Asian Journal of Social and Humanities
https://ajosh.org/

Time Analysis and Cost Estimation of Construction of Village Water Distribution Works For Clean Water Needs (Case Study of Tamangil Nuhuten Village, South Kei Besar Kec. Southeast Maluku Regency)

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KEYWORDS
investment feasibility analysis, BCR, IRR, NPV, PP, Hospital, Sensitivity

ABSTRACT
Water is a fundamental need for all living things, especially humans, to support survival. Tamangil Nuhuten Village, located in South Kei Besar Sub-district, Southeast Maluku Regency, faces great challenges in meeting the clean water needs of its residents. This study was conducted to evaluate the clean water distribution scheme through technical and economic approaches. The methods used included field surveys, water distribution simulation using EPANET 2.2 software, infrastructure development cost analysis, and a comprehensive assessment of construction time requirements. The results of the analysis show that the hilly topography of the village is the main obstacle in water distribution. To overcome this obstacle, a gravity-based distribution system is recommended. Based on EPANET 2.2 simulation, this system is able to fulfill the community's clean water needs efficiently. The total cost of building the distribution network is estimated at Rp8,202,383,000.00 with a construction time of six months. Furthermore, this research provides an in-depth analysis of the required time allocation for each construction phase to ensure project feasibility and efficiency. This research is expected to be a reference for the government and related parties in designing a water distribution system that is effective, sustainable, and in accordance with the needs of the Tamangil Nuhuten Village community.

Introduction

Water is one of the most important and basic needs for every living thing, especially humans, for survival. The existence of water both in quality and quantity will affect human life because basically the need for water will increase along with human growth. The central government to local governments must fulfill the basic needs, namely the provision of clean water for the community because this is also a social right of every citizen. The increasing welfare of the community is influenced by the availability of clean water. Clean water that is available in sufficient quantities can encourage public health levels and increase productivity, thereby increasing the economic growth of the community (Patriadi et al., 2023).

Tamangil Nuhuten Village is one of the villages in South Kei Besar Sub-district, Southeast Maluku Regency. The village has a varied topography, ranging from lowlands to hilly areas. The presence of small islands and geographical isolation often leads to limitations in terms of accessibility and infrastructure. Tamangil Nuhuten village faces issues related to clean water management that affect the quality of life of the community. Water resources in this area are often inadequate or not optimally managed, leading to problems such as water shortages during the dry season and water pollution that can impact on public health. This condition calls for better efforts to improve the management of clean water management in Tamangil Nuhuten village (Ariyanti & Lutfi, 2023).

For clean water needs, there are several sources of raw water that are used to meet clean water needs, including surface water, in the form of springs, rivers, lakes reservoirs, reservoirs, etc. Groundwater is a source of raw water that is generally used for community consumption needs, where groundwater can be in the form of wells both deep and shallow. Groundwater is a source of raw water that is generally used for community consumption needs, where groundwater can be in the form of deep or shallow wells. A source of water that is not rarely used by the community in meeting daily needs is rainwater (Harso et al., 2023). Basically for water quality, springs as a water source have a clearer water quality compared to the quality of water sources derived from other surface water such as rivers, reservoirs, lakes, ponds, etc., so springs are more recommended for use compared to other surface water. However, in the current era of modernization, the existence of these springs continues to decrease and even tends to run out / extinct, so groundwater is expected to be one of the alternative water sources in meeting human raw water needs, but not least as a result of uncontrolled groundwater use and not accompanied by good recharge, it will become a new problem for the decline in groundwater levels. It is not uncommon in areas that experience limited water sources to use rainwater as a source of water, but one of the biggest problems is the dependence of rainwater on the amount of rainfall and the rainy season, therefore the alternative that is needed if you want to use rainwater as the main source of water, you must prepare a tank or reservoir on a large scale that functions as a rainwater reservoir, so that when the rainfall is large it can be accommodated as a reserve, and during the dry season it can be used as a source of water to fulfill daily needs (Setijawan et al., 2020).

