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Study on Sustainable PAMSIMAS Drinking Water Management Using the Rapfish Method in Tembalang District, Semarang City

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ABSTRACT:

This research analyzes the sustainability of the community-based drinking water supply system (*PAMSIMAS*) in Tembalang District, Semarang City, which includes three villages, namely Tembalang, Bulusan, and Jangli. Using a multidisciplinary approach through the Multidimensional Scaling (MDS) method with the help of Rapfish software, this study evaluates five key dimensions of sustainability: ecological, technological, social, institutional, and economic. The results showed variations in the level of sustainability in the three locations, with scores of 72.81 (Tembalang), 73.58 (Bulusan), and 73.86 (Jangli), respectively, which were classified as quite sustainable. Further analysis revealed that each village has a unique sustainability profile—Tembalang excels in ecological and social aspects but is weak in technology and economy, while Bulusan shows strength in the technological and institutional dimensions but needs improvement in the economic sphere. Through SWOT analysis, the study identifies several key strategies to improve system sustainability, including improving SOPs, strengthening institutions, and optimizing financial management. The findings of the research not only make a practical contribution to local *PAMSIMAS* managers but also offer an evaluation framework that can be applied to similar systems in other regions, while supporting the achievement of the Sustainable Development Goals (SDGs), especially in terms of equitable and sustainable access to clean water.

Keywords: PAMSIMAS; Rapfish Method; SWOT Analysis; Sustainability

INTRODUCTION

Water is an irreplaceable basic human need. In Semarang City, the provision of drinking water remains a challenge, especially in areas not served by the Regional Drinking Water Company (PDAM). This issue is exacerbated by rapid urbanization and climate variability that strain existing water infrastructure (Fitriani et al., 2022; Gunawan & Arifin, 2023). Currently, the clean water and sanitation program is included in the 2030 Agenda for Sustainable Development (SDGs), a global commitment adopted by the United Nations to ensure access to clean water and sanitation for all (United Nations, 2015; Murshed et al., 2021). This framework aims to promote social, economic, and environmental sustainability with principled development that meets present

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needs without compromising the ability of future generations to meet theirs (Khatri & Vairavamoorthy, 2019; Rahmawati & Pramudya, 2020; Wulandari & Suwondo, 2021).

Regarding clean water and proper sanitation, ensuring widespread access to safe and affordable water sources requires steps such as investing in supportive infrastructure development, providing necessary facilities, and encouraging the protection of water-related ecosystems—such as forests, mountains, swamps, and rivers—to reduce water scarcity. Sustainable water management must integrate ecosystem-based approaches with community-based infrastructure (Liu et al., 2020; Wichelns, 2015). Investments in resilient water infrastructure have been shown to improve water quality and access, particularly in underserved rural and peri-urban areas (Khalid et al., 2022; Abedin et al., 2021). Moreover, preserving natural ecosystems, including watersheds and wetlands, contributes significantly to maintaining the hydrological cycle and reducing risks of drought (Jalilov et al., 2018; Hagos et al., 2023). Efforts to improve sanitation must be aligned with policies that protect water resources and promote long-term sustainability (Assefa & Tadesse, 2019).

To meet the SDG targets by 2030, especially in Semarang City, urban residents primarily rely on water supply from PDAM. In contrast, areas not served by PDAM turn to the *PAMSIMAS* Program as an alternative solution that involves community participation in water resource management. However, the sustainability of this system still faces various challenges, notably in institutional and economic aspects (Bringezu et al., 2016).

The management of *PAMSIMAS* involves several critical steps to achieve sustainability: needs identification, planning, infrastructure development, community training and education, operational management, maintenance and repair, and evaluation monitoring to meet water needs in underserved areas. This is a significant challenge faced by many regions worldwide (Ahmad et al., 2022). Therefore, finding sustainable solutions to meet communities' drinking water needs through community-based water and sanitation programs like *PAMSIMAS* is essential. However, coverage of the community-based clean water supply system remains relatively low, affecting its sustainability. As stated by Deasi (2016), it is necessary to study the problems behind the low service coverage to achieve sustainable clean water.

In Tembalang District, several areas still rely on *PAMSIMAS* as their clean water source. Initially, the program was highly beneficial for the community in accessing clean water. Over time, however, not all residents from the three villages in Tembalang District have had their clean water needs fully met. The water problem is not just about quality but also concerns continuity and other service performance aspects. Hence, the *PAMSIMAS* development program in Tembalang District urgently needs improvement to meet clean water demands and achieve Millennium Development Goals (MDGs).

The community-based program built by the government to fulfill clean water needs is considered not fully successful because service problems remain, particularly related to the system or technical issues such as declining water quality and lack of water continuity during the dry season.

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Based on the above, especially to improve clean water services in Tembalang District, this study was conducted to analyze the sustainability of *PAMSIMAS* in Tembalang District from ecological, technological, social, institutional, and economic perspectives. The research area administratively consists of three villages participating in the *PAMSIMAS* program: Tembalang, Bulusan, and Jangli.

