www.bircu-journal.com/index.php/birci
Budapest International Research and Critics Institute-Journal (BIRCI-Journal)
Humanities and Social Sciences
ISSN 2615-3076 Online)
ISSN 2615-1715 (Print)
Budapest Institute

Performance Improvement Strategy Sustainable Domestic Wastewater Treatment Installation (Case Study: Sanimas Neglasari Village, Sayati Village and Cipaku Village, Bandung Regency)

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Abstract

The West Java Provincial Government has inaugurated a community-based sanitation program in 18 Bandung districts. Especially in the Citarum river basin, domestic waste contributes 68% to river pollution and has a water quality status for the last 10 years, showing 54% heavily polluted, 23% moderately polluted, 20% lightly polluted and only 3% meet the quality standards. . Efforts to improve the control of domestic wastewater pollution require the selection of technology which is influenced by many factors, so a theoretical and practical approach is needed that pays attention to the sustainability aspect. Neglasari Village, Banjaran Sub-district, Sayati Village, Margahayu Sub-district and Cipaku Village, Paseh Sub-district, are sub-districts in Bandung Regency that have implemented the Sanimas program that has not met the muku standard so that it is necessary to improve the performance of a sustainable Sanimas wastewater treatment plant. Of the three locations of the Sanimas wastewater treatment plant spread from upstream of the river, the location of the Sanimas wastewater treatment plant is in a densely populated area and an area prone to sanitation, also has a need for handling sanitation problems. This research was conducted using the SWOT method. SWOT analysis is carried out to obtain priority strategy recommendations.

Keywords
wastewater treatment plant; sustainability; sanimas; SWOT

I. Introduction

Indonesia's access to proper sanitation in 2020 is 79.53% (Pokja PPAS, 2021). This is dangerous for the environment and public health because many people still use groundwater as a source of clean water for washing and cooking needs. The rapid growth of Indonesia's population, especially in urban areas, has a serious impact on the decline in the carrying capacity of the environment. These impacts must be handled appropriately, especially in wastewater management. Disposal of domestic wastewater has a very large impact on the environment, waste water disposal without going through a processing process will result in environmental pollution of raw water sources for drinking water, both surface water and ground water. River pollution in urban areas, more than 60% comes from domestic activities, partly because the local WWTP system that dominates residential areas has not been effective in meeting effluent quality standards. Domestic wastewater infrastructure, especially the communal scale or settlement scale, has been built with various treatment systems, but some have not met the quality standards of the LHK

DOI: *https://doi.org/10.33258/birci.v5i3.6839*

Ministerial Regulation No. 68 of 2016. This can result in pollution and a decrease in the quality of the residential environment. In addition, the generation of sludge or biosolids from the degradation of organic matter from the WWTP has not been managed regularly, resulting in decreased processing performance and safe access has not been achieved. The development of the Sanimas WWTP system has begun to be carried out in stages since the enactment of the LHK effluent quality standard no.68 of 2016 and a sustainability study is needed. As for the WWTP system that was built before the enactment of the quality standard, it requires efforts to improve performance according to various processing units. Organization must have a goal to be achieved by the organizational members (Niati et al., 2021). The success of leadership is partly determined by the ability of leaders to develop their organizational culture. (Arif, 2019).

The West Java Provincial Government has inaugurated this Sanimas program in 18 Bandung regencies. Neglasari Village, Banjaran District, Sayati Village, Margahayu District, and Cipaku Village, Paseh District, are sub-districts in Bandung Regency that have implemented the Sanimas program. Improving the performance of domestic wastewater treatment plants with the application of additional technology is one of the efforts to manage wastewater that has a positive impact if accompanied by the right strategy. In this study, the appropriate strategy for sustainable domestic wastewater management will be defined. Analysis of domestic wastewater performance strategy is assessed based on technical aspects, economic aspects, community participation aspects, institutional aspects and environmental aspects.

II. Review of Literature

2.1 Hypotheses

The hypothesis of this study is that the application of additional technology can improve the performance of the Sanimas domestic wastewater treatment plant.

