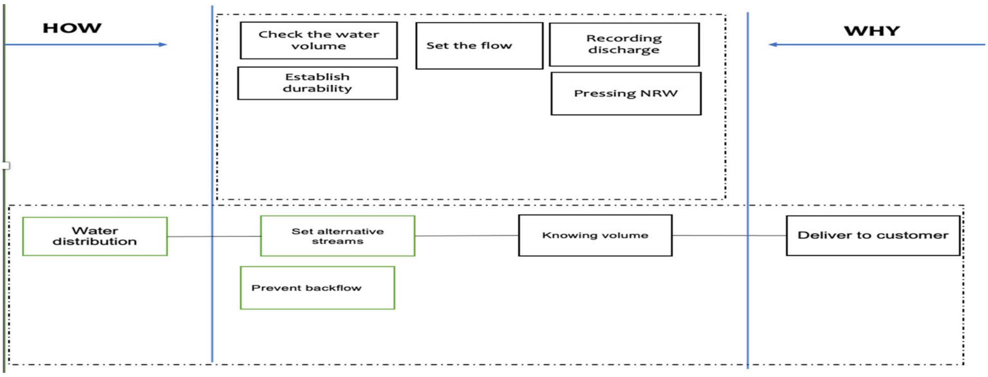

Fig. 2. Fast diagram alternative 2.

3.4 Evaluation phase

In the creative phase, ideas have been generated that need to be evaluated using MCA.

a. Parameters

There are five criteria used in the evaluation, namely discharge reading accuracy, ease of locking and reactivation, risk of being damaged, opened, or removed by other parties, operation and maintenance, and device installation, as described in Table 1.

Table 1. Parameters.

PARAMETERS	Score		
	1	**2**	**3**
Discharge reading accuracy	Not accurate	Relative Not accurate	Accurate
Ease of locking and reactivation,	Difficult	Easy	Very easy
Risk of being damaged/ opened/ removed by other parties	Easy to open and tamper with	Relatively easy enough	Difficult to open, or need a special key (1 master key)
Operation and maintenance	Harder	A little more difficult	Easier or relatively the same
SR device installation	Harder	A little more difficult	Easier or relatively the same

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b. Assess with the MCA

Table 2. MCA Assessment.

PARAMETER	WEIGHT	Alternative 1		Alternative 2	
		Score	**Mark**	**Score**	**Mark**
Discharge reading accuracy	25%	3	0,75	3	0,75
Ease of locking and reactivation,	17%	3	0,17	3	0,52
Risk of being damaged/opened/removed by other parties	39%	2	0,78	3	1,16
Operation and maintenance	12%	3	0,23	3	0,35
SR device installation	7%	3	0,14	3	0,22
Total	100%		2,61	3,00	

Table 2 shows the results of the analysis using MCA where the results of option 2 have a value of 3.00, higher than design option 1.

4 Conclusion

The MCA method is used to technical aspects as a basis for decision making. The new design is lockable valve, ferulle pusfit, and pushfit elbow have a higher MCA value on 3 than the original house connection plan 2,61.

This result show how the MCA method is useful for decision making in Value Engineering. The results of this research are limited to the case of clean water connections in Manado, other research should be developed for other areas.

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