Traditional water sources such as wells or springs are often unable to accommodate the community's water needs during the dry season. However, in my previous research I had previously calculated the need and availability of clean water in the village of Tamangil Nuhuten. Where the Existing Spring, namely wiak spring which has a discharge of 1.0595 liters / second, is unable to meet the needs of the community but there are alternative springs that can be used, namely baluruk spring, (Rumihin & Soebagio, 2023) There are a number of challenges in water management in Tamangil Nuhuten Village, such as limited infrastructure and lack of maintenance of water management systems. Based on this, a proper water supply system is needed and in planning it must be planned and built in such a way as to meet the requirements of clean water, the availability of water at all times and continuously and the availability of water that is affordable to the community of Kecamatan Water demand is the amount of water used for various uses and desires of the community in the area.

Continuing this research is important to find workable solutions to improve water management in Tamangil Nuhuten Village. Continued research is expected to provide solutions to existing problems in Tamangil Nuhuten Village and can provide useful recommendations for improving the clean water management system. This research uses the EPANET application. EPANET itself is software specifically designed to simulate hydraulic behavior and water quality in distribution pipelines. Since it was first launched in 1993, EPANET has become a widely used tool to design and manage clean water distribution effectively. ERPANET has many functions to support water distribution management. These functions include hydraulic analysis, water quality analysis, network planning, and operational management. In addition, ERPANET also offers several benefits such as improved management efficiency, design optimization, water quality monitoring, and long-term planning.

Based on this background, the objectives of this study are divided into two main points. The objectives of this research are described as follows.

1. Analyzing the length of time required to complete clean water distribution work in Tamangil Nuhuten Village, Kec. South Kei Besar. Southeast Maluku district
2. Analyzing the cost of clean water works in Tamangil Nuhuten Village, Kec. Kei Besar Selatan. Southeast Maluku District

According to Effendi (2003), raw water quality is crucial for clean water management as it is often influenced by environmental factors such as industrial waste and weather, and can greatly impact the health of a community. The presence of pollutants in the water can complicate the treatment process, necessitating careful monitoring and management. Similarly, Kristanto et al. (2020) argue that water sources such as groundwater and surface water are essential in regions with inadequate infrastructure, and improving water supply systems can greatly enhance water quality and availability for the population.

The urgency of this research arises from the challenges faced by Tamangil Nuhuten Village in meeting its clean water needs due to its hilly terrain and isolated location in Southeast Maluku Regency. This research is critical as it addresses the need for sustainable and effective water distribution systems that can overcome geographical barriers and ensure consistent water availability. By utilizing advanced simulation tools like EPANET and conducting a detailed time and cost analysis, this study aims to offer actionable recommendations for improving clean water management in the village and meeting its growing needs.

While previous studies have highlighted the importance of water quality and the challenges of water distribution, there is a lack of research focused on the specific technical and economic aspects of clean water distribution in rural, geographically challenging areas like Tamangil Nuhuten Village. Most existing studies have concentrated on urban settings or large-scale infrastructure projects, leaving a gap in understanding the feasibility and practicality of small-scale, gravity-based distribution systems in remote areas.

This study introduces a novel approach by combining technical simulations using EPANET with a comprehensive cost and time analysis to design a water distribution system tailored to the unique conditions of Tamangil Nuhuten Village. The research is innovative in proposing a gravity-based distribution system as a feasible solution for overcoming the topographical challenges of the village, offering a practical, cost-effective, and sustainable model for rural water supply systems.

The primary objective of this research is to analyze and design an efficient, sustainable water distribution system for Tamangil Nuhuten Village, taking into account both technical feasibility and cost-effectiveness. The study aims to provide a detailed time and cost estimate for constructing the water distribution system, ensuring it meets the village's clean water needs. The benefits of this research include offering local governments and stakeholders valuable insights into optimizing water distribution systems in rural, topographically challenging areas. Additionally, it contributes to the academic literature on water management by providing a practical example of applying EPANET software for small-scale water supply projects, potentially serving as a model for similar rural communities facing water access issues.

Literature Review

Raw Water Characteristics

Raw water sources that can be utilized for drinking water treatment include springs, groundwater and surface water. Surface water can be in the form of river water, lakes, sea water, reservoirs, and ponds (Kristanto et al., 2020). According to Effendi (2003), raw water is determined by several aspects of quality, quantity, and continuity.