2.2 Description of The Study Area

The study area in this research is Neglasari Village, Banjaran District, Sayati Village, Margahayu District and Cipaku Village, Paseh District. The location and condition of the existing Sanimas IPAL infrastructure, Neglasari Village, Banjaran Subdistrict, Sayati Village, Margahayu Subdistrict and Cipaku Village, Paseh Subdistrict are shown in Figure 1, Figure 2 below:

***Figure 1**. Sanimas Building, Neglasari Village, Banjaran Subdistrict*

Sanimas IPAL, Neglasari Village was built in 2018 and officially operated in 2019. The Sanimas IPAL in Neglasari Village is located in Citeureup Village, Neglasari Village, Banjaran District, Bandung Regency. The land status of Sanimas WWTP in Neglasari Village is a grant from residents with an area of 45 m2, while the building area is about 33 m2. The distance from the Sanimas WWTP in Neglasari Village to the river body is 5 m,

while the nearest settlement is 10 m. The Sanimas IPAL in Neglasari Village was built with APBN funds by the West Java Provincial Settlement Infrastructure Center. The handover of assets and management of the Sanimas IPAL has been handed over from the West Java BPPW to the village. Currently, the Sanimas IPAL in Neglasari Village serves 70 families or 300 people. The WWTP Sanimas Desa Neglasari uses an Anaerobic Filter with the media it uses comes from used bottle packaging. The Sanimas WWTP in Neglasari Village is managed by 1 active KPP manager who is in charge of maintaining the WWTP, checking every tub in the WWTP, cleaning dirt that causes clogging of the processing unit and checking control tubs around house connections.

Figure 2. *The Sanimas Building in Sayati Village, Margahayu Sub*

IPALSayati Village, was built in November 2020 and will start operating in 2021.Sanimas built on grant land owned by residents and cultivates 22 families. IPAL Sanimas treats gray water and black water. Problems that occur in the WWTPSanimas Desa Sayati include social problems because there are pro and contra parties regarding the acceptance of IPAL, there are people who don't want to install grease traps, there is still a lot of garbage that goes to IPAL and there is no submission from KSM to KPP. Meanwhile, from the technical aspect, the problem with the WWTP in Sayati Village is outletis clogged and during the rainy season, the flow of water from the WWTP returns to the WWTP because the river flow is getting heavier. MCK and Sanimas IPAL, Cipaku Village, built in 2016 with Biofilter technology. The number of users of MCK and IPAL in Cipaku Village is 20 families waste gray water and black water.

The physical condition of the Sanimas MCK and IPAL in Cipaku Village showed damage to pipes, ceramics, walls, and manhole. The flow of water in the WWTP treatment unit is also not running smoothly. Problems that occur in the WWTP in Cipaku Village, among others, there is still a lot of waste entering the WWTP, the height of the mud is more than 1/3 compartment, the location of the WWTP cannot be accessed by faecal trucks, KPP requires a mud pump and it is difficult for the community to pay regular fees.

The location of the Sanimas WWTP is in the range of the Village category to the Big City, so that its domestic clean water needs are in the range of 60 liters/person/day - 120 liters/person/day. The use of clean water for the three Sanimas WWTPs surveyed is in the range of 60 liters/person/day - 120 L/person/day.

2.3 Performance of Sanimas WWTP

Based on the survey results of the three Sanimas WWTPs from upstream, Table 1. describes the system and performance of the treatment plant applied to the WWTP Sanimas.

Table 1. Sanimas IPAL Performance

No	Parameter	Existing Condition		
		Neglasari	Village Sayati	Village Cipaku Village
1	Type of treatment system	Anaerobic	Biofilter Anaerobic Biofilter - Aerobic	Anaerobic Baffled Reactor - Anaerobic Filter
2	Treatment unit volume	90 m	50 m^3	60 m^3
3	Organic load (kg BOD 5/m^3 day)	6.2	16.8	19.73
4	Hydraulic load (m^3/m^2.day)	0.130	0.095	0.052
5	Detention time (days)	32	2	8

2.3 Quality of Efluent and Influent WWTP Sanimas

Sampling of influent and effluent quality of WWTP Sanimas is conducted to identify and select technology processing can be done more carefully and on target. Table 2. shows the results of sampling and testing the quality of the effluent and influent of the three Sanimas WWTPs surveyed.

