Prepublished copy

Nature Environment & Pollution Technology

This is a peer-reviewed prepublished version of the paper

Evaluating the Impact of Community Attitudes on the Sustainability of 3R Temporary Waste Disposal Sites Using Structural Equation Modeling-Partial Least Square (SEM-PLS) in Sukoharjo

Wahyu Kisworo[1], Sapta Suhardono[1*], Irfan AN[1], I Wayan Koko Suryawan[2]

[1] Department of Environmental Sciences, Faculty of Mathematics and Natural Sciences, Universitas Sebelas Maret, Surakarta, 57126, Indonesia

[2] Department of Environmental Engineering, Faculty of Infrastructure Planning, Universitas Pertamina, Jakarta Selatan 12220, Indonesia

** Corresponding author's e-mail: sapta.suhardono@staff.uns.ac.id*

ABSTRACT

In 2023, the waste management situation in Sukoharjo showed a combination of achievements and difficulties. Out of the 12 Temporary Waste Disposal Sites with 3R (Reduce, Reuse, Recycle) facilities, only 4, including Temporary Waste Disposal Sites with 3R (Temporary Waste Disposal Sites 3R) Anugrah Palur, were functioning at their best. This study examines the factors that impact the establishment and long-term viability of these facilities, employing a combination of research methods that incorporates RAP-Temporary Waste Disposal Sites 3R analysis, partial least squares (SEM-PLS), observations, and interviews. The results emphasise that attitude is the most influential component in supporting the growth of Temporary Waste Disposal Sites with 3R, as indicated by a p-value of 0.000. On the other hand, knowledge (0.052) and behaviour (0.279) are identified as the least important aspects that hinder the development. The Temporary Waste Disposal Sites with 3R has an overall sustainability rating of 72.79, which classifies it as 'very sustainable.' The environmental component achieved a score of 79.54, the social dimension scored 72.88, the management and infrastructure dimension scored 71.30, and the economic dimension scored 65.44. These findings emphasise the crucial importance of community attitudes in promoting sustainable waste management practices. They also highlight specific areas that can be improved to enhance the effectiveness and sustainability of Temporary Waste Disposal Sites with 3R facilities.

Key Words	Temporary Waste Disposal Sites, SEM-PLS, RAP-Temporary Waste Disposal Sites 3R, Sustainability
DOI	https://doi.org/10.46488/NEPT.2025.v24i02.D1702 (DOI will be active only after the final publication of the paper)
Citation of the Paper	Wahyu Kisworo, Sapta Suhardono, Irfan AN, I Wayan Koko Suryawan, 2025. Evaluating the Impact of Community Attitudes on the Sustainability of 3R Temporary Waste Disposal Sites Using

	Structural Equation Modeling-Partial Least Square (SEM-PLS) in Sukoharjo . *Nature Environment and Pollution Technology*, 24(2), D1681. https://doi.org/10.46488/NEPT.2025.v24i02.D1681

INTRODUCTION

The topic of waste management has been identified as a significant concern for both Indonesian and worldwide society. The issue of waste management is a multifaceted and significant one that confronts numerous countries, encompassing both emerging and industrialised nations. The garbage issue in Indonesia remains unresolved, although the growing population has led to an increase in the amount of waste produced from human activities (Purwaningrum, 2016). The projected waste generation in Indonesia for the year 2022 is estimated to be 35,289,535 tonnes per year. This figure is based on information collected from 299 districts and cities, as reported by SIPSN KLHK in 2023. The burgeoning human population and urbanisation have resulted in a consistent rise in the quantity of waste generated. The management of garbage varies among established and developing countries, urban and rural groups, and residential and industrial producers (Demirbas, 2011). The global population's demographic mix is undergoing rapid changes and is still expanding. Rapid urbanisation is taking place globally, primarily in small and midsized cities located in low-income nations, as reported by Sun et al. (2020). Population expansion, economic development, urbanisation, and higher living conditions are the main factors contributing to the significant rise in waste generation and the subsequent socio-economic and environmental problems (Malinauskaite et al., 2017).

Municipal solid waste (MSW) refers to the waste generated from many sources such as homes, businesses, schools, workplaces, and retail enterprises. Examples of these wastes include cardboards, newspapers, cartons, fruits, vegetables, furniture, leftover food, papers, clothing, organic material, as well as non-renewable items such as plastic containers and tin. Municipal solid waste (MSW) refers to any materials that are discarded, unnecessary, and abandoned due to societal and daily activities. Municipal solid waste excludes industrial, radioactive, and medical garbage. These types of wastes are managed in a distinct manner (Subramani et al, 2014). MSW, or municipal solid waste, encompasses materials of many physical states, including solid, semi-solid, liquid, or gaseous, that are generated by human activities. The composition of this waste primarily consists of organic matter that undergoes natural decomposition, along with cellulose-based items including food, cardboard, and paper (Kaur et al., 2023). Human activity inevitably produces solid waste, and the way it is handled has a negative impact on the environment and public health (Khan et al., 2022). As plastic and electronic consumer products become more easily accessible worldwide, people are disposing of a greater amount of waste, which now has a more intricate makeup. These two tendencies pose a challenge for cities responsible for protecting their residents from garbage. Waste, garbage, rubbish, discards, and junk are terms that can be challenging to define precisely and can vary depending on the specific meaning used. Urban regions are experiencing a growing concentration of trash as a result of population movement. The study conducted by Ferronato and Torretta (2019) suggests that there is a positive correlation between population growth, urbanisation, expanding income levels, and the amount of waste produced. The composition of household garbage varies among regions due to factors such as lifestyle, economic situations, and waste management policies (Abdel and Mansour, 2018). Gaining insight into the composition of garbage in a given location can facilitate the development of suitable and efficient management solutions. Household garbage often consists of a variety of materials, such as food waste, paper, plastic, glass, cloth, and other miscellaneous items.

The key components of any MSW management system are segregation, collection, storage, transportation, and final disposal (Malav et al., 2020). Improper disposal of waste outside leads to detrimental effects on adjacent water bodies as a result of both organic and inorganic contamination. Moreover, it serves as a magnet for contagious diseases and puts individuals residing in close proximity to the perilous elements of the refuse at risk, so jeopardising human well-being. Persistent organic pollutants (POPs) are hazardous substances that are assimilated into the environment and pose a risk to human health. Methane, a significant contributor to greenhouse gas emissions, is emitted during the decomposition of organic waste in landfills, making waste management a primary source of this greenhouse gas (Khan et al., 2022). Landfill sites can have detrimental effects on human health and provide a hazard to public safety as a result of soil contamination, water pollution, landfill gas emissions, and accidental fires. These fires have the potential to emit extremely carcinogenic chemicals such as dioxins and furans into the atmosphere (Vassiliadou et al., 2019). Overflowing landfills provide an escalating danger to public safety. In 2015, a landslip occurred at a landfill site in Shenzhen, resulting in 73 human injuries. The landfill was designed to hold a maximum of 4 million cubic metres of garbage at a height of 95 metres. However, it actually contained 5.8 million cubic metres of waste, reaching a height of 160 metres (Lee et al., 2020). To address the diminishing availability of landfill space, fulfil the public's desire for more recycling, and reduce greenhouse gas emissions, regulatory frameworks are providing support for emerging technologies (Reno, 2015). If waste is perceived just as a source of pollution, there will be a reduced level of commitment towards recycling it before to its disposal in a landfill or extracting valuable materials from it afterwards (Johansson et al., 2012).