The objectives of this research are to evaluate the existing conditions of the *PAMSIMAS* provider system managed by water groups in Tembalang District, assess factors influencing its sustainability, and propose efforts for the sustainable development of this community-based clean water system. The results are expected to provide practical benefits for local governments and water groups in improving *PAMSIMAS* governance, support policy recommendations aligned with SDG targets, and offer a framework applicable to other regions with similar conditions. Thus, this research aims to strengthen *PAMSIMAS*'s role in realizing equitable and sustainable access to clean water in Tembalang District.

RESEARCH METHOD

The flow chart of this research can be seen in Figure 1.

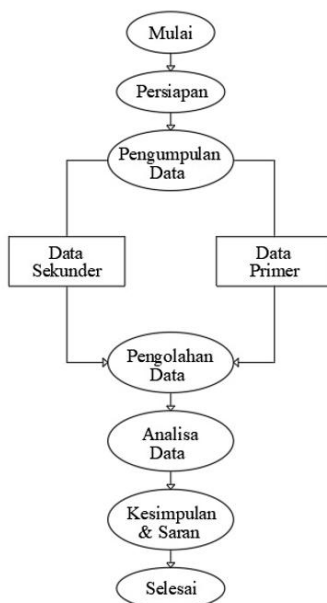


Figure 1. Research Flow Chart
Source: Researcher analysis, 2024

This study used a descriptive-analytical research type with a quantitative approach to evaluate the level of sustainability of the *PAMSIMAS* system in Tembalang District. This method was chosen to describe the existing conditions of community-based clean water supply systems while analyzing the factors that affected their sustainability.

Two types of data were collected in this study: primary and secondary data. Primary data were obtained through direct questionnaires administered to *PAMSIMAS* customers. Meanwhile,

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secondary data included rainfall data, water group financial reports, and other relevant information. The primary and secondary data collected were processed using the Multidimensional Scaling (MDS) method to assess and analyze the level of sustainability in each water group.

The research was conducted in three villages within Tembalang District, namely Tembalang Village, Bulusan Village, and Jangli Village. The map of the research location is shown in Figure 2.

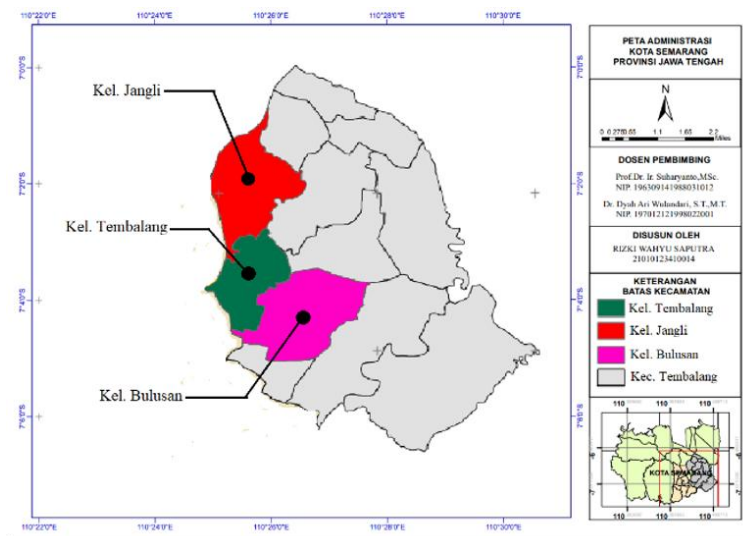


Figure 2. Research Location in Tembalang District

Source: Semarang City Public Works Office, 2023

The data collection method in this study is as follows.

1. Questionnaire or Questionnaire

Questionnaire or questionnaire is a data collection technique through a form that contains questions that are asked in writing to a person or a group of people to get answers or responses and information needed by researchers (Mardalis, 2008). This research uses questionnaires or questionnaires; the list of questions is made in a structured manner in the form of multiple choice questions. This method is used to obtain data on the perception of community-based clean water supply systems. The aspect of the questionnaire refers to previous research (Krismawati, A. D. 2016). Diponegoro University. Semarang." Which refers to the Ministry of Home Affairs No. 47 of 1999 concerning Guidelines for Performance Assessment of PDAM and the Ministry of Public Works BPPSPAM. 2010 Namely about PDAM Performance Assessment.

2. Documentation Method

The documentation method is data collection where researchers investigate written objects such as books, magazines, documents, regulations, and so on (Arikunto, 2002). This method is used to obtain data on population data, water group managers, topography, financing and data from related agencies.

Stages of data analysis were:

1. Sustainability Analysis of Berdih Water Supply System

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The analysis of the sustainability of the community-based clean water supply system was carried out using the Multidimensional Scaling (MDS) method using the Rapfish (Rap Appraisal for Fishery) software developed by the University of British Columbia Fisheries Center since 1998. . (Kavanagh, 2001.) The scoring of the sustainability attributes of the community-based clean water supply system is based on the provisions of the score range with the MDS technique.