Table 2. Quality of Effluent and Influent WWTP

No	Parameter	Quality Standard	Existing Condition		
			L1	L2	L3
Influent Quality Testing					
1	Physical Condition		Liquid Brownish	Cloudy	Liquid
2	pH		6.47	6.97	6.89
3	COD (mg/L)		195	433	245
4	BOD (mg/L)		200	300	148
5	NH_3 (mg/L)		> 20	> 10	> 20
6	TSS (mg/L)		248	127	198
Effluent Quality Testing					
1	Physical Condition		Cloudy	Liquid Cloudy	Liquid
2	pH	6 - 9	7.03	6.99	8.07
3	COD (mg/L)	100	57	186*	131.18*
4	BOD (mg/L)	30	90*	100*	49.13*
5	NH_3 (mg/L)	10	> 20*	> 10*	5,236*
6	TSS (mg/L)	30	45*	42*	50*

**Description: Parameter exceeds the quality standard PERMEN LHK No. 68 Year 2016*

Source: DLH Laboratory Test Results Bandung Regency

Information:
L1 = Sanimas Neglasari, Bandung Regency
L2 = Sanimas Sayati, Bandung Regency
L3=Sanimas Cipaku, Bandung Regency

III. Research Method

The methodology in this research is to study literature, collect secondary data and primary data, data processing, results and conclusions. The scope of the research area is in the Bandung Regency area in 3 (three) villages, including: Neglasari Village, Sayati Village and Cipaku Village which were built with Sanimas facilities. The scheme of the research methodology can be seen in Figure 4.

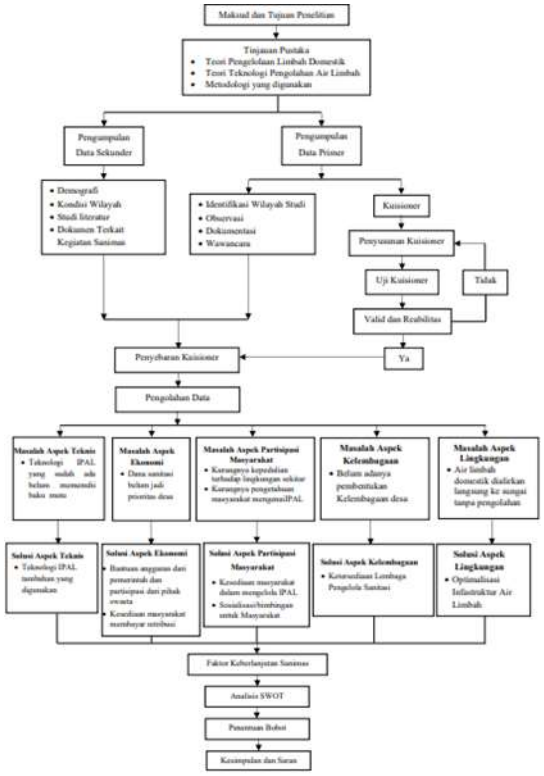

***Figure 3**. Research Flowchart*

This research is intended to determine the variables that affect the sustainability of sanitation infrastructure utilization in Neglasari Village, Sayati Village and Cipaku Village, Bandung Regency, to determine the indicators that have the highest contribution to explain each -each variable in this study and to develop strategies that can be developed in an effort to sustain the use of sanitation infrastructure in Neglasari Village, Sayati Village and Cipaku Village, Bandung Regency. First, the researcher identifies the problems that will be discussed in this study and then formulates the research objectives, conducts field observations to find out the existing conditions of the research object. Next, look for literature studies related to the research to be carried out and determine the variables that will be used as indicators of the sustainability of the sanitation infrastructure utilization.

3.1 Data Collection

In this study, the sampling technique used was cluster sampling. The required sample size is calculated using the Yamane equation where the Yamane equation is as follows.

$$n = \frac{N}{1 + Ne^2}$$

n = Sample size
N = Population size
e = Margin of error

Based on the data obtained, the number of family heads in Neglasari Village is 120 households, Sayati Village is 134 households and Cipaku Village is 176 households. So, based on the calculation of the Yamane formula, the number of samples from Neglasari Village, Sayati Village and Cipaku Village, Bandung Regency is 82 families.