1. Raw Water Quality

   Water quality can change over time due to several factors such as industrial waste, domestic waste, and weather (Kristanto et al., 2020). The water quality parameters analyzed at Ngagel 1 IPA are temperature, turbidity, electrical conductivity, pH, alkalinity, free CO2, organic matter, total coliform, eschericia coli, free chlorine, detergent, total dissolved solid (TDS), color, dissolved oxygen (DO), ammonia, nitrite, nitrate, phosphate, silicate, calcium, magnesium, chloride, sulfate, fluoride, iron, aluminum, hexavalent chrome, cadmium, manganese, zinc, copper, and lead. The water quality parameters used in PDAM Surya Sembada can be explained from several aspects. These include turbidity, organic matter, pH, dissolved oxygen (DO), temperature/temperature, color, total coliform, ammonia, and sulfate (Te Chow, 1959).

2. Raw Water Quantity

   The availability of raw water according to its source is a requirement for the quantity of raw water. This can be interpreted that the amount of water available is able to meet regional needs to the management of each resident. The quantity of raw water can also be based on the amount of water flow in accordance with applicable standards to the hands of consumers which is in accordance with the volume of clean water needed. Geographical location, culture, economic level to the scale of urban or residential areas are the causes of the varying clean water needs of each population. In general, the water discharge from each water source will change from time to time (Joko, 2022).

3. Raw Water Continuity

   Raw water for clean water must be obtained on an ongoing or long-term basis with a relatively low discharge during the rainy or dry season. The availability of raw water indefinitely is also the definition of continuity. Continuity can also mean that raw water must always be available at any time when needed. According to Joko (2010), consumer needs can be an aspect in reviewing raw water continuity.

Clean Water and Drinking Water

The fulfillment of water quality in accordance with the standards set by several responsible institutions or state legislation is the definition of clean water according to Kodatie (2010). Meanwhile, the definition of drinking water according to the Regulation of the Minister of Health of the Republic of Indonesia No. 492/Menkes/PER/IX/2010 is water through processing or without processing that meets health requirements and can be drunk directly.

Clean Water Needs

Clean water demand is the quantity or volume of water consumed by the community and takes into account water loss. The need for clean water is influenced by water availability, population habits, patterns and levels of life, water prices, economic and social conditions, and technical factors such as connection facilities (Lubis & Affandy, 2014). According to the Ministry of PUPR (2016) clean water needs are grouped into:

1. Domestic Needs

   Households and social establishments are the origin of this domestic water demand. The consumption standard for domestic use is based on the average daily water use required by each person.

2. Non-Domestic Needs

   City support activities from commercial activities such as industry, offices, commerce, and social activities (schools, hospitals, and worship) are non-domestic activities that are the source of non-domestic demand. The factors underlying this type of demand are population and facility units such as public facilities, industry, and other commercial activities.

$$Qtiap\ fasilitas = F_n \times kebutuhan\ air\ (l/org.unit.hari) \times \sum pemakaian$$

Fluctuations in Water Demand

The use of water varies every time in a certain period is called water usage fluctuations (Ministry of PUPR, 2016). Fluctuations in water demand become a reference to the high and low demand for water used by consumers. Water demand on maximum days and maximum hours through reference to the average daily water demand becomes the basis of water demand. Fluctuations in water demand are as follows (Ministry of PUPR, 2016):

1. Average daily water demand (Qrh)

   Average water demand is the average daily drinking water demand. Average water demand is the amount of water needed to meet clean water needs, both domestic, non-domestic, and water loss.

$$Qrh = Q_{domestik} + Q_{non-domestik} + Q_{kehilangan\ air}$$

2. Maximum daily water demand (Qhm)

$$Qhm = fhm \times Qrh$$

   Description:
   fhm= maximum daily fluctuation factor (1.12 - 1.5)

3. Maximum hourly water demand

   Maximum hourly water demand is the highest drinking water demand that occurs at a certain hour each day. The equation in determining the maximum hourly water demand is as follows:

$$Qm = fjm \times Qrh$$

Description:
fjm = maximum hour fluctuation factor (1.75 - 2.1)

The maximum hour factor is the ratio of the maximum hourly water demand to the average water demand.