2. Determining Dimensions and Attributes and Scoring

In determining the dimensions and attributes in the scoring used in the Multi Dimension Scaling analysis in this study, it refers to several studies that have been conducted or previous research (Krismawati, 2016)

3. SWOT Analyzer

In determining strategies for the sustainability of community-based clean water supply systems, this study uses SWOT (Strength, Weakness, Opportunity, Threats) analysis. The research variables used to determine the sustainability strategy of the community-based clean water supply system are sensitive attributes obtained from Leverage and Pareto analysis

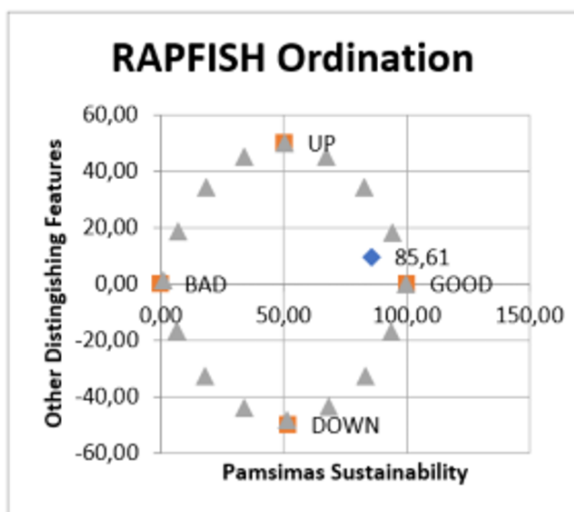
Sensitive attributes are then classified into internal factors (strengths, weaknesses) and external factors (opportunities, threats) which are then given weight and scale. The weights and scales are used to determine where each water group is located. So that from each of these positions, the right strategy can be determined to maintain and increase the sustainability of each water group.

RESULTS AND DISCUSSION

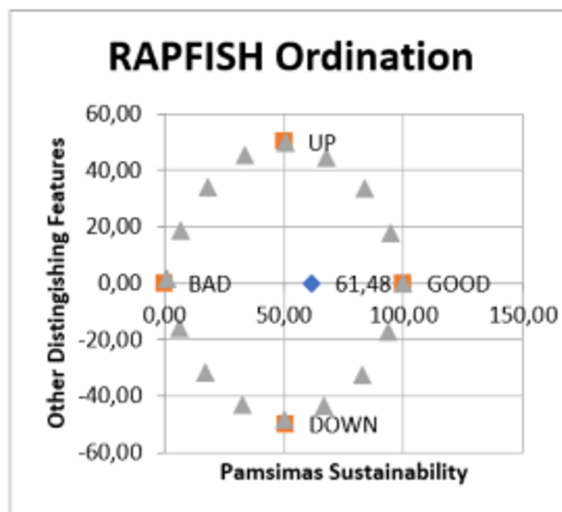
1. MDS Results on the Rapfish Method

Sustainability Status Based on Ecological Dimensions

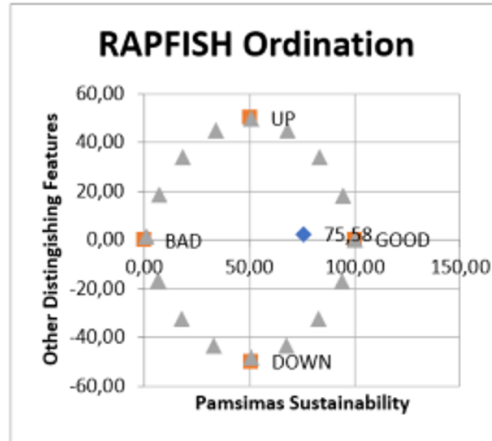
The results of the scoring research processed using Rapfish Software modifications based on ecological dimensions can be seen in Figure 3.



a. Tirta Tembalang Water Group



b. Tirta Bulusan Water Group



c. Tirta Jangli Water Group

Figure 3. Sustainability Status Based on Ecological Dimensions

Source: Rapfish data processing, 2024

From Figure 3, the results of the assessment using Rapfish Software modifications to 5 attributes of the ecological dimension show the sustainability status of each of these water groups. The status of sustainability is summarized in Table 1.

Table 1. Ecological Dimension Water Group Sustainability Status

No	Water Group	Value	Sustainability Status
1	Tirta Tembalang	85,6	Sustainable
2	Tirta Bulusan	61,5	Quite Sustainable
3	Tirta Jangli	75,6	Sustainable

Source: Questionnaire analysis, 2024

The scoring results in Table 1 show the sustainability value in the ecological dimension. In terms of ecological dimensions, the Tirta Bulusan Water Group has a status of "quite sustainable", meaning that the water group has been able to maintain and maintain water sources to meet customer needs for now, but there are several things that still need to be improved and improved to increase the sustainability index. The Tirta Tembalang Water Group has a "sustainable" status which means that the water group has been able to maintain and maintain water sources to meet the needs of clean water services for now and in the future.

Sustainability Status Based on Technology Dimensions

The results of the scoring research processed using Rapfish Software modifications based on the technological dimensions can be seen in Figure 4.

