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The Development of Rural Water Supply System in Tulungagung Regency

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Abstract— *The overall funding in Tulungagung Regency for the development of rural drinking water supply systems (SPAM) is limited and unbalanced compared to the number of villages in the district area. This research is conducted to obtain an alternative ranking sequence of the construction of rural SPAM in Tulungagung Regency in accordance with the budget ceiling. The method of data analysis is the Analytic Hierarchy Process (AHP) toward data obtained from questionnaire distributed to 16 respondents. Respondents are people who know and are involved in allocating funds for the construction of SPAM in Jengglungharjo Village, Pucanglaban, Talang, Keboireng, Tugu and Gondanggunung in Tulungagung Regency. Of all the six villages as the alternatives for the location of rural SPAM development, Talang Village obtains the highest weighing score (0.364), followed by Jengglungharjo Village (0.218), Pucanglaban (0.169), Gondanggunung (0.102), Keboireng (0.089) and Tugu (0.058). Therefore, the result of AHP analysis suggests Talang Village as the first priority for the SPAM development site. Regarding the limited fund, the construction of rural SPAM in Talang Village can be carried out gradually and supported by other funding sources.*

Keywords—*AHP, Water Supply System, Priority, Rural.*

I. INTRODUCTION

Water is an important aspect in the quality and sustainability of human life. Water for daily use can be obtained from the soil, surface water, or directly from rainwater (Rica Danis 2010). Therefore, drinking water absolutely must be available in adequate quantity and quality (Permen PU No. 14 / PRT / M / 2010). In the Sustainable Development Goals (SDGs) agreement, the fulfillment of the right to water is stipulated in the sixth goal, which is "guaranteeing the availability and management of clean water and sustainable sanitation for all". The goal of the SDGs in 2030 is to achieve universal and equitable access to safe and affordable drinking water for all. In Indonesia, these targets and targets have been set in the 2015-2019 RPJMN, through increasing access to improved drinking water services in 2019 to 100% (Indonesian Cabinet Secretariat, 2017).

Uneven population growth and activities have caused various impacts on changes in environmental order and balance, resulting in a decrease in the quantity and quantity of water resources. Difficulties in fulfilling access to clean water are caused by high growth rates and population densities (Juwana, 2016). To bridge the relationship between the availability of clean water and population growth, the application of technology, policy, and culture is carried out (Mujiani et al., 2006).

Provision of rural drinking water in the area of East Java Province, particularly in Tulungagung Regency is an important agenda in meeting Minimum Service Standards (Minister of Public Works Regulation Number: 14 / PRT / M / 2010). However, the funding for Rural Water Supply System (SPAM) in each year is uncertain and even still very limited. This is one of the toughest challenges in infrastructure issues in Tulungagung Regency. For this reason, it is necessary to prioritize the selection or determination of the development of Rural SPAM that will be carried out first in accordance with the available budget ceiling.

In its development, the determination of the priority sequence for the development of the Drinking Water Supply System in Tulungagung Regency was carried out based on Law No.25 of 2004 concerning the National Development Planning System and the community's proposal through the Development Planning Consultation (Musrenbang) mechanism. However, so far there has not been obtained a decision-making method that can be scientifically justified, so it is very important to do research to get the right decision-making method for the development of rural drinking water supply systems that can be accounted for and adjusted to the available funds.

II. LITERATURE REVIEW

A. The Services of Drinking Water Supply

Every Government program intended for the community has advantages and offers satisfaction even though the results are not tied to physical products (Sinambela, 2010). Every public service delivery must have a standard and be published as a guarantee of certainty for the community. The service standard is a standardized rule in the administration of public services that must be obeyed by the service provider and or recipient. Drinking water services can be defined as a process of assistance to others in certain ways, especially in the case of drinking water, which requires sensitivity to interpersonal relationships to support the creation of satisfaction and success.

B. The Principles of Drinking Water Supply

The principles of drinking water supply include:

1. Collection of raw water from the source.
2. Water treatment.
3. Transmission (drainage from water sources or water treatment plants to the service areas).
4. Distribution (distributing water to consumers in service areas).