3.2 Data Processing

Data processing consists of qualitative analysis and quantitative analysis. Qualitative analysis is used to determine the company's environment such as strengths, weaknesses, opportunities, and threats faced by the company and the SWOT matrix. Quantitative analysis was used for the IFAS matrix, EFAS matrix, and SWOT Quadrant matrix. The quantitative data was processed using Microsoft Excel.

IV. Result and Discussion

4.1 Analysis of The Existing Condition of Sanitation Management

An analysis of the existing condition of sanitation at the research site is needed to obtain an overview of the existing condition of the system used by the community and identify or identify problems that are still found in the research location related to the condition of sanitation management. The analysis of the existing condition of sanitation in this study includes the condition of domestic wastewater management and the condition of clean water facilities and infrastructure. The description of the condition of domestic wastewater management and the condition of the clean water infrastructure and facilities is shown in Figure 4 and Figure 5.

***Figure 4**. Graph of the condition of wastewater*

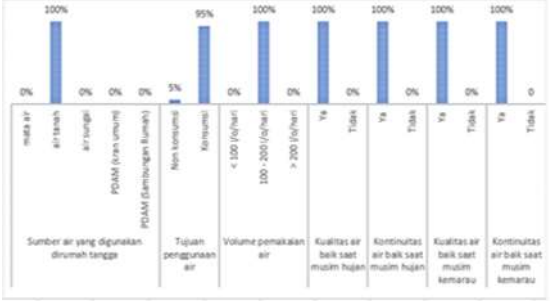

***Figure 5.** Graph of the condition of clean water facilities and infrastructure*

4.2 Identification of Sanimas WWTP System Development Factors

From the surrounding environmental conditions IPAL and according to the Sanimas Technical Guidelines for 2021 issued by the Sanitation Directorate of the Ministry of Public Works and Public Housing, the Sanimas IPAL is designed to serve a minimum of 70 families, while for MCK and Sanimas IPAL it is designed to serve a minimum of 25 families. Of the three Sanimas WWTP locations surveyed from upstream of the Citarum watershed, the MCK and Sanimas WWTPs, Cipaku Village, had users who did not meet the design criteria. This could be due to the fact that the Sanimas MCK and IPAL in Cipaku Village were built in 2016 and the Sanimas IPAL in Sayati Village, which was built in 2020, is currently having fewer users because the people around the MCK and IPAL already have their own toilets at home. Meanwhile, the other Sanimas MCK and IPAL, namely Neglasari Village IPAL, have met the design criteria for Sanimas IPAL users. The next design criteria for the Sanimas WWTP is the type of wastewater treated by the Sanimas IPAL which is expected to treat mixed wastewater, black water and gray water.

The third beneficiaries of the Sanimas WWTP surveyed are Low-Income Communities (MBR), which will be the chosen location according to the 2021 Sanimas Technical Guidance Guidelines issued by the Sanitation Directorate of the Ministry of Public Works and Public Housing in one location and environmental conditions, namely, Sanimas IPAL in Neglasari village, District Banjaran Regency of Bandung.

4.3 Sanimas WWTP Development Plan

a. Technical Aspects

The results of the Sanimas WWTP effluent quality test in Neglasari village still do not meet the quality standards for wastewater effluent quality, which refers to PERMEN LHK No. 68 of 2016, the parameters that still do not meet the quality standards include TSS, BOD5, and Ammonium. For this reason, with a strategy to improve the performance of sustainable wastewater treatment plants, the right technology can be selected and applied to reduce the pollutant load so that the quality standards of wastewater effluent can be met. However, in addition to the non-fulfillment of quality standards for wastewater effluent, the following problems are encountered in the Neglasari Village WWTP:

1. Some of the biofilter media are cracked and destroyed so that the manager takes out about 5 liters of media every month. The
2. service sub-system is not equipped with a grease trap, while many houses sell food or processed food.
3. Requires local sludge treatment facilities because dung trucks are difficult to access the location
4. Biofilter media (plastic bottles) liquefy quickly
5. Cleaning equipment and slurry pumps are not yet available.
6. Sustainability of WWTP management is in danger of not being managed due to mindset that WWTP does not provide benefits to them.