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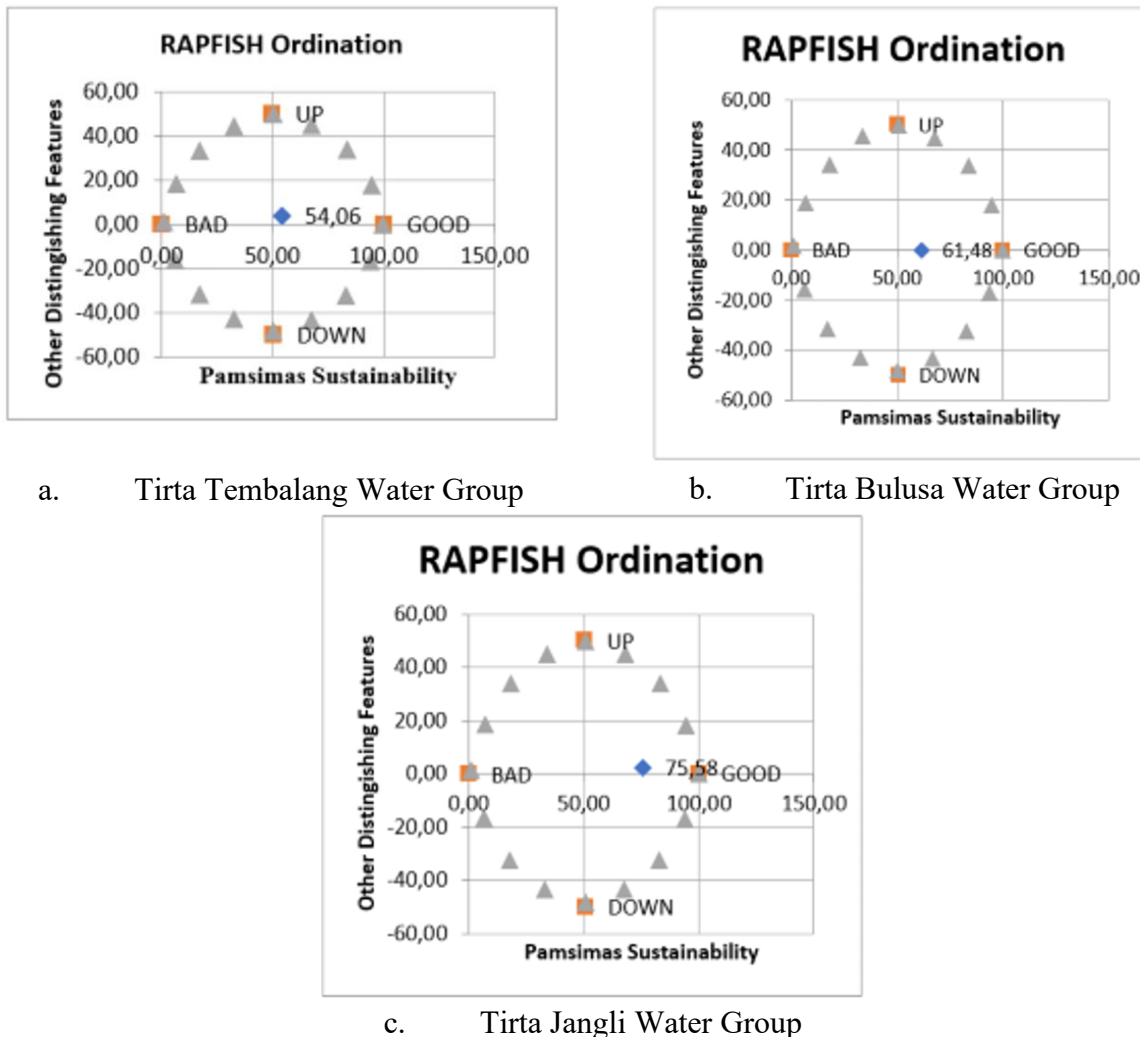


Figure 4. Sustainability Status Based on Technology Dimensions

Source: Rapfish data processing, 2024

From Figure 4, the results of the assessment using Rapfish Software modifications to 5 attributes of the technology dimension show the sustainability status of each of these water groups. The status of sustainability is summarized in Table 2.

Table 2. Sustainability Status of Water Group Technology Dimension

No	Water Group	Value	Sustainability Status
1	Tirta Tembalang	54,1	Quite Sustainable
2	Tirta Bulusan	74	Quite Sustainable
3	Tirta Jangli	77,8	Sustainable

Source: Document analysis, 2024

The scoring results in Table 2 show the value of sustainability in the Technology dimension. In terms of technological dimensions, the Tirta Tembalang Water Group and the Tirta Bulusan Water Group have a fairly sustainable status, which means that the water group has been able to

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provide facilities and infrastructure to support clean water services for now, but there are several things that still need to be improved. The Tirta Jangli Water Group has a sustainable status in the technological dimension, which means that the water group has fully met the sustainable criteria in the technological dimension and operates efficiently for a long period of time.

Sustainability Status Based on Social Dimensions

The results of scoring research processed using Rapfish Software modifications based on social dimensions can be seen in Figure 5.