Water Current Velocity Measurement Method

The following are methods that can be used to measure water current velocity:

a. Velocity Curved Method

This method requires measurements at many points in a vertical line from the water surface to the riverbed. In general, measurements are taken at every 1/10th part inward starting from points 0.1 part to 0.9 part. This method is used to obtain accurate measurement results and is carried out at locations where the flow conditions are not very good, for example the flow is too fast and there is a lot of garbage (Jannah et al., 2021).

b. Two-Point Method

Measurement of water flow velocity in this way was carried out at depths of 0.2 and 0.8 from the water surface. The average water flow velocity is obtained by averaging the velocities measured at these two points. This method is recommended not to measure water flow velocity at locations less than 0.76 meters deep, because at a depth of less than 0.76 meters, the 0.8 depth and 0.2 depth points will be less than 0.15 meters from both the surface and the bottom of the river, and will cause friction between the propeller and the river or air.

c. Six-Tenths Method (0.6 depth measurement method)

This measurement method is carried out at a point 0.6 depth from the water surface. This method is used when the two-point method cannot be done. The measurement results at the 0.6 depth point are the average speed at the depth of the water in question. This method can be done if the water conditions are as follows:

- The water depth is between 0.25 meters and 0.7 meters.
- The water flow carries a lot of debris, making it difficult to measure at many points.
- When the measuring instrument cannot be placed at the 0.8 depth point.
- Water levels change quickly and measurements must be taken quickly.

EPANET Program

The EPANET program is a computer program that describes the hydraulic simulation and water quality trends flowing in a piping network. The piping network consists of pipes, nodes (pipe connection points), pumps, valves, and water tanks. EPANET explores the water flow at each pump, the water pressure conditions at each point, and the concentration conditions of chemicals flowing in the pipes during the flow period, as well as the water age and source tracking (Rossman, 2000).

According to Agustina (2007), the EPANET version 2.0 program has several uses in distribution network analysis as follows:

1. The EPANET program version 2.0 was designed as a tool to determine the development and movement of water and the degradation of chemical elements in distribution pipe water;
2. The EPANET version 2.0 program can be used as a basis for analysis and various distribution systems, design details, hydraulic calibration models, chlorine residual analysis and various other elements;
3. The EPANET version 2.0 program can help determine strategic alternatives for management and distribution pipe network systems, among others, as follows:
   a. As a determination of alternative sources or installations, if there are many sources or installations;
   b. as a simulation in determining alternative pump operations in filling reservoirs and injection into the distribution system;

   c. used as a treatment center such as where the chlorination process is carried out, either at the installation or in the network system;
   d. can be used as a prioritization of pipes to be cleaned or replaced.
4. EPANET program version 2.0 is a hydraulic analysis consisting of:
   a. Hydraulics analysis is not limited by the location of the network;
   b. Pressure loss due to friction is calculated using the Hazen-Williams, Darcy Weisbach, or Chezy Manning equations;
   c. Major losses and minor losses (pressure losses at the bend, elbow, and fitting) can be calculated;
   d. constant or variable pump speed model;
   e. energy and pump cost calculations;
   f. various types of valve models equipped with shut off and check. Pressure regulating and valves equipped with speed control;
   g. reservoirs of various shapes and sizes;
   h. water usage fluctuation factor;
   i. as the basis of the operating system to control the water level in the reservoir and time.
5. The EPANET version 2.0 program also provides water quality, among others, with some modeling as follows:
   a. Model the movement of non-reactive material elements through the network at any time;
   b. Reactive material change model in disinfection process and residual chlorine;
   c. elemental model of water flowing in the network;
   d. modeled chemical reactions as a result of the movement of water and pipe walls.

In the operation of the EPANET version 2.0 program, there are several data that are very important in the process of analysis, evaluation, and simulation of distribution systems in drinking water supply systems. According to Agustina (2007), these important data include:

a. Network map;
b. nodes or junctions of distribution components;
c. Elevation;
d. the length of the distribution pipe;
e. inner diameter of the pipe;
f. type of pipe used;
g. pipe life;
h. type of raw water source (spring, borehole, drinking water treatment plant, etc.);
i. pump specifications (if using a pump);
j. reservoir shape and size;
k. load of each node;
l. water usage fluctuation factor;
m. chlorine concentration at the source.