The Anugrah Palur Temporary Waste Disposal Site, which was created by the Central Java Province Environment and Forestry Service, is one of the functioning 3R sites in Sukoharjo Regency. This method focuses on managing biodegradable garbage at a local level, namely within groups of 200-2,000 houses (Raharjo, 2017). It requires active involvement from both citizens and government entities, particularly the Ministry of Public Works and Public Housing (2020). The Anugrah Palur Temporary Waste Disposal Site is a waste management facility that utilises social resources and advanced waste processing technology to achieve efficient disposal and recovery at each stage (Heidari et al., 2019). The waste processing conducted at The Anugrah Palur Temporary Waste Disposal Site (TPS) 3R is of utmost importance in order to avoid direct landfilling, hence safeguarding the integrity of the site, alleviating the burden on landfills, and prolonging its operational lifespan (Mulyati et al., 2019). This research employs an approach similar to prior studies but specifically emphasises distinct elements. Wielgosiński et al. (2021) conducted a study in Poland to examine the mass balance of municipal solid waste in relation to circular economy principles. They estimated that implementing these principles might potentially reduce trash by 3.0–3.5 million metric tonnes. Muhammed et al. (2021), utilised the Structural Equation Modeling-Partial Least Squares (SEM-PLS) technique to develop a model for implementing 3R (Reduce, Reuse, Recycle) methods in order to achieve sustainable construction waste reduction. Their efforts resulted in a significant decrease of 2.47 tonnes per day in housing projects, with a high explanatory power shown by an R2 value of 0.83%. Mulyana et al. (2021) evaluated the sustainability of waste banks in schools through the application of RAPFISH analysis. The findings indicated a robust performance in both ecological and institutional aspects. In a study conducted by Amin and Ahmed (2024), it is stressed that including community perspectives and economic considerations in waste management strategies is crucial. The study highlights the influence of tourists' awareness and willingness to financially support sustainable beach waste management on the development of effective policies. This enhances the utilization of SEM-PLS in our research, which seeks to assess the elements that impact community engagement and the long-term viability of waste management strategies. Furthermore, the revised RAP-Temporary Waste Disposal Sites 3R methodology will be utilized to evaluate the sustainability of the Anugrah Palur Temporary Waste Disposal Site.

METHODS

1. Location and Time of Research

The investigation was conducted in Palur Village, Mojolaban District, Sukoharjo Regency, Central Java. The research will be conducted in Palur Village, specifically at the Anugrah Palur Temporary Waste Disposal Site (TPS) with 3R. The precise geographical coordinates for the location of Temporary Waste Disposal Sites 3R Anugrah Palur are 7.34'20.4 South Latitude and 110.51'48.3 East Longitude. The study was conducted between February 2024 and April 2024.

2. Research Tools and Materials

This research necessitates the use of many technologies to ensure the uninterrupted progress of the study. These tools include computers, questionnaire forms, interview forms, voice recorders, documentation tools or cameras, Microsoft Excel 2019 software, Microsoft Excel – Add Ins Rapfish software, and SmartPLS software version 3.29. The research materials utilised in this study encompass the data findings derived from questionnaires administered to managers and depositors at Temporary Waste Disposal Sites with 3R, as well as the outcomes of interviews conducted with Temporary Waste Disposal Sites with 3R management. Additionally, population data and information pertaining to the community that deposits garbage at Temporary Waste Disposal Sites with 3R were also incorporated.

3. Data Analysis Technique

The methods used in this research are mixed methods (quantitative and qualitative methods). The analytical techniques used in this research include:

Analysis of Supporting and Inhibiting Factors

Structural Equation Modeling (SEM) is a multivariate analysis method that combines path analysis, factor analysis and regression analysis (Novian and Herlina, 2022). An analysis was conducted using Structural Equation Modeling-Partial Least Square (SEM-PLS) to examine the elements that encourage or hinder community engagement in Temporary Waste Disposal Sites with 3R in Anugrah Palur Temporary Waste Disposal Sites 3R. The study is conducted using SmartPLS version 3.29 software. The independent variable examined in this study is the presence of Temporary Waste Disposal Sites that offer 3R services. Factors that impact include knowledge, behaviour, and attitudes. The Likert scale is employed for measurement. The evaluation of community engagement is measured on a scale from 1 to 5, with 1 being the lowest score and 5 being the greatest score. The latent variables and indicators employed, as per Haqq's (2018) methodology, have been presented in table 1, with several modifications made for this particular study.

Table 1. Variables and Indicators of Supporting and Inhibiting Factors for Temporary Waste Disposal Sites 3R

VARIABLE	INDICATOR
Service of Temporary Waste Disposal Sites 3R	
$Y_{1.1}$	Find out the affordability of Temporary Waste Disposal Sites 3R locations
$Y_{1.2}$	Find out the ease of the process of depositing waste to Temporary Waste Disposal Sites 3R
$Y_{1.3}$	Know the accuracy of the Temporary Waste Disposal Sites 3R activity schedule
$Y_{1.4}$	Knowing the economic benefits of waste sorting at Temporary Waste Disposal Sites 3R
$Y_{1.5}$	Knowing public awareness of the environment through Temporary Waste Disposal Sites 3R facilities
SOCIETY PARTICIPATION	
Identity	
$X_{1.1}$	Gender (1) Male (2) Female
$X_{1.2}$	Last Education (1) Elementary School/equal (2) Junior High School/equal (3) Senior High School/equal (4) S1/S2/S3/ equal
$X_{1.3}$	Job (1) Work (2) Not Work
$X_{1.4}$	Expenses per month (1) ≤ Rp.2.215.482 (2) > Rp.2.215.482
VARIABLE	**INDICATOR**
Knowledge	
$X_{2.1}$	Knowing about waste sorting