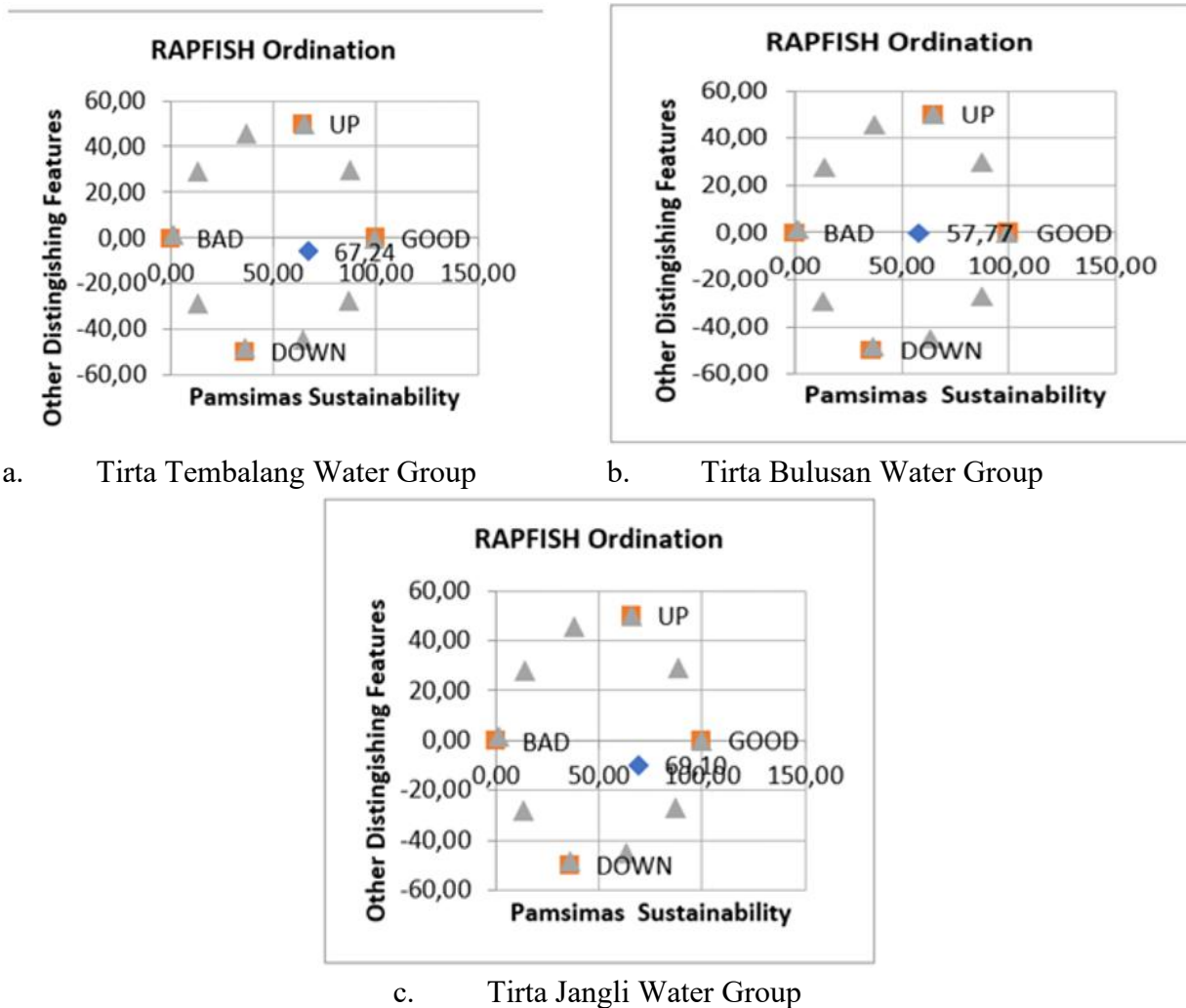


Figure 5. Sustainability Status Based on Social Dimensions

Source: Interview results, 2024

From Figure 5, the results of the assessment using Rapfish Software modifications to 5 attributes from the social dimension show the sustainability status of each of these water groups. The status of sustainability is summarized in Table 3.

Table 3. Sustainability Status of Water Groups Social Dimension

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No	Water Group	Value	Sustainability Status
1	Tirta Tembalang	82,4	Sustainable
2	Tirta Bulusan	72,7	Quite Sustainable
3	Tirta Jangli	67,1	Quite Sustainable

Source: Questionnaire analysis, 2024

The scoring results in Table 3 show the value of sustainability in the social dimension. In terms of social dimensions, the Tirta Tembalang Water Group has a "sustainable" status, which means that the water group has fully fulfilled the social aspect in carrying out services. The Tirta Bulusan Water Group and the Tirta Jangli Water Group have a status of "quite sustainable" which means that the water group has sufficiently met the social aspect in carrying out services, but there are several things that need to be improved again to increase the sustainability index.

Sustainability status based on institutional dimensions

The results of the scoring research processed using Rapfish Software modifications based on institutional dimensions can be seen in Figure 6.