Seeing the problems that occurred in the Sanimas WWTP in Neglasari village, the technology development plan needed at the Sanimas WWTP in Neglasari village, among others:

1. Partial replacement of biofilter
   Media Replacement of biofilter media from used drinking bottle packaging into manufacturing media in the form of plastic rocks can be seen in Figure 6 and Figure 7.

Figure 6. *Existing biofilter media from used bottles*

Figure 7. *Biofilter media for plastic coral type manufacturer*

2. Addition stirrer
   The addition stirrer in the first tank is intended to equalize the flow and load of wastewater before entering the physical treatment so that the installation treatment process can be carried out with an even and better load. Details stirrer placement stirrer can be seen in Figure 8 and Figure 9.

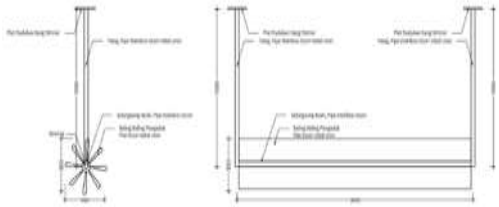

Figure 8*. Stirrer details*

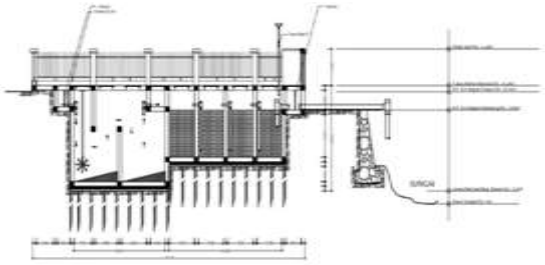

Figure 9. *Placement of stirrer in the WWTP unit*

3. Addition of a disinfectant system
   System that will be applied at the Sanimas WWTP in Neglasari Village is eco-disinfection using chlorine and diesel disinfection. can be seen in Figure 10 and Figure 11

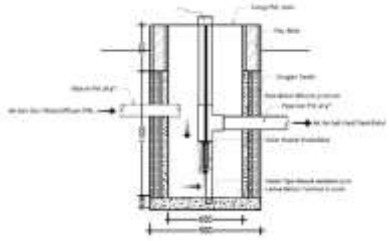

Figure 10. *Sistem desinfeksi solar*

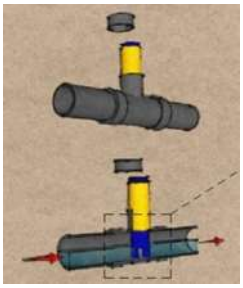

Figure 11.

4. Safe garden for food crops
   To improve the economic aspect and community empowerment with the aim of sustaining the operation and maintenance of the Sanimas WWTP, safe garden for food crops on vacant land beside the Sanimas WWTP can be seen in Figure 12.

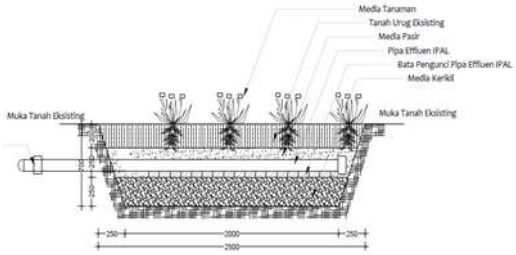

Figure 12. *Infiltration plants or safe garden*

b. Aspects of Institutional

In order to ensure the smooth and continuous use of the results of the development of technology development activities in the sanitation sectorSanimasfor the domestic wastewater WWTPBeneficiary and Maintenance Group (KPP) which was formed at the beginning of the construction of theSanimas.organizational structure can be seen in Figure 13.