$X_{2.2}$	Knowing that waste can have economic value
$X_{2.3}$	Understand about 3R activities
$X_{2.4}$	Understand the benefits of Temporary Waste Disposal Sites 3R facilities
$X_{2.5}$	Knowing that Temporary Waste Disposal Sites 3R activities are a means of increasing awareness of the environment
Behavior	
$X_{3.1}$	Sorting household waste
$X_{3.2}$	Participated in socialization regarding waste management held by the government or environmental cadres
$X_{3.3}$	Provide ideas/thoughts in managing Temporary Waste Disposal Sites 3R in the future
$X_{3.4}$	Provide feedback on the Temporary Waste Disposal Sites 3R program
Attitude	
$X_{4.1}$	Willing to sort waste from home
$X_{4.2}$	The program for transporting waste to Temporary Waste Disposal Sites 3R has no problems
$X_{4.3}$	Depositing waste at Temporary Waste Disposal Sites 3R helps in managing waste
$X_{4.4}$	Willing to participate in outreach activities about waste sorting/management

The variables in the SEM analysis used include temporary waste disposal 3R services and community participation (knowledge, behavior, attitudes). Identity is only used to determine the general characteristics of the respondent. The total variables used for SEM analysis are 4 with 18 indicators. Evaluation of SEM analysis consists of 2 types, namely measurement model evaluation and structural model evaluation. Evaluation of the measurement model includes validity and reliability tests. Meanwhile, structural evaluation was carried out to evaluate the relationship between existing latent variables using R-square (R^2), Q-square Predictive Relevance (Q^2), and Goodness of Fit (GoF) values. The R^2 value provides an illustration of the ability of the influencing variable to explain variations in the influenced variable. The value of Q^2 shows the predictive ability of the existing model with the formula:

$$Q^2 = 1 - (1 - R^2) \quad (4)$$

The R^2 and Q^2 assessment are carried out with classifications with categories less than 0.33, a weak classification, more than equal to 0.33 and less than 0.67 classified as moderate, and equal to more than 0.67, a strong classification. Next, Goodness of Fit (GoF) is carried out to test the accuracy of the model that has been formed. The classification values used are GoF < 0.25 low classification, 0.25 ≤ GoF < 0.36 medium classification, and GoF ≥ 0.36 high classification. The formula used in the GoF assessment is as follows.

$$GoF = \sqrt{\overline{AVE} \ x \ \overline{R^2}} \quad (5)$$

Next, correlation tests and significance tests were carried out. The correlation test is carried out to determine the magnitude of the relationship between existing variables, with a value range of 1 to -1. Assessing the correlation test, it can be said that the variables have a close relationship if they approach the value -1 or 1. The significance test is carried out to reveal variables that can provide the final results of this analysis. The initial hypothesis for the significance test in this research is as follows.

1. Variables influencing the development of Temporary Waste Disposal Sites 3R

Hypothesis:

H_0: The variables do not have a significant effect on the development of Temporary Waste Disposal Sites 3R

H_1: Variables have a significant effect on the development of Temporary Waste Disposal Sites 3R

The significance level (α) is 5% = 0,05

Critical area: H_0 rejected dan H_1 accepted if the p value < 0,05

Sustainability Analysis

Rapfish method was initially developed to formulate development policies related to sustainable fisheries, but as science developed it began to be implemented in the fields of agriculture, forestry, animal husbandry, and environmental management (Warningsih et al., 2020). Sustainability status at Temporary Waste Disposal Sites 3R was analyzed using the modified RAPFISH (Rapid Appraisal Techniques for Fisheries) technique or RAP-Temporary Waste Disposal Sites 3R. According to Rossi (2022), the stages of sustainability analysis through RAPFISH are as follows:

1. Determination of dimensions and attributes of the object under study.
2. Scoring is carried out on predetermined attributes based on an ordinal scale.
3. Multidimensional Scaling for bad or good units (Sustainability index value) via the ALSCAL algorithm.
4. Leveraging analysis to detect dominant attributes with values ranging between 2% to 6%, as measured by changes in root mean square (RMS).

Modified RAPFISH or RAP-Temporary Waste Disposal Sites 3R analysis was carried out. The RAPFISH dimensions for sustainable fisheries management include ecological, technological, ethical, social, and economic dimensions (Muslim et al., 2019). The scoring of the questionnaire was assessed as very suitable (5), suitable (4), quite suitable (3), not suitable (2), and very unsuitable (1). For analysis in this study, RAP-Temporary Waste Disposal Sites 3R was used based on 4 dimensions with 6 attributes. The management and infrastructure dimensions have attributes in the form of organizational structure, completeness and application of the main processing technology, processing capacity, trained staff, volume of residue transported to the landfill, as well as the condition of buildings and land for development. The environmental dimension attributes the quality of the surrounding environment, the ability to reduce pollution, waste sorting at Temporary Waste Disposal Sites 3R, availability of green open space, the waste transportation process, and processing alternatives. The social dimension with attributes includes social networks, norms (social conditions of society in disposing of waste), trust in waste management, employment, socialization and education, willingness to pay contributions. The economic dimension has attributes including financial assistance from the government, financial independence, processing costs, product and service marketing programs, village economic equality, and labor income. The final result is the ordination of the sustainability index in categories with a value of 0–25 having unsustainable status, a value >25 – 50 having less sustainable status, a value >50 – 75 having moderately sustainable status, and >75–100 having sustainable status (Rossi, 2022).

RESULT AND DISCUSSION

Overview of Questionnaire Respondents

Respondents to the questionnaire for analysis of inhibiting-supporting factors and sustainability of Temporary Waste Disposal Sites 3R Anugrah Palur were people who deposited waste and managed Temporary Waste Disposal Sites 3R. The number of respondents in this study was 78 people. The characteristics of the respondents obtained include gender, age, highest level of education, occupation, number of family members, and monthly expenses. According to Kumar and Samandder (2017), the amount of waste generated can be influenced by total family income, education, employment, etc. The characteristics of the respondents can be seen in table 2.