C. The Objectives of Water Supply Management

The purpose of drinking water treatment is:

1. To obtain water for consumption.
2. To obtain good quality water for the community (clear, odorless, tasteless, and algid enough).
3. To obtain water with facilities that are built and operated at a reasonable cost, so that the community can afford it.

According to the Government Regulation of the Republic of Indonesia Number 122, Year 2015, the provision of clean water needs for the community is guided by 4 main principles, namely quality, quantity, continuity, and affordability.

1. Quality. Raw water must meet the quality standard. Water quality standards that are suitable for consumption/drink refer to several requirements, namely free from pathogenic organisms, have a low content of acutely toxic substances, clear, not salty, free of odor and taste-causing substances, do not contain corrosive substances.
2. Quantity. The amount of water available must meet the basic needs of the population, such as bathing, drinking, and others.
3. Continuity. The available water must be able to meet the needs of consumers in a continuous-time throughout the year.
4. Affordability. Communities can get water at affordable prices from facilities built and costs that are operated.

D. Water Management

The water processing system in Tulungagung Regency generally aims to maintain the water quality so that it is always appropriate (safe and healthy) for consumption by the community (Minister of Public Works Regulation Number: 18 / PRT / M / 2007). The SPAM water treatment unit in Tulungagung Regency consists of the following processes:

- Screening. This is the process of capturing solid particles, floating, with a certain diameter which is generally installed at the intake (water catcher), the end of the well pump or at the gates.
- Prasedimentation Unit (clarifier), is the process of precipitation of coarse and heavy particles by utilizing flow length, flow type, particle weight, and depth of the body. The pre-sedimentation unit is the initial deposition process of the water treatment plant before the next treatment process. This unit is very dependent on the level of turbidity of raw water.
- Coagulation-Flocculation Process, this process is the mixing of raw water with chemicals that are binding to fine particles of raw water to become flocks that are easily deposited by gravity. This mixing uses both fast and slow stirring which is designed through water drainage or a separate mixing container by using a mixer to mix evenly.
- Sedimentation process. This is the process of settling particles that have undergone a process of coagulation-flocculation. The sedimentation unit is equipped with a settling tank to capture and precipitate flocculent particles. The results of deposition in the form of mud, then cleaned mechanically / manually by opening the drain valve on the bottom side.
- Filter Unit, water that has passed the sedimentation process will be filtered through the filter as a physical end process. Filtering is done in an effort to hold coarse and fine particles from being carried into the pipeline. This can cause the blockage of the pipe.
- Reservoir. This is a place to store processed water and as a water reserve when the water demand is high. Existing reservoirs in rural SPAM Tulungagung regency are generally made of reinforced concrete construction.
- Mixing/pouring chemicals, the use of mixing tanks is only carried out in areas with very low pollution or water quality so that the tub is very rare. The function of the mixing bath is as a particle binder and as a disinfectant for biological parameters, especially from organic pathogens. Chemicals are first mixed in a chemical mixing unit before being injected into the processing unit.

III. METHOD

This study uses a survey method with the aim to find out the opinions, experiences, and attitudes of respondents regarding problems in the development of rural drinking water supply systems in Tulungagung Regency. The research objective is to obtain the weight of aspects and criteria considered in determining alternative development of rural SPAM. Based on the aspects and criteria, the next aspects, criteria, and alternatives are determined to be used as question items in the questionnaire. Furthermore, research data were processed using the Expert Choice program.

A. Research Location

Tulungagung Regency has several rivers that flow throughout the year. Some of these rivers have quite extensive river basins and form a drainage basin. Drainage basin in Tulungagung Regency is divided into 3 large watersheds, namely the Lahar, Ngrowo, and Ngasinan and Selosewu Watershed. The division of watershed areas is explained in Table 1.

TABLE 1. Drainage basin in Tulungagung Regency

Drainage Basin (DAS)	Area Coverage
Sub-DAS Lahar	Districts of Sendang, Karangrejo, Ngantru, Kedungwaru, Sumbergempol, Ngunut, Rejotangan.
Sub-DAS Ngrowo Ngasinan	Districts of Sendang, Pagerwojo, Karangrejo, Kedungwaru, Tulungagung, Kauman, Gondang, Boyolangu, Pakel, Campurdarat, Kalidawir, Pucanglaban, Bandung, Besuki, Sumbergempol, Ngunut, Rejotangan, Tanggunggunung.
DAS/DAL Selosewu	Districts of Tanggunggunung, Kalidawir, Pucanglaban, Besuki.