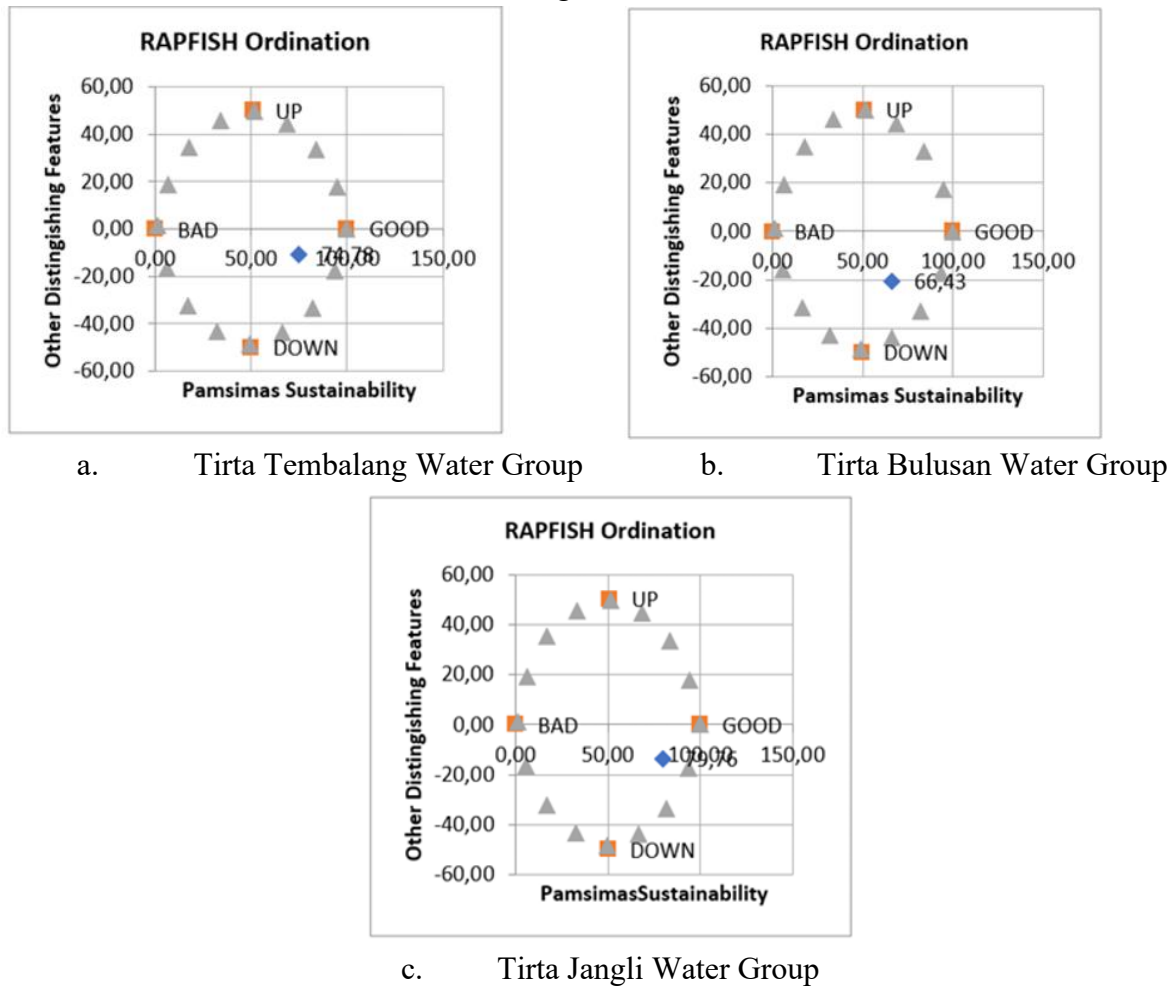


Figure 6. Sustainability status based on institutional dimensions

Source: AD/ART document analysis, 2024

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From Figure 6, the results of the assessment were obtained using Rapfish Software modification of 5 attributes from the institutional dimension showing the sustainability status of each of the water groups. The status of sustainability is summarized in Table 4.

Table 4. Institutional Dimension Water Group Sustainability Status

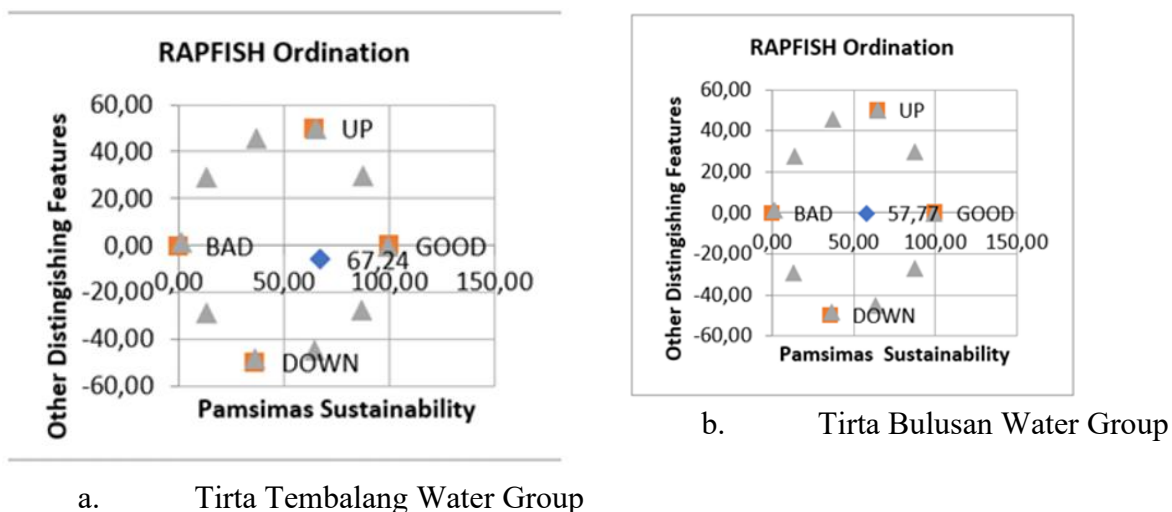
No	Water Group	Value	Sustainability Status
1	Tirta Tembalang	74,8	Sustainable
2	Tirta Bulusan	66,4	Quite Sustainable
3	Tirta Jangli	79,8	Quite Sustainable