Table 2. Results of Respondent Characteristics

No	Category	Number of Respondents (people)	Percentage (%)
	Gender		
1.	Male	48	61,54
2.	Female	30	38,46
	Age		
1.	17-25	8	10,26
2.	26-45	44	56,41
3.	>45	26	33,33
	Last Education		
1.	Elementary School/equal	7	8,97
2.	Junior High School/equal	13	16,67
3.	Senior High School/equal	41	52,56
4.	S1/equal	16	20,51
5.	S2/equal	1	1,28
	Job		
1.	Government employees	4	5,13
2.	Private employees	27	34,62
3.	Businessman	13	16,67
4.	Student/Students	3	3,85
5.	Temporary Waste Disposal Sites 3R officer	6	7,69
6.	Other	1	1,28
7.	Doesn't work	24	30,76
	Number of Family Members (people)		
1.	1	6	7,69
2.	2	13	16,67
3.	3	30	38,46
4.	>3	29	37,18
	Monthly Expenses (IDR)		
1.	≤ Rp.2.215.482	36	46,15

2.	> Rp.2.215.482	42	53,85

The distribution of male respondents was 48 people (61.54%). The majority of respondents were male because interviews were conducted during non-productive hours. The ages of the respondents were quite varied, between 17-62 years. The average age of the respondents is 41 years. Respondents' ages were predominantly between 26-45 years, with a proportion of 44 people (56.41%). The distribution of respondents based on their latest education was dominated by the high school/equivalent category with a percentage of 52.56%. The distribution of respondents who had family members of 1 person was 6 people, the number of family members of 2 people was 13 people, the number of family members of 3 people was 30 people, and the number of family members >3 people was 29 people. The average number of respondents' family members is 3 people. The number of family members tends to influence consumption patterns and waste composition. The amount of Rp. 2,215,482 is the minimum wage for Sukoharjo Regency in 2024. Based on the results, which show that the monthly expenditure of respondents depositing waste to TPS 3R is dominated by a monthly expenditure of more than Rp. 2,215,482.

Supporting and Inhibiting Factors

A. Evaluation of Measurement Models / *Outer Model*

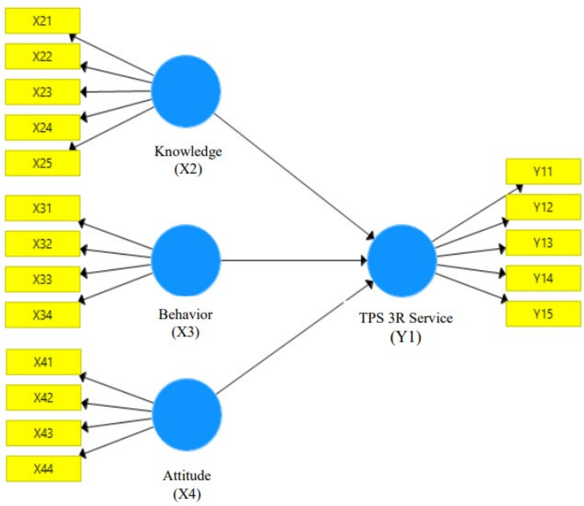

Figure 1. Supporting and Inhibiting Factor Model Diagram
Source: Analysis, Primary Data (2024)

Figure 1 is a diagram model resulting from processing in the SEM-PLS application for variable and indicator. Validity test is a test to determine whether an indicator can be used and is valid. The validity test in this research can be seen in table 3.

Table 3. Results of Validity

No	Variable	Indicator	Loading Factor
1.	Temporary Waste Disposal Sites 3R Services	Y11	0,668
2.		Y12	0,680
3.		Y13	0,777
4.		Y14	0,723
5.		Y15	0,691

6.	Knowledge	X11	0,727
7.		X12	0,779
8.		X13	0,642
9.		X14	0,775
10.		X15	0,666
11.	Behavior	X21	0,771
12.		X22	0,803
13.		X23	0,695
14.		X24	0,735
15.	Attitude	X31	0,861
16.		X32	0,738
17.		X33	0,648
18.		X34	0,644

Loading factor is a correlation of existing variables and indicators. Each indicator in the supporting and inhibiting factors aspects of Temporary Waste Disposal Sites 3R has a loading factor value of more than 0.5. Thus, each indicator used in this analysis is valid and can be understood by respondents. The reliability test is carried out after the validity test to determine whether the level or value of the existing indicators is reliable or reliable for use in measuring the value of existing variables. The reliability of each indicator is measured using the results of Cronbach's alpha and composite reliability values. The reliability results for each variable are in table 4.

Table 4. Result of Reliability

No	Variable	*Cronbach's Alpha*	*Composite Reliability*
1.	Service of Temporary Waste Disposal Sites 3R	0,753	0,834
2.	Knowledge	0,772	0,843
3.	Behavior	0,788	0,838
4.	Attitude	0,700	0,816

Based on table 4, the reliability test for Temporary Waste Disposal Sites 3R service variables, knowledge, behavior and attitudes has reliable values, namely with Cronbach's alpha value ≥ 0.5 and composite reliability value ≥ 0.7 for each existing variable. Thus, the validity and reliability test of the variables used is reliable or reliable in evaluating the measurement model (outer model) of the structural equation model.

B. Structural Model Evaluation / *Inner Model*

Structural model evaluation is carried out after evaluating the measurement model to determine the relationship between variables and ensure that the structural model that has been formed is accurate. Structural model evaluation was carried out using R-Square, Q-Square, and Goodness of Fit. The R-Square (R^2) value or determinant coefficient can represent the level of ability of the influencing/independent variable (X) to explain the variance contained in the influenced/dependent variable (Y). The assessment range for R^2 is 0 to 1, where the closer the value to 1, the better the value. The R^2 value obtained for the Temporary Waste Disposal Sites 3R service variable is 0.497. The R^2 value shows that Temporary Waste Disposal Sites 3R services can be explained by 0.497 by the existing variables, namely knowledge, behavior and attitude variables. Another 0.503 value is explained by variables outside the model formed.

Q-Square (Q^2) or predictive relevance is a measurement of the predictive ability of a model or the level of observation values that can be produced from a model. The value obtained for Q^2 is 0.497, which is classified as moderate. Based on this value, the relevance of the predictions formed from the model is classified as moderate. Goodness of fit (GoF) is useful for assessing the accuracy of the model that has been formed. GoF can be assessed after knowing the Average Variance Extracted (AVE) value. AVE values that have an assessment of > 0.5 are classified as having good discriminant validity. The following are the AVE values contained in each variable which can be seen in table 5.

Table 5. Average Variance Extracted Results

No	Variable	AVE value
1.	Service of Temporary Waste Disposal Sites 3R	0,503
2.	Knowledge	0,518
3.	Behavior	0,565
4.	Attitude	0,530

Based on the AVE values that have been obtained, all the variables used have good values, namely more than 0.5. Next, calculations are carried out to determine the GoF value. The GoF value obtained was 0.513. Referring to the existing categories, the GoF value is relatively high, namely ≥ 0.36. A GoF value of 0.513 can indicate that the model formed is classified as high or good.

C. Correlation Test

Correlation tests are carried out to determine the magnitude of the relationship between influencing variables that exist on the influenced variable. This correlation test has a range of values ranging from -1 to 1. Correlation values that are closer to 1 or -1 can be concluded that the variable relationship is getting closer. The correlation test results can be seen in table 6.