Source: RTRW Tulungagung Regency

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In Tulungagung Regency, there are potential sources of water, both surface water, and groundwater.

1. Surface water is freshwater found in rivers, canals, lakes/ponds, swamps, ponds, and so on. Tulungagung Regency has 2 river flow patterns (DAS), namely Brantas DAS and Gedangan DAS.
2. Groundwater is water below ground level that is formed from rainwater that experiences infiltration (impregnation), forms water in the root zone (soil water), and then undergoes percolation and forms groundwater. There are 8 subdistricts that have relatively good groundwater and moderate groundwater conditions (in terms of quality and quantity), namely the districts of Kalidawir, Ngunut, Sumbergempol, Boyolangu, Tulungagung, Kedungwaru, Ngantru, and Gondang.

In addition to being drained by these rivers, the hydrological state is also determined by the presence of reservoirs, dams, springs, water pumps and bore wells. This research was conducted in several locations of the development of rural drinking water supply systems which are under the authority of the Government of Tulungagung Regency and are spread in the northern and southern regions (Table 2). Figure 1 shows the location of the alternative selection of a rural drinking water supply system (SPAM) in Tulungagung Regency.

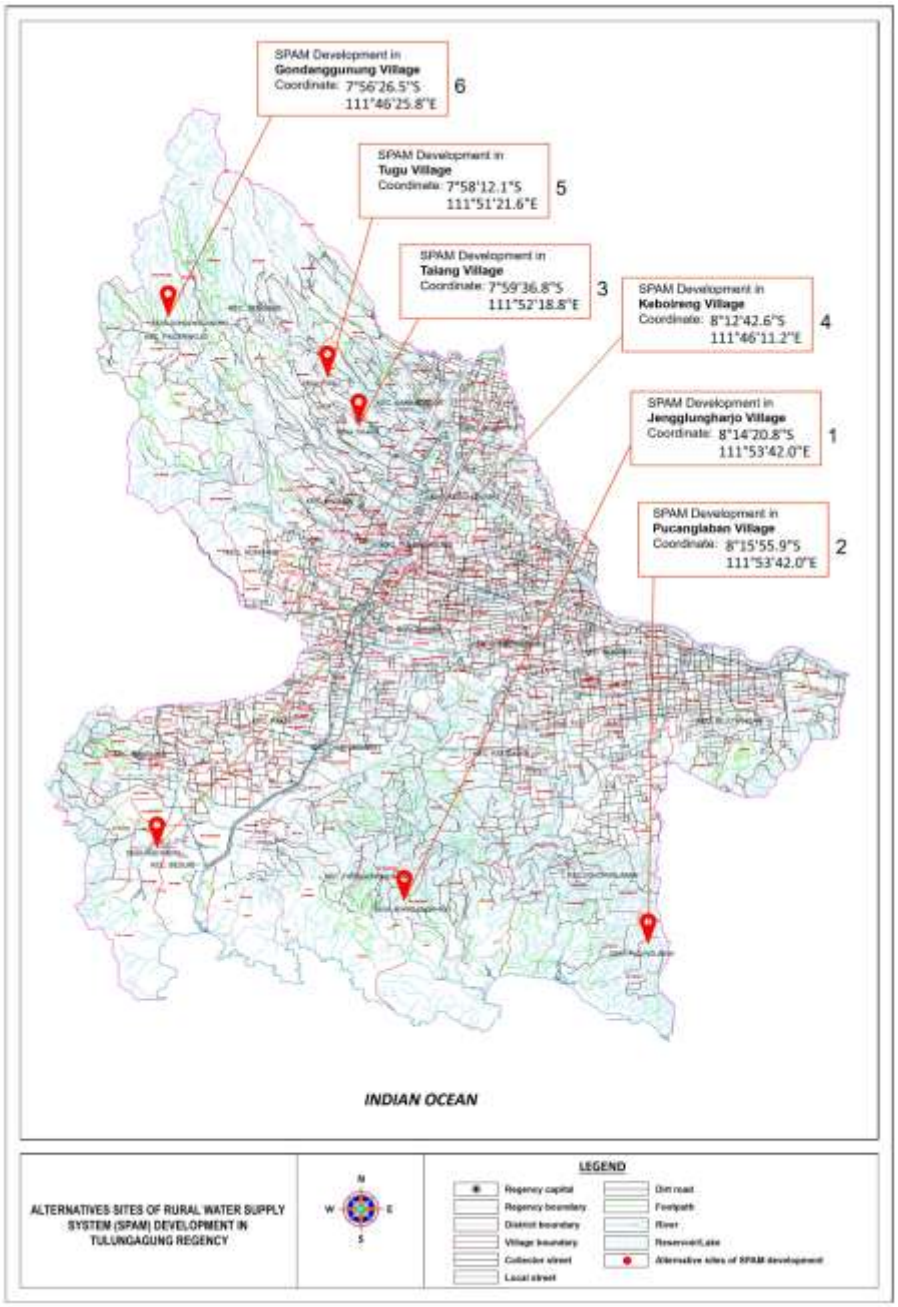

Fig 1. Map of Study Location (Tulungagung Regency)

B. Population and Sample

The population of this study is people who are policymakers as well as people who know and are involved in determining policies and developing a Rural Water Supply System (SPAM) in Tulungagung Regency. The main party is the Department of Public Works and Spatial Planning of Tulungagung Regency, which in this study was sampled as many as 16 respondents. Samples were taken randomly using Disproportionate stratified random sampling (Sugiyono, 2009).

C. Data Collection

Primary data were obtained using a questionnaire that was prepared based on relevant analytical parameters according to the aims and objectives of the study. Data obtained directly from respondents who have been selected as research samples. In addition, secondary data includes literature studies relating to the theoretical foundation, concepts, variables obtained from notes, books, journals and so on to support this explanation in the study.

Evaluation of each aspect, criteria, and alternatives obtained through a questionnaire was carried out using a pairwise comparison of the 9-1-9 scale. Number 1 is the respondent's response code which states that the two elements are equally important, while number 9 is the respondent's response code which states one element is absolutely more important than the other element.