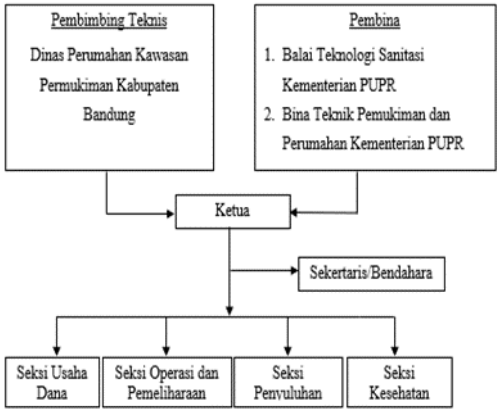

***Figure 13**. Organizational Structure of KPP IPAL Sanimas Neglasari Village*

c. Aspects of Community Participation

Overall, community involvement in the implementation of the Sanimas program is the subject (main actor). The target community conducts a situation analysis by raising the social conditions of the target community, raises the need for problems in sanitation conditions, for planning activities to improve sanitation facilities. The community assistance process is planned to follow the activity stages, which can be seen in Table 3 below

Table 3. Community assistance in service areas

Stage	Topic	Participants	Output
Preliminary Survey	Identification of problems	WWTP management Sanimas and the community	1. Onsite influent and effluent testing , 2. Level of understanding, awareness of healthy living
Land Preparation	Consolidation with land owners	Community (land owners)	Readiness to manage by KSM
Data Collection community	Interviews with managers and community users	of Sanimas IPAL Manager and Neglasari village community	Recap of questionnaires
Residents Meeting	Socialization of residents of	Sanimas Neglasari WWTP Manager and communities in service areas	1. Waste water 2. materials Technology materials performance improvement WWTP 3. Simple water quality monitoring practice
Education	, Assistance in WWTP operation and maintenance WWTP	manager Sanimas Neglasari and the community in the service area	New management, SOP, simple water testing practice
	Wastewater Treatment Technology	WWTP Manager Sanimas Neglasari	Hydroponic practices and *safe garden*

d. Economic Aspects Economic

Investment analysis is important to know, to provide an overview of the benefits of investment activities. This investment analysis uses Benefit Cost Ratio (BCR) analysis. The calculation of the BCR analysis can be seen in Table 4.

Table 4. Investment analysis with BCR analysis calculations

No.	Data Description of	WWTP Neglasari, District Banjaran	IPAL Sayati, Sub-district Margahayu	IPAL Cipaku, District Paseh
1	Performance of WWTP Unit	Housing	Housing	Housing
	Number of Services	70 SR	22 SR	20 SR
2	Expenditures			
a	Electricity	1,200,000	1,200,000	1,200,000
b	Disinfectant Capsules	600,000	300,000	300,000
c	Maintenance Costs (accessories and pumps)	600,000	600,000	600,000
d	Wage for WWTP Maintenance	2,400,000	2,400,000	2,400 .000
e	Wages for	Gardening 1,200,000	1,200,000	1,200,000
f	Purchase of Vegetable Seeds	115,000	115,000	115,000
g	Hydroponic Equipment	310,000	310,000	310,000
	Cost	6,425,000	6,125,000	6,125,000
3	Income			
a	Citizens' Fee	6,000,000	-	1,800,000
b	Sales of Garden	Products 1,975,000	1,975,000	1,975,000
	Benefit	7,975,000	1,975,000	3,775,000
4	*Benefit Cost Ratio*	1,24	0,32	0,62

e. Economic Aspects Economic

Prior to the WWTPSanimasby domestic wastewaterpolluted which was discharged into drains without treatment. However, after the IPALSanimas , the condition of the residents' wells will be clean and odorless.

4.3 Swot Analysis A Swot

Analysis for the sustainable use of Sanimas infrastructure in Neglasari village can be seen in Table 5, Table 6, Table 7 and Table 8 below.