Table 6. Result of Correlation Test

No	Variable	Correlation Value
1.	Knowledge→Temporary Waste Disposal Sites 3R Services	0,543
2.	Behavior→Temporary Waste Disposal Sites 3R Services	0,248
3.	Attitude→Temporary Waste Disposal Sites 3R Services	0,677

Based on table 6, the correlation test value for variables influencing the variables influenced or Temporary Waste Disposal Sites 3R services is obtained, including the knowledge variable of 0.543, the behavior variable of 0.248, and the attitude variable of 0.677. The highest correlation value was obtained for the attitude variable (0.677), while the lowest correlation value was for the behavior variable (0.248).

D. Significance Test

Each variable definitely has an influence, but in order to evaluate variables with a significant level in the measurement model and structural model, a significance test is carried out. The significant test produces 2 assessment criteria, namely T-statistics and p-value. One of the assessment criteria can be used, namely the T-statistics assessment is said to be significant if the value is > 1.96, while the p-value assessment is said to be significant if the value is < 0.05. The significance assessment in this study uses p-value. The following are the results of the variable significance values which can be seen in table 7 below.

Table 7. Result of Variable Significance Test

No	Variable	*T-statistics*	*p-value*
1.	Knowledge→Temporary Waste Disposal Sites 3R Services	1,941	0,052
2.	Behavior→Temporary Waste Disposal Sites 3R Services	1,084	0,279
3.	Attitude→Temporary Waste Disposal Sites 3R Services	4,918	0,000

Based on table 7, the significance values for the knowledge, behavior and attitude variables are obtained. The variable that has a significant effect is the attitude variable which has a value of 0.000. The significant influencing variables from highest to lowest respectively according to the p-value are the attitude variable of 0.000, the knowledge variable of 0.052, and the behavior variable of 0.279. Thus, it was found that the supporting factors for the running of services and the development of Temporary Waste Disposal Sites 3R were found in the attitude variable, while the knowledge and behavior variables did not have a significant effect and were an inhibiting factor for development, but it cannot be said that it is hindering the current Temporary Waste Disposal Sites 3R service. For optimal development in Temporary Waste Disposal Sites 3R, it is necessary to increase knowledge and behavior variables.

The significance test is also used to measure the significant influence of each indicator in forming variables. The following are the results of the significance values for each indicator which can be seen in the table 8.

Table 8. Results of Indicator Significance Test

No	Variable	*T-statistics*	*p-value*
1.	Y11←Temporary Waste Disposal Sites 3R Services	3,334	0,001
2.	Y12←Temporary Waste Disposal Sites 3R Services	3,432	0,001

3.	Y13←Temporary Waste Disposal Sites 3R Services	5,317	0,000
4.	Y14←Temporary Waste Disposal Sites 3R Services	4,851	0,000
5.	Y15←Temporary Waste Disposal Sites 3R Services	3,747	0,000
6.	X21←Knowledge	4,738	0,000
7.	X22←Knowledge	3,365	0,001
8.	X23←Knowledge	1,803	0,071
9.	X24←Knowledge	2,890	0,004
10.	X25←Knowledge	3,429	0,001
11.	X31←Behavior	1,544	0,123
12.	X32←Behavior	2,374	0,018
13.	X33←Behavior	0,873	0,383
14.	X34←Behavior	0,836	0,403
15.	X41←Attitude	7,800	0,000
16.	X42←Attitude	4,144	0,000
17.	X43←Attitude	3,858	0,000
18.	X44←Attitude	2,858	0,004

Based on the results of the indicator significance test obtained, the Temporary Waste Disposal Sites 3R service variable has a significant value for all indicators for the development of Temporary Waste Disposal Sites 3R, namely <0.05. These indicators include affordability, ease of depositing waste, accuracy of transportation schedules, benefits from waste sorting, and public awareness of the environment through the existence of 3R TPS facilities. The knowledge variable has a significant influence on the indicator X21 with a value of 0.000, X22 with a value of 0.001, X24 with a value of 0.004, and X25 with a value of 0.001. Indicators with significant influence can be interpreted as meaning that the community understands the existing indicators and is a supporting factor in the development of Temporary Waste Disposal Sites 3R, namely public knowledge regarding waste sorting, waste can have economic value, the usefulness of Temporary Waste Disposal Sites 3R facilities, and Temporary Waste Disposal Sites 3R activities as a means of increasing awareness of the environment. Meanwhile, there is no significant influence on the X23 indicator with a value of 0.071, which is an understanding of 3R activities.

The indicator for the behavioral variable with a significant influence value as a supporting factor for the development of Temporary Waste Disposal Sites 3R is indicator X32 with a value of 0.018, namely regarding participation in socialization of waste management. Indicators of behavioral variables with insignificant influence as inhibiting factors for the development of Temporary Waste Disposal Sites 3R are indicator X31 with a value of 0.123, X33 with a value of 0.383, X34 with a value of 0.403. These indicators relate to behavior in sorting waste, providing ideas, and providing responses to the Temporary Waste Disposal Sites 3R program. The attitude variable has a value with a significant influence as a supporting factor for the development of Temporary Waste Disposal Sites 3R on all indicators, namely with a total value of <0.05. These indicators include the willingness to sort waste from home, the absence of obstacles to transporting waste, the level of assistance from the community in managing waste, and the willingness to participate in waste management socialization.

The attitude of the community's willingness to sort waste if it is required in the future by TPS 3R Anugrah Palur is relatively high which has an influence on the development of TPS 3R Anugrah Palur. As long as TPS 3R Anugrah Palur has been running, there have been no obstacles that have had a significant impact on the community, especially in the transportation process. This is due to the regular schedule for transporting waste, namely Monday to Saturday and routine maintenance to support the optimal operation of TPS 3R Anugrah Palur. The significant value of the attitude variable makes this variable support the development of TPS 3R from the aspect of community participation.

In previous research regarding aspects of community participation in waste management facilities using SEM-PLS analysis by Haqq (2018), it was found that variables with a significant influence as supporting the development of waste bank facilities in the South Surabaya area according to the p-value were behavior (0.040), while the variable with an insignificant effect obtained on the knowledge (0.210) and attitude (0.580) variables. Previous research related to facilities on behavioral variables has the highest value in supporting the development of waste banks in the Surabaya area, which is supported by indicators of significant influence on the community who have sorted waste from home and participated in socialization.