TABLE 2. Degree of Importance

Definition	Equally important	Equally to moderately important	Moderately important	Moderately to strongly important	Strongly important	Strongly to very strongly important	Very strongly important	Very strongly to absolutely important	Absolutely important
Scale	1	2	3	4	5	6	7	8	9
Scale	1/1	1/2	1/3	1/4	1/5	1/6	1/7	1/8	1/9

Source: Saaty (1993).

D. Analytic Hierarchy Process (AHP)

AHP analysis is used to determine the weight of each aspect, criteria, and alternatives. This weighting process was carried out with the help of Expert Choice version 11 software. In this study, Expert Choice was used to analyze questionnaire data obtained from 16 respondents. Respondents are people who know and are involved in the development of rural drinking water supply systems in Tulungagung Regency.

IV. Result and Discussion

A. General Description of Study Location

The data in this study were obtained from the results of distributing questionnaires to 16 respondents. Respondents are policymakers as well as people who know and are involved in determining priority policies for the development of Rural Water Supply System (SPAM) in Tulungagung Regency. The party is the Department of Public Works and Spatial Planning, Tulungagung Regency.

TABLE 3. The data of alternative locations for Rural SPAM Development

No.	Alternative Locations	Distance to Downtown (Km)
1	Jengglungharjo Village, Tanggunggunung	28
2.	Pucanglaban Village, Pucanglaban District	36
3.	Talang Village, Sendang District	19
4.	Keboireng Village, Besuki District	26
5.	Tugu Village, Sendang District	19
6.	Gondanggunung Village, Pagerwojo District	16

Source: BPS (Statistics Indonesia) Tulungagung (2018).

Respondents were asked to fill out a list of questions in the questionnaire, as well as provide information directly in the interview session to clarify the answers that have been written on the questionnaire. Data analysis was carried out to find aspects and criteria that became the priority in the development of rural Water Supply System (SPAM) in Tulungagung Regency. Thus, aspects, criteria, and alternatives for SPAM development are used as questions in the questionnaire. The data that has been obtained will be analyzed to obtain the weighting of aspects, criteria and alternative locations for the development of rural drinking water supply systems. Table 3 explains data on alternative locations for the development of Rural SPAM in Tulungagung Regency.