Table 5. IFAS (Internal Factor Strategies) – Strengths

No	Strategic Factors	Weight	Branches	Score
1	There is a willingness of managers to play an active role	0.154	3.7	0.570
2	Adequate technical staff capability	0.138	3.6	0.497
3	Managers have participated in training to increase their knowledge about sanitation	0.140	3.7	0.518
4	Availability of personnel who have expertise in dealing with damage in the field	0.129	3.5	0.452
5	The selected technology is in accordance with the ability to manage in maintenance and repair	0.147	3.6	0.529
6	The selected technology is technology that is easy and inexpensive to operate and maintain	0.149	3.8	0.566
7	Community involved in technology selection	0.143	3.5	0.501
Total				**3,632**

Table 6. IFAS (Internal Factor Strategies) - Weaknesses

No	Strategic Factors	Weight	Branches	Value
1	Manager lacks the ability in managing finances	0.166	2.20	0.365
2	Performance reporting and financial management has not been running	0.168	2.50	0.420
3	The community has not been disciplined in paying dues	0.170	2.10	0.357
4	Operational and repair costs have not fully come from contributions	0.165	2.40	0.396
5	There is no financial benefit from the management of Sanimas	0.162	3.70	0.599
6	There is no periodic replacement of managers	0.169	2, 10	0.355
Total				**2,493**

Table 7. EFAS (External Factor Strategies) - Opportunity

No	Strategic Factors	Weight	Branches	Score
1	High community participation in the planning stage	0.160	3.5	0.544
2	High community participation in the development stage	0.161	3.5	0.564
3	Community participation high in the operation and maintenance stage	0.168	3.7	0.622
4	Wastewater management has an influence on improving the quality of public health	0.169	3.6	0.608
5	There is a change in the environment to be clean and healt	0.168	3.7	0.622
6	There is public awareness not to dispose of their waste water carelessly	0.170	3.8	0.646
7	Increasing public knowledge about clean and healthy living behavior t	0.172	3.7	4,242
Total				**0.636**

Table 8. EFAS (External Factor Strategies) - Threat

No	Strategic Factors	Weight	Branches	Score
1	Community income in low-income areas does not fully support the sustainability of Sanimas	0.162	2.4	0.389
2	Lack of community willingness to pay contributions	0.163	3.3	0.538
3	Not fully developed Sanimas infrastructure based on community demand	0.172	2.5	0.430
4	Public trust in Sanimas managers is not good	0.162	2.8	0.454
5	training assistance for managers from local government	0.166	3.1	0.515
6	Lack of funding from the private sector to Sanimas infrastructure development	0.175	2.4	2.745
Total				**Based**

On the results of the SWOT scoring the following scores were obtained:

a. IFAS
- Strength (S) score is 3.632
- Weakness score (W) is 2.493
- X axis is strength - weakness
  = 3.632 - 2.493 = 1.140

b. EFAS
- Opportunity score (O) is 4.242
- Threat score (T) is 2.745
- Y axis is opportunity - threat
  = 4.242 - 2.745 = 1.497

D From the results of the SWOT analysis, to improve the sustainability of the utilization of Sanimas infrastructure, Neglasari Village, Banjaran District, alternative I can be used, namely development (aggressive strategy), with Stable Growth Strategy , namely a stable growth strategy where development is carried out in stages and targets are adjusted to existing conditions. The SWOT diagram can be seen in Figure 14.

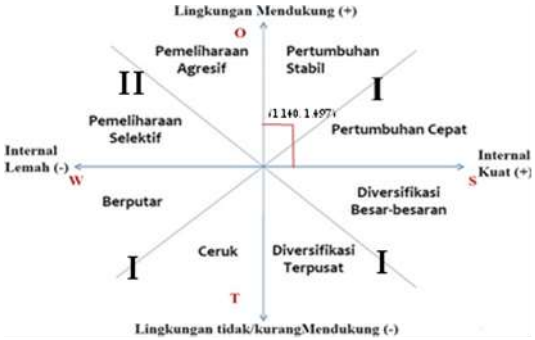

Figure 14. *SWOT Diagram*

V. Conclusion

From the results of the SWOT analysis, namely IFAS (Internal Factor Strategies) and EFAS (External Factor Strategies), the strength 1,140 and the competitive 1,437. The position of the value is in quadrant I (first) of the second space. The recommended alternative strategy is an aggressive strategy or an SO strategy. The proposed strategy includes the provision of training by the Regional Government to gradually increase the capacity of Sanimas managers and the addition of Sanimas infrastructure to improve the quality of the environment to be cleaner and healthier.

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