Education and age are indirect factors apart from indicators that influence the knowledge, behavior, and attitude variables. Education can be a means for someone to gain knowledge in protecting the environment, obtain information on the importance of managing waste, and provide information related to behavior that has a positive impact on waste management. This correlates with the education level of the respondents, which is dominated by high school and bachelor's degrees. However, the factor that causes the knowledge variable to be insignificant is the lack of intensity of socialization or non-formal education related to waste management at TPS 3R. TPS 3R socialization was only carried out 3 times. The age of respondents was dominated by those between 26-45 years old. According to Meidiana et al. (2021), age is an important factor in determining a person's decisions, especially behavior in waste management. This is in line with this statement, where in this study it was found that the dominance of those aged 26-45 years indirectly influenced the high value of the attitude variable.

So, it is necessary to increase the knowledge variable, namely the understanding indicator regarding 3R activities and increase the attitude variable in the behavioral indicators in sorting waste, providing ideas, and providing responses to the 3R TPS program. These variables can be improved to support the development of Temporary Waste Disposal Sites 3R through routine outreach, policies for separating waste from homes, as well as opening access for the community to provide ideas and responses to Temporary Waste Disposal Sites 3R.

Prepublished copy
Nature Environment & Pollution Technology
This is a peer-reviewed prepublished version of the paper

Sustainability of Temporary Waste Disposal Sites 3R Anugrah Palur

A. Sustainability Status of Management and Infrastructure Dimensions

The management and infrastructure dimension has six attributes used in sustainability analysis, namely organizational structure, completeness and application of main processing technology, processing capacity, trained staff, volume of residue transported to landfill, and condition of buildings and land for development. This sustainability analysis is carried out to determine the value of the sustainability index for sustainability status and leverage to determine the sensitive value of existing attributes. The following is a mapping of the sustainability index coordination from the management and infrastructure dimensions shown in figure 2 below.

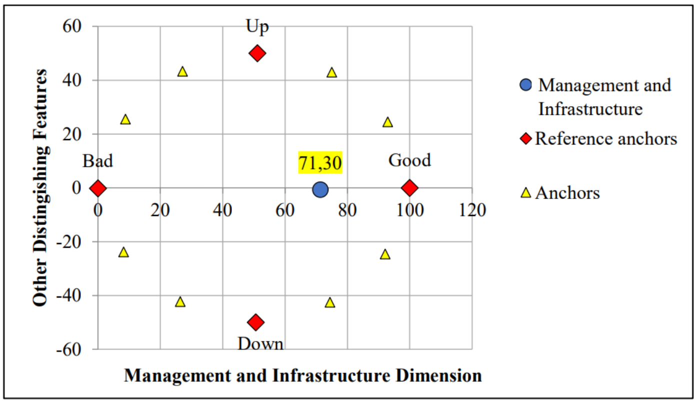

Figure 2. Management and Infrastructure Dimensions Sustainability Ordinance
Source: Analysis, Primary Data (2024)

Based on the coordination analysis carried out on the management and infrastructure dimensions, a sustainability index value of 71.30 was obtained. These results show that the management and infrastructure dimensions of Temporary Waste Disposal Sites 3R have a fairly sustainable sustainability status category. The results of the leverage analysis of management and infrastructure dimensions can be seen in table figure 3.

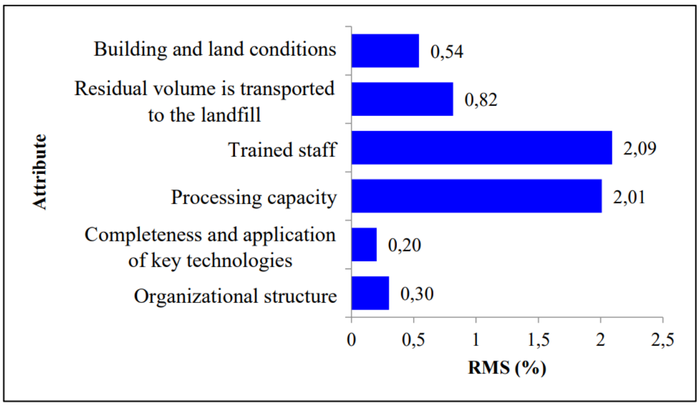

Figure 3. Leverage Dimensions of Management and Infrastructure
Source: Analysis, Primary Data (2024)

Based on figure 3, leverage analysis shows that there are 2 dominant sensitive attributes for sustainability, namely processing capacity and trained staff. Processing capacity is a sensitive attribute with a root mean square (rms) value of 2.01%. The existing processing capacity that enters Temporary Waste Disposal Sites 3R Anugrah Palur per day is an average of 724.76 kg. The daily amount of waste is suitable for entering the organic sorting and chopping room, and is in accordance with the number of officers for the processing process. Waste processing at Temporary Waste Disposal Sites 3R is focused on organic waste, namely into compost with an estimated waiting period of 2-3 months. For sustainability of this attribute, it is necessary to increase processing capacity in parallel with increasing capacity or can be adjusted to waste processing working hours. Adjustments to working hours have now been made, namely if on certain days there is excess waste capacity at Temporary Waste Disposal Sites 3R, overtime hours are carried out with additional payments to Temporary Waste Disposal Sites 3R officers.

The most sensitive attribute in the management and infrastructure dimensions is the trained staff attribute with an RMS value of 2.9%. This trained staff attribute is a sensitive attribute because Temporary Waste Disposal Sites 3R staff or officers are an important element in the sustainability of Temporary Waste Disposal Sites 3R, especially in transporting, sorting and processing waste. Staff on duty at Temporary Waste Disposal Sites 3R are trained informally at the start of work regarding operational mechanisms in the field as well as standard operational procedures that need to be adhered to in carrying out work. It is necessary to improve aspects that support staff to be better trained, which can be done through formal training for Temporary Waste Disposal Sites 3R officers and comparative studies of other Temporary Waste Disposal Sites 3R that have been operating for a long time. Meanwhile, other attributes in the management and infrastructure dimensions are classified as not dominant with each sensitive value including organizational structure (0.30%), completeness and application of the main processing technology (0.20%), volume of residue transported to landfill (0.82), and building and land conditions for development (0.54).

B. Environmental Dimension Sustainability Status

Attributes in the environmental dimension analysis consist of the quality of the surrounding environment, the ability to reduce pollution, waste sorting at Temporary Waste Disposal Sites 3R, availability of green open space, waste transportation process, and processing alternatives. The environmental dimension is an important aspect that needs to be considered in implementing and developing Temporary Waste Disposal Sites 3R. The following are the results of the environmental dimension coordination mapping which can be seen in figure 4.