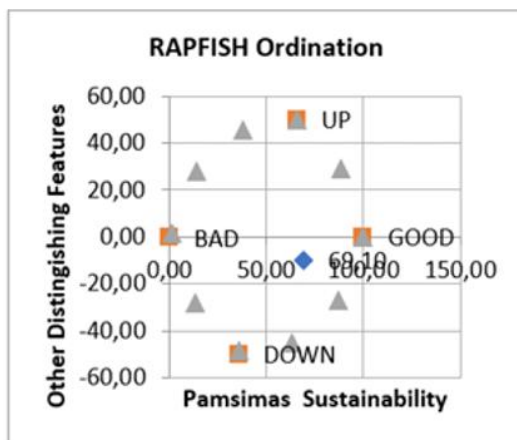
Source: Group financial statements, 2024

The scoring results in Table 4 show the value of sustainability in the institutional dimension. In terms of institutional dimensions, the Tirta Tembalang Water Group and the Tirta Bulusan Water Group have a status of "quite sustainable" which means that in running the organization it is quite effective and transparent, but fortunately to increase the sustainability index, the institutional dimension needs to make improvements in several things, for example the creation of the legality of water groups. The Tirta Jangli Water Group has a "sustainable" status, which means that in running the organization, the water group has met the sustainable criteria within the institutional scope.

Sustainability Status Based on Economic Dimension

The results of scoring research processed using Rapfish Software modifications based on economic dimensions can be seen in Figure 6.





c. Tirta Jangli Water Group

Figure 7. Sustainability Status Based on Economic Dimension

Source: Secondary data analysis, 2024

From Figure 7, the results of the assessment using Rapfish Software modifications to 5 attributes from the economic dimension show the sustainability status of each of these water groups. The status of sustainability is summarized in Table 5.

Table 5. Sustainability Status of Water Group Economic Dimension

No	Water Group	Value	Sustainability Status
1	Tirta Tembalang	67,2	Quite Sustainable
2	Tirta Bulusan	57,8	Quite Sustainable
3	Tirta Jangli	69,1	Quite Sustainable

Source: Operational report, 2024

The scoring results in Table 5 show the value of sustainability in the economic dimension. In terms of the economic dimension, the Tirta Tembalang Water Group, the Tirta Bulusan Water Group and the Tirta Jangli Water Group have a status of "quite sustainable" which means that PAMSIMAS' financial management is quite good and has a positive effect on the economy of customers, but it still needs to be improved to increase the sustainability index.

Of the 3 water groups studied, each water group as the manager of the community-based water supply system continues to strive to keep this clean water supply system running and functioning. However, in its management, each water group has advantages and disadvantages. The Tirta Tembalang Water Group has advantages in 3 dimensional aspects, namely the ecological, social and institutional dimensions and has shortcomings in the technological and economic dimensions so that the Tirta Tembalang Water Group gets an average score of 72.81 (quite sustainable) which means that the Tirta Tembalang Water Group has provided effective and long-term water services, but there are still some improvements needed in technological and economic aspects to increase the index sustainability of water groups. The Tirta Bulusan Water Group has advantages in 2 dimensional aspects, namely the technological and social dimensions and has shortcomings in the economic, ecological and institutional dimensions. so that the Tirta

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Bulusan Water Group gets an average score of 66.47 (quite sustainable) which means that the Tirta Bulusan Water Group has provided effective and long-term water services, but there is still some improvement needed in ecological, institutional and economic aspects to increase the sustainability index of the water group. The Tirta Jangli Water Group has advantages in 3 dimensional aspects, namely the ecological, technological and institutional dimensions and has shortcomings in the social and economic dimensions so that the Tirta Jangli Water Group gets an average score of 73.86 (quite sustainable) which means that the Tirta Jangli Water Group has provided effective and long-term water services, but there is still some improvement needed in social and economic aspects to increase the sustainability index water group.