Research Methods

Research Location

Southeast Maluku Regency is one of eleven regencies/cities in Maluku province, the capital city of this regency is Langgur City which is located in Kei Kecil sub-district. Southeast Maluku Regency has an area of ± 4,212.34 km2, which is administratively bordered by:

- North: Banda Sea
- South: Arafura Sea
- West: Tual City and Banda Sea
- East: Aru Sea

The research location is in Tamangil Nuhuten Village, one of the villages in South Kei Besar District, Southeast Maluku Regency, Maluku Province. Kei Besar is one of the largest islands in Southeast Maluku Regency with a large population. Tamangil Nuhuten Village has an area of ± 4.99 km^2.

Data

The data in this study consists of two types of data, namely primary data and secondary data. Primary data is collected through observation and going directly to the field such as collecting the discharge of water sources available for distribution needs. Measurement of water discharge is done by two ways, namely manually and using a *current meter*. Manual measurement was carried out with the help of ping-pong balls and corks where before the research began, researchers looked for the right location along the Baluruk Spring by choosing the most stable segment for research. Through the *current meter,* researchers tried to measure the water discharge at the source directly by using a current meter tool to get the water velocity at the research location, where the experiment was carried out 5 times also at the same point as the manual discharge measurement and measurements were taken at 3 different heights, namely 1/3h, 1/2h and 3/4h of the water level at the time of measurement or the height of the wet section. Meanwhile, secondary data was collected from other sources, such as population, data on non-domestic facilities that potentially require clean water (e.g. industries, schools, or other public facilities) and basic price data of Maluku Province. Researchers obtained secondary data by downloading the data through the official BPS website.

Data Analysis

Water Demand Analysis

Water demand projection analysis is the projection of domestic and non-domestic water demand along with water loss according to the planning year. In this study, water demand projection is to estimate the demand for drinking water in the next ten years starting from 2024. Domestic water demand projections are based on population projections and the average drinking water demand in the planning area. public facilities and the average drinking water demand are based on secondary data from the literature. In the analysis of water demand projections, the calculation of average water demand and maximum hourly water demand in the planning area is carried out (Triatmodjo, 2008).

Schematic Simulation Using Epanet Application

Simulation of the distribution piping network for the next twenty years starting from 2021 using EPANET software version 2.0. The data entered into the program include a map of the planning area, reservoir, pump, node, elevation, pipe length, pipe diameter, pipe roughness coefficient, water pressure (pressure), headloss, and water density in the pump. The running process in the program is used to determine whether or not the network plan model can be used for an optimal drinking water supply system.

Cost Calculation

This distribution network system cost calculation analysis includes a hydraulic profile of pipe planting and RAB calculations. The components calculated in the RAB calculation include the number of pipes used, the number and type of pipe accessories used, the volume of pipe excavation, the volume of soil backfill, unit price analysis, and cost budget for each job**.**

Results and Discussions

Analysis of Clean Water Distribution System Using EPANET 2.2.

Analysis of distribution network development in the water supply system in the planning area using the EPANET program version 2.2. The data used as data in distribution network modeling is the water demand that has been analyzed in accordance with the projected water demand in 2033. The results of running the distribution network development also show that the distribution network development model meets the criteria.

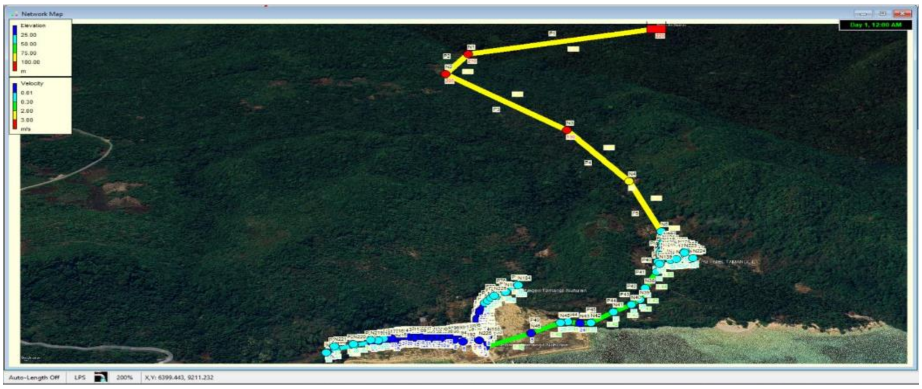

Figure 1. EPANET Running Results

Based on the results of the modeling analysis of the development plan for the clean water supply system through the distribution network in the planning area using the EPANET version 2.2 program, the average pipe has a velocity that meets the criteria, which ranges from 0.3m/s - 4.5m/s. So that the pipes used in the distribution network are HDPE PN 10 type pipes with a diameter of each:

- Transmission Pipe : 355 mm
- Distribution Pipe : 225 mm
- SR pipe : 50 mm

Budget Plan for the Construction of Clean Water Distribution System of Tamangil Nuhuten Village

The RAB calculation in this plan is used to determine the cost requirements in developing a clean water distribution system in the planning area. The RAB calculation in this planning includes RAB in the piping system in the distribution network. The RAB calculation is calculated based on the Basic Price of Maluku Province in 2023. cost requirements for piping and pipe accessories used based on market prices. Analysis of the unit price of work on the piping system includes excavation of soil, soil backfill, sand backfill, soil disposal and pipe installation. The results of the calculation of the Piping System Budget Plan in the Distribution Network can be seen in Table 1.

Table 1. RAB for the Construction of a Clean Water Distribution Network in Tamangil Nuhuten Village

NO	JOB DESCRIPTION	SAT	VOL	UNIT PRICE (Rp)	AMOUNT PRICE (Rp)
1	*2*	*3*	*4*	*5*	*6*
A	**BRONCHAPTERING CONSTRUCTION WORK**				
I	EARTHWORKS				
1	Excavation of bronchaptering building soil	M3	0.45	308.292.00	138.731.40
II	CONCRETE WORK				
1	Working floor (crushed concrete camp.1:3:5 t=5 cm)	M3	0.05	3.873.848.60	193.692.43
2	Bronchaptering base floor plate t=20 cm				
	- Concrete (K225)	M3	0.45	4.439.891.25	1.997.951.06
	- Iron	Kg	135.03	37.885.03	5.115.488.64
	- Formwork	M2	3.61	1.301.375.65	4.697.966.10
3	Bronchaptering wall t=15 cm				
	- Concrete (K225)	M3	0.90	4.439.891.25	3.995.902.13
	- Iron	Kg	312.69	37.885.03	11.846.394.75
	- Formwork	M2	12.00	1.301.375.65	15.616.507.80
4	Bronchaptering cover plate t=10 cm				
	- Concrete (K225)	M3	0.23	4.439.891.25	998.975.53
	- Iron	Kg	118.40	37.885.03	4.485.586.96
	- Formwork	M2	5.78	1.301.375.65	7.521.951.26
III	PLASTERING AND ACIAN WORK				
1	Plastering (Wall, and Top Plate)	M2	14.25	156.009.00	2.223.128.25
2	Acian (Wall, and Top Plate)	M2	14.25	77.515.75	1.104.599.44
IV	PROCUREMENT / INSTALLATION OF PIPES AND ACCESSORIES				
1	HDPE Outlet Pipe dia. 355 mm	M'	3.00	1.588.700.00	4.766.100.00
2	HDPE Inlet Pipe dia. 355 mm	M'	3.00	1.588.700.00	4.766.100.00
3	Medium Class GIP Overflow Pipe dia. 100 mm	M'	6.00	511.000.00	3.066.000.00
4	Medium Class GIP Drain Pipe dia. 100 mm	M'	3.00	511.000.00	1.533.000.00
5	Gate Valve Flange dia.150 mm	Bh	1.00	6.415.300.00	6.415.300.00
6	Gate Valve Flange dia.100 mm	Bh	1.00	5.612.400.00	5.612.400.00
7	Bend Flange dia. 150x45°	Bh	2.00	551.600.00	1.103.200.00
8	Bend Flange dia. 100x90°	Bh	2.00	514.900.00	1.029.800.00
9	Flange Weld dia. 150 mm	Bh	5.00	406.700.00	2.033.500.00
10	Flange Weld dia. 100 mm	Bh	4.00	282.700.00	1.130.800.00
11	Karet Paking dia.150 mm	Bh	5.00	99.400.00	497.000.00
12	Karet Paking dia.100 mm	Bh	2.00	92.400.00	184.800.00