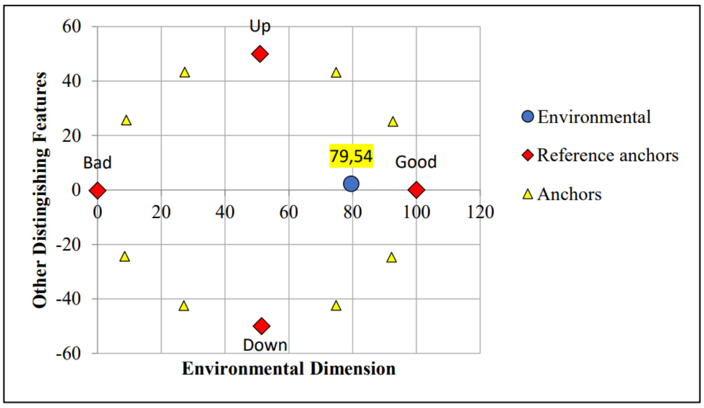

Figure 4. Ordination of the Environmental Dimension Sustainability Index
Source: Analysis, Primary Data (2024)

Based on figure 4, the results of the environmental dimension index ordination analysis obtained a sustainability index value of 79.54. The sustainability index value of 79.54 indicates that the environmental dimension has a sustainable category. The environmental dimension has the highest sustainable index value compared to other dimensions in Temporary Waste Disposal Sites 3R. The results of the environmental dimension leverage analysis can be seen in figure 5 below.

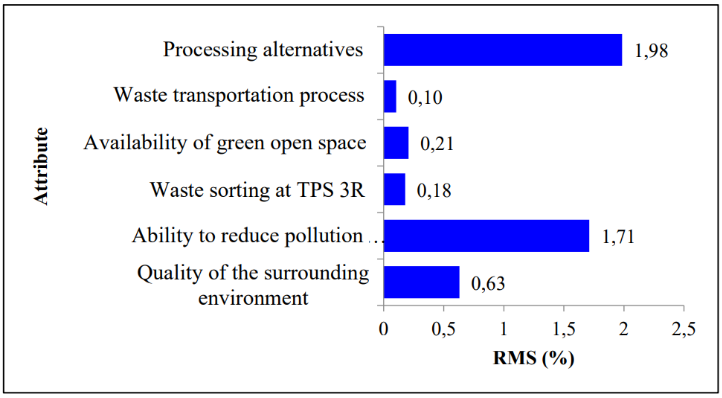

Figure 5. Environmental Dimension Leverage
Source: Analysis, Primary Data (2024)

Based on figure 5, none of the attributes in the environmental dimension are within the sensitive value range of 2-6%. The sensitive value of each attribute includes the quality of the surrounding environment (0.62%), the ability to reduce pollution (1.71%), waste sorting at Temporary Waste Disposal Sites 3R (0.18%), availability of green open space (0.21%), waste transportation process (0.10%), and processing alternatives (1.98%). The rms value of alternative waste processing attributes shows a sensitive value of 1.98%. Waste processing at Temporary Waste Disposal Sites 3R is currently focused on processing organic waste into compost. Previously, there was waste management using maggots but it has been stopped. The technology or tools for processing inorganic waste currently do not exist at Temporary Waste Disposal Sites 3R, so inorganic marketable waste is stored in the inorganic waste warehouse and sold during periods of increasing selling prices to local collectors. This improvement can be done by adding inorganic waste processing technology such as plastic chopping machines and plastic pellet machines.

C. Social Dimension Sustainability Status

The social dimension for sustainability analysis uses 6 attributes including social networks, norms (social conditions of society in disposing of waste), trust in waste management, employment, socialization and education, and willingness to pay contributions. The following is a mapping of the social dimension of Temporary Waste Disposal Sites 3R sustainability status coordination which can be seen in figure 6 below.

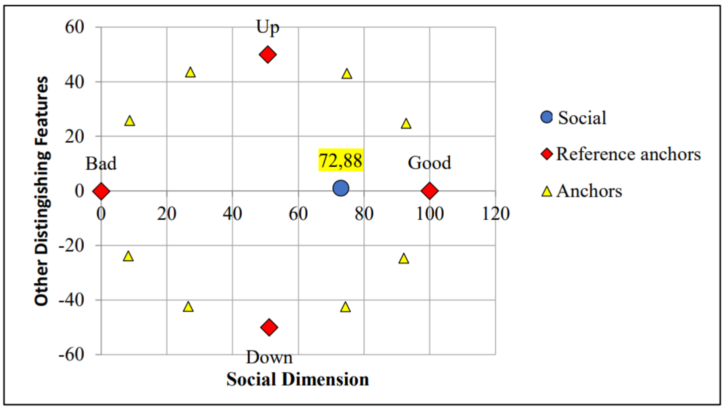

Figure 6. Ordination of the Social Dimension Sustainability Index
Source: Analysis, Primary Data (2024)

Based on figure 6, the results of the social dimension ordination analysis obtained a sustainability index value of 72.88. The sustainability index value shows that the social dimension has a fairly sustainable category. The results of the social dimension leverage analysis can be seen in figure 7 below.

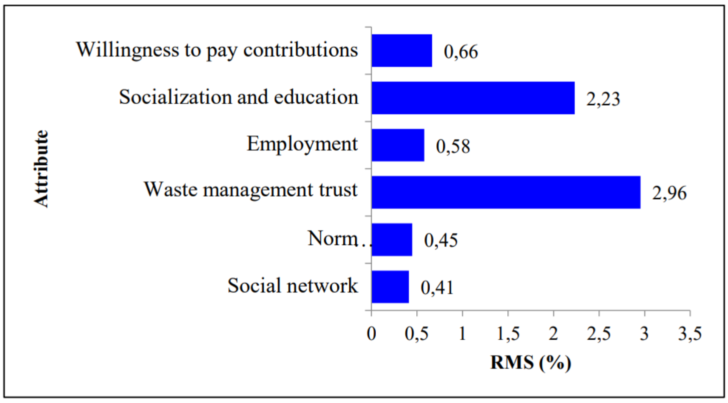

Figure 7. Social Dimension Leverage
Source: Analysis, Primary Data (2024)

Based on figure 7, there are leverage values which show 2 attributes with dominant sensitive values in the social dimension. These attributes include trust in waste management as well as outreach and education. The waste management trust attribute is the highest sensitive attribute in the social dimension with rms value of 2.96%. The trust attribute is an element that forms social capital in society, along with social network attributes and norm attributes. Trust is a form of hope that arises in a group that acts normally, honestly, and works together according to shared norms in order to achieve common interests (Fadli, 2020). The existence of trust can produce effective cooperation because there is a willingness to prioritize common interests. The management trust attribute is an important aspect in the sustainability of Temporary Waste Disposal Sites 3R, especially in preparing for further development. Temporary Waste Disposal Sites 3R is trusted by the public to manage household waste and reduce waste before it goes to the landfill. Thus, public trust in Temporary Waste Disposal Sites 3R needs to continue to be increased for the sustainability of Temporary Waste Disposal Sites 3R. To increase trust in waste management, this can be done by rebranding waste service information to the public, namely regarding changes in services, previously there was a TPS but it has been changed to Temporary Waste Disposal Sites 3R. This can be done through routine outreach to the community.