Clarification of Attributes in SWOT

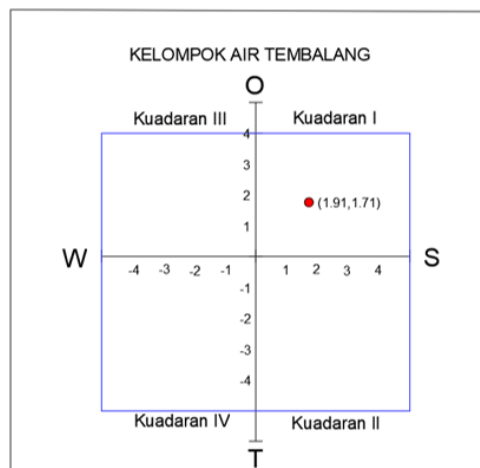


Figure 8. SWOT Matrix of Tirta Tembalang Water Group

Source: Researcher analysis, 2024

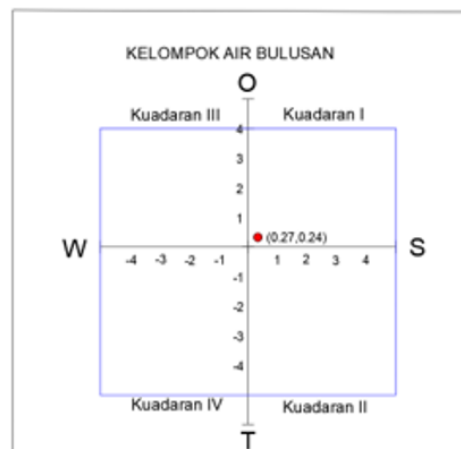


Figure 9. SWOT Matrix of Tirta Bulusan Water Group

Source: Researcher analysis, 2024

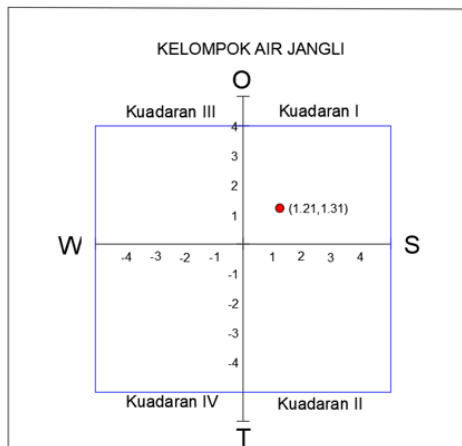


Figure 10. SWOT Matrix of Tirta Jangli Water Group

Source: Researcher analysis, 2024

The SWOT matrix of each group can be used to determine strategies to improve the sustainability of the community-based water supply system of each water group. After knowing the x and y points of each water group, it can be known where the position of each water group is from the matrix in Figure 8 to Figure 10.

Tirta Tembalang Water Group

From the matrix of Figure 8, the Tirta Tembalang Water Group is in Quadrant I (positive, positive), this position indicates a strong organization and has the potential to develop. The strategy recommendations given are defensive strategies, meaning that the internal condition of the organization is in a fairly good state. Therefore, organizations are advised to use defensive strategies, controlling internal performance so that it does not develop further. This strategy is maintained while continuing to strive to improve services.

Strategies that can be carried out by using the existing strengths in the Tirta Tembalang Water Group and taking advantage of opportunities by maintaining regular and timely water account billing as well as maintaining customer service for better service and maintaining and maintaining the clean water sources used. As well as improving the administrative system in water groups, namely by making Standard Operating Procedures, making organizational plans and budgets, and making internal or external reports regularly and on time. As well as to improve services, it can be by building cooperation with the local government and the private sector.

Tirta Bulusan Water Group

From the matrix of Figure 9, the Tirta Bulusan Water Group is in Quadrant I (positive, positive), this position indicates a strong organization and has the potential to develop. The strategy recommendations given are defensive strategies, meaning that the internal condition of the organization is in a fairly good state. Therefore, organizations are advised to use defensive

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strategies, controlling internal performance so that it does not develop further. This strategy is maintained while continuing to strive to improve services.

Strategies that can be carried out by using the existing strengths in the Tirta Bulusan Water Group and taking advantage of opportunities are to maintain the level of service to the community and maintain the maintenance of facilities and infrastructure that support water services to the community. In addition, the Tirta Bulusan Water Group does not yet have the legality of the water group, so in order to increase the sustainable index, it is necessary to make legality for the water group. As well as taking advantage of the enthusiasm of the community to support even better services

Tirta Jangli Water Group

From the matrix of Figure 10, the Jangli water group is in Quadrant I (positive, positive), this position indicates a strong organization and has the potential to develop. The strategy recommendations given are defensive strategies, meaning that the internal condition of the organization is in a fairly good state. Therefore, organizations are advised to use a defensive strategy, control internal performance to maintain service stability and strive to improve services.

Strategies that can be carried out by using the existing strengths in the Tirta Jangli Water Group and taking advantage of opportunities by maintaining the level of service to the community and maintaining the maintenance of facilities and infrastructure that support water services to the community. In addition, the Tirta Jangli Water Group does not yet have the legality of the water group, so in order to increase the sustainable index, it is necessary to make legality for the Tirta Jangli Water Group. As well as taking advantage of the enthusiasm of the community to support even better services.

CONCLUSION

Based on the research and data analysis, the Tirta Tembalang Water Group demonstrated strengths in ecological, social, and institutional dimensions but faced challenges in technological and economic aspects, resulting in an average sustainability score of 72.81, categorized as fairly sustainable. The Tirta Bulusan Water Group excelled in technological and social dimensions but lagged in economic, ecological, and institutional areas, with a slightly lower sustainability score of 66.47, also fairly sustainable. Tirta Jangli Water Group showed advantages in ecological, technological, and institutional dimensions but weaknesses in social and economic ones, achieving the highest average score of 73.86 within the fairly sustainable range. Overall, ecological, technological, and social dimensions displayed moderate sustainability, while institutional and economic dimensions were comparatively weaker. Key strategies to enhance sustainability included establishing and effectively implementing standard operating procedures (SOPs) and organizational bylaws (AD/ART), ensuring active management participation, regular water billing to cover operational costs, and timely internal reporting. For future research, it is suggested to explore innovative economic and institutional models that can strengthen financial viability and

governance structures, as well as to assess the long-term impact of these strategies on sustainability across diverse community-based water systems.

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