13	Nut + Bolt dia. 5/8", P=7 cm	Bh	44.00	30.800.00	1.355.200.00
14	Ring dia. 5/8"	Bh	88.00	3.300.00	290.400.00
V	OTHER JOBS				
1	Painting Bronchaptering	M2	14.25	56.214.53	801.057.05
2	Flange Welding Cost dia.150 mm	Point	1.00	275.000.00	275.000.00
3	Flange Welding Cost dia.100 mm	Point	1.00	220.000.00	220.000.00
4	Manhole 60x60 cm	Unit	1.00	770.000.00	770.000.00
5	Stairs Up and Down GIP Pipe dia.40 mm	Unit	1.00	1.045.000.00	1.045.000.00
6	Vent Pipe dia. 50 mm	Unit	1.00	165.000.00	165.000.00
	TOTAL A. WORK. BRONCHAPTERING CONSTRUCTION				**96.996.532.80**
B	**TRANSMISSION PIPE INSTALLATION PROCUREMENT WORK**				
I	Procurement of HDPE PIPE dia.355 mm (PN 10) AND ACCESSORIES				
1	Procurement of 355 mm HDPE Pipe (PN 10)	M'	2.238.00	1.919.317.80	4.295.433.236.40
2	HDPE 355 mm socket	Bh	373.00	1.650.000.00	615.450.000.00
3	Bend Socket HDPE dia. 355 mm x 90°	Bh	2.00	1.897.500.00	3.795.000.00
4	Bend Socket HDPE dia. 355 mm x 45°	Bh	2.00	1.897.500.00	3.795.000.00
5	Reducer HDPE dia. 355 x 225 mm	Bh	1.00	1.897.500.00	1.897.500.00
II	HDPE pipe installation works dia.355 mm and Accesorries				
1	Hard Soil Excavation	M3	559.50	308.292.00	172.489.374.00
2	Backfill	M3	186.50	110.285.00	20.568.152.50
3	Installation of HDPE Pipe dia.355 mm	M'	2.238.00	184.625.60	413.192.092.80
	TOTAL B. PEK. PROCUREMENT OF TRANSMISSION PIPE INSTALLATION				**5.526.620.355.70**
1	***2***	***3***	***4***	***5***	***6***
C I	**DISTRIBUTION PIPE INSTALLATION PROCUREMENT WORK**				
	Procurement of HDPE pipe dia.225 mm (PN) 10) AND ACCESSORIES				
1	225 mm HDPE pipe (PN 10)	M'	804.00	778.819.10	626.170.556.40
2	HDPE 225 mm socket	Bh	134.00	1.259.500.00	168.773.000.00
3	Bend Socket HDPE dia.225 mm x 90°	Bh	1.00	1.386.000.00	1.386.000.00
4	Bend Socket HDPE dia. 225 mm x 45°	Bh	3.00	1.386.000.00	4.158.000.00
5	Tee Socket HDPE dia. 225 mm x 50 mm	Bh	5.00	1.419.000.00	7.095.000.00
6	HDPE Reducer dia. 225 x 225 mm	Bh	1.00	1.072.500.00	1.072.500.00
II	HDPE pipe installation works dia.225 mm and Accesorries				
1	Hard Soil Excavation	M3	201.00	308.292.00	61.966.692.00
2	Backfill	M3	67.00	110.285.00	7.389.095.00
3	Installation of HDPE Pipe dia.225 mm	M'	804.00	84.718.20	68.113.432.80
	TOTAL C. PEK. PROCUREMENT OF DISTRIBUTION PIPE INSTALLATION				**946.124.276.20**
D	**SR PIPE INSTALLATION PROCUREMENT WORK**				

I	Procurement of HDPE pipe dia.50 mm (PN 10) AND ACCESSORIES				
1	HDPE pipe dia. 50 mm (PN 10)	M'	5.130.00	48.293.10	247.743.603.00
2	HDPE 50 mm socket	Bh	855.00	292.900.00	250.429.500.00
3	Bend Socket HDPE dia. 50 mm x 90°	Bh	10.00	324.500.00	3.245.000.00
4	Bend Socket HDPE dia. 50 mm x 45°	Bh	5.00	324.500.00	1.622.500.00
5	Tee Socket HDPE dia. 50 mm x 50 mm	Bh	80.00	346.500.00	27.720.000.00
II	HDPE pipe installation works dia.50 mm and Accesorries				
1	Hard Soil Excavation	M3	513.00	308.292.00	158.153.796.00
2	Backfill	M3	171.00	110.285.00	18.858.735.00
3	Installation of HDPE Pipe dia.355 mm	M'	5.130.00	21.836.20	112.019.706.00
	TOTAL C. PEK. PROCUREMENT OF SR PIPE INSTALLATION				**819.792.840.00**

Based on the results of the calculation of the Cost Budget Plan for the piping system in the distribution network shown in Table 2, the results of the recapitulation of the cost budget in this planning can be seen in Table 2. Based on this table, the total cost budget based on the recapitulation of the cost budget plan in planning the Clean Water Distribution System in the planning area is Rp8,202,383,000.00.