B. Hierarchy Structure

Functional hierarchy is useful to help direct the system in accordance with the desired goals. In this study, the hierarchy used is a functional hierarchy consisting of three levels.

1. First Level is the objective, which is the determination of criteria or the factors on why SPAM development is important to be done.
2. Second level, consisting of four aspects:
   A. Technical Aspect
   B. Community aspirations aspect
   C. Cost Aspect
   D. Regional development aspect
3. Third level, which includes 14 criteria.
   A1. Availability of raw water
   A2. Difficulty level of SPAM development
   A3. Number of user that can be served
   B1. Community aspirations from the representatives (DPRD member)
   B2. Community aspirations from OPD
   B3. Include in RPJMD or RISPAM
   B4. Community aspirations from organized by MUSRENBANG
   C1. Planning cost
   C2. Material cost
   C3. Equipment cost
   C4. Labor cost
   D1. Geographical location
   D2. Economic activities
   D3. The health of community
4. Fourth Level, including:
   E1. Rural SPAM development in Jengglungharjo Village
   E2. Rural SPAM development in Pucanglaban Village

E3. Rural SPAM development in Talang Village
E4. Rural SPAM development in Keboireng Village
E5. Rural SPAM development in Tugu Village
E6. Rural SPAM development in Gondanggunung Village

C. Priority Determination

The initial stage of data processing is to enter data from an aspect comparison questionnaire obtained from 16 respondents with assessment weights. After calculating the comparison, the Consistency Ratio is then calculated by comparing the Consistency Index with the Random Consistency Index with the condition that it should not exceed a predetermined threshold. After all data are confirmed to be consistent, the geometric mean ($\overline{X}_g$) for each aspect pair is obtained.

D. Holistic Determination of the Priority of Alternatives

Determination of alternative priorities as a whole is the final conclusion of several main priorities obtained based on aspects and criteria. The weighting results for overall alternative selection priorities are presented in Table 4.

TABLE 4. Priority of alternatives

Alternative	Scale
Jengglungharjo Village (E1)	0.218
Pucanglaban Village (E2)	0.169
Talang Village (E3)	0.364
Keboireng Village (E4)	0.089
Tugu Village (E5)	0.058
Gondanggunung Village (E6)	0.102

Table 4 shows that alternative SPAM Development in Jengglungharjo Village (E1) has an overall weighing score of 0.218. Meanwhile, Pucanglaban Village (E2) obtained 0.169, Talang Village (E3) obtained 0.364, Keboireng Village (E4) obtained 0.089, Tugu Village (E5) obtained 0.058 and Gondanggunung Village (E6) 0.102. the results are then ranked to determine the highest priority for the construction site of the rural SPAM development (Table 5).

TABLE 5. Holistic determination of the degree of importance

Alternative	Scale	Rank
Talang Village (E3)	0.364	1
Jengglungharjo Village (E1)	0.218	2
Pucanglaban Village (E2)	0.169	3
Gondanggunung Village (E6)	0.102	4
Keboireng Village (E4)	0.089	5
Tugu Village (E5)	0.058	6

Based on Table 5, it can be seen that overall the third alternative (E3), namely the construction of SPAM in Talang Village has the largest scale, which is 36.4%. So, it can be said that the SPAM Development fund allocation can be prioritized for Talang Village first.

V. CONCLUSION

Based on the results, it can be concluded that the highest rank of alternative locations for the construction of rural drinking water supply systems (SPAM) in Tulungagung Regency was obtained by Talang Village (0.364), followed by Jengglungharjo Village (0.218), Pucanglaban Village (0.169), Gondanggunung Village (0.102), Keboireng Village (0.089) and Tugu Village (0.058).

VI. SUGGESTIONS

It is recommended to the stakeholders to draw up a plan for setting priorities for the development of drinking water supply systems in Tulungagung Regency by implementing clear, measurable and accountable mechanisms. In addition, local governments are advised to prioritize the allocation of funds for the development of drinking water supply systems by preparing larger funds in the following years. The availability and accessibility of drinking water will be very beneficial for improving the health and economic status of the community in Tulungagung Regency.

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