Table 2. Recapitulation of Budget Plan

NO	**JOB DESCRIPTION**	**AMOUNT PRICE (Rp)**
1	***2***	***3***
A	Bronchaptering Construction Work	96.996.532.80
B	Transmission Pipe Installation Procurement Work	5.526.620.355.70
C	Distribution Pipe Installation Procurement Work	946.124.276.20
D	Sr Pipe Installation Procurement Work	819.792.840.00
	Amount	7.389.534.004.70
	11% Vat	812.848.740.52
	Total	8.202.382.745.21
	Updated	**8.202.383.000.00**
Retrieved	**Eight Billion Two Hundred Million One Hundred Fifty Thousand Rupiahs**	

Source: 2024 Analysis

Job Time Analysis

Time and cost are two interrelated aspects in the implementation of construction projects. Good construction planning can minimize both time and cost. In construction project planning, the implementation time must be meticulously planned, as it directly impacts cost estimation. In this subsection, the work time analysis is conducted based on the Budget Plan (RAB) outlined in the previous subsection. The results of the work time analysis detail the allocation of tasks for each phase of the construction work. The total duration of the construction work for the clean water distribution network in Tamangil Nuhuten Village is planned to be six months. The stages of work include earthworks, the installation of transmission and distribution pipes, as well as the completion of other supporting accessories. With a detailed time allocation, the project is expected to be completed within the planned schedule and budget.

Discussion

The duration of the construction of the clean water distribution network in Tamangil Nuhuten Village has been planned for six months, based on a detailed time analysis. This plan includes stages of work such as earthworks, the installation of transmission and distribution pipes, and the installation of supporting accessories. Each stage is designed by taking into account the hilly topography of Tamangil Nuhuten Village, the availability of human resources, and the types of materials used. Simulations using the EPANET 2.2 software indicate that the flow and pressure within the pipe network meet the expected standards, thereby supporting the planned duration. This time planning aligns with project efficiency principles, where each implementation phase is structured to avoid delays that could increase project costs.

The estimated construction cost amounts to IDR 8,202,383,000, which covers all aspects of work, from material procurement to field implementation. The main cost components include the purchase of HDPE PN 10 pipes, installation costs, earthworks, and the provision of supporting accessories such as gate valves and sockets. This cost analysis follows the Budget Plan (RAB) approach, referring to the latest material prices and wages in Maluku Province as of 2023. The choice of materials, such as HDPE pipes resistant to pressure and corrosion, reflects that this estimate considers not only short-term needs but also the sustainability of the clean water distribution network for the long term.

The relationship between duration and cost in this project is one of the critical points in the discussion. Well-planned duration allows for more efficient cost management. By dividing the work phases in detail, the project can optimize resource allocation, both in terms of labor and materials, thereby minimizing the risk of unexpected expenses due to delays or errors in implementation. This relationship aligns with construction management theory, which states that efficient time planning directly contributes to controlling project costs.

The results of this study have practical implications for local governments and related stakeholders in managing the development of clean water infrastructure, particularly in remote areas with significant topographical challenges. Additionally, this study also contributes theoretically by demonstrating the application of EPANET software in simulating clean water distribution, which can serve as a reference for similar research in the future. Thus, this study not only offers technical solutions but also provides insights for more effective and sustainable project management.

Conclusion

Based on the analysis, it can be concluded that the construction of the Clean Water Distribution Network in Tamangil Nuhuten Village is projected to take 6 months to complete. The total cost required for this project is estimated at IDR 8,202,383,000.00, reflecting the necessary resources and scope of work involved in establishing the network. This analysis highlights the timeline and financial commitment essential for the successful implementation of the clean water infrastructure in the village.

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