Socialization and education are included in the dominant sensitive attributes with an RMS value of 2.23%. Since Temporary Waste Disposal Sites 3R began operating in 2023 until it started operating in 2024, there have been 3 formal outreach and education sessions for the community. Apart from that, socialization has been carried out regarding waste management at Temporary Waste Disposal Sites 3R which was conveyed by the sub-district and BUMDes to each RT-RW head. Each RT-RW head conveyed this outreach to the local community at regular meetings in their respective areas. The socialization and education attributes are the dominant sensitive attributes in the sustainability of Temporary Waste Disposal Sites 3R, so more attention is needed for improvement to ensure the sustainability of Temporary Waste Disposal Sites 3R. There is a need to increase the intensity of outreach and education to the public, this can be done offline with a regular schedule and online, namely outreach in the form of information on digital flyers or distribution in the form of invitations to sort waste from home.

D. Economic Dimension Sustainability Status

The sustainability status of the economic dimension is analyzed using 6 attributes including financial assistance from the government, financial independence, processing costs, product and service marketing programs, village economic equality, and labor income. The following are the results of mapping the ordination of the economic dimension of the sustainability index which can be seen in figure 8 below.

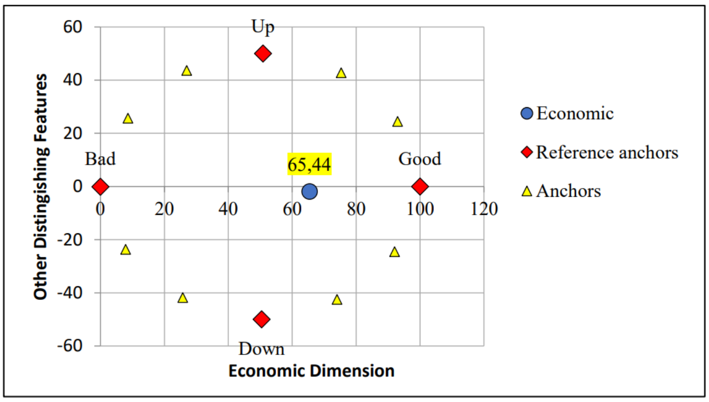

Figure 8. Ordination of the Economic Dimension Sustainability Index

Source: Analysis, Primary Data (2024)

Based on figure 8, the results of the economic dimension ordination analysis obtained a sustainability index value of 65.44. The sustainability index value shows that the economic dimension has a fairly sustainable category. The economic dimension has the lowest sustainable index value compared to other dimensions in Temporary Waste Disposal Sites 3R. The results of the economic dimension leverage analysis can be seen in figure 9.

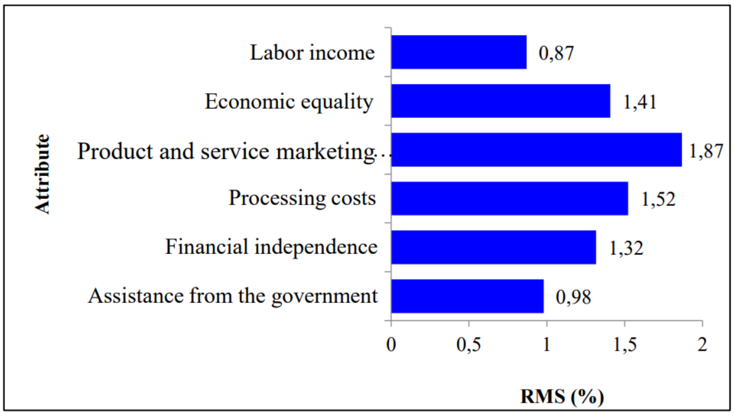

Figure 9. Economic Dimension Leverage
Source: Analysis, Primary Data (2024)

Based on figure 9, there are no sensitive attributes with a dominant level of more than 2%. The product and service marketing program attributes obtained an RMS value of 1.87%. Product and service marketing programs are the attributes with the highest sensitive value on the economic dimension. This attribute is in line with Village SDGs Number 12, namely environmentally conscious village consumption and production. Marketing of organic products is carried out by selling compost fertilizer to farmers and plant cultivators at a price of IDR 10,000 per 10 kg. Most of the marketable inorganic waste is sold to collectors in the Palur sub-district area during periods of rising prices. Efforts that can be made to increase sustainability in marketing program and service attributes are to increase the marketing reach of products outside Palur Subdistrict.

E. Multidimensional Analysis of Temporary Waste Disposal Sites 3R Sustainability

Analysis of each attribute has been carried out and a sustainability index value has been produced for each dimension. The following is a continuous kite diagram of each which can be seen in figure 10.

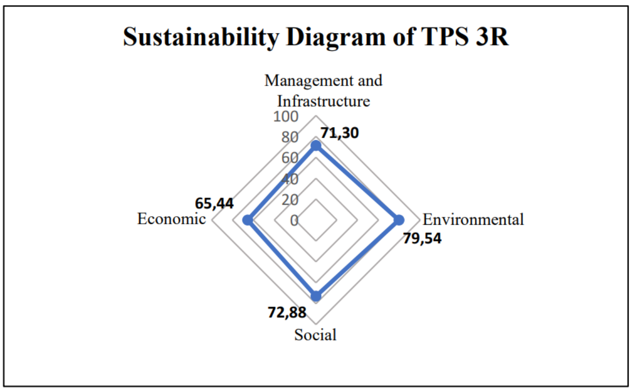

Figure 10. Temporary Waste Disposal Sites 3R Sustainability Kite Diagram
Source: Analysis, Primary Data (2024)

Based on the diagram above, the sustainability index values with the highest to lowest values respectively include the environmental dimension (79.54), the social dimension (72.88), the management and infrastructure dimension (71.30), and the economic dimension (65.44). The environmental dimension has the highest sustainability value with the sustainable status category. Meanwhile, the management and infrastructure dimensions, social dimensions and economic dimensions are in the moderately sustainable status category.

The details of the sustainability index value, stress value, and R-Square for each dimension can be seen in table 9 below. Thus, efforts are needed to improve management and infrastructure, social and economic dimensions to support the sustainability of Temporary Waste Disposal Sites 3R.

Table 9. Sustainability Index Value, Stress Value, and R-Square

No	Dimension	Sustainability Index Value	Sustainability Status	Parameter	
				Stress	R^2
1.	Management and Infrastructure	71,30	Quite Sustainable	0,15	0,95
2.	Environmental	79,54	Sustainable	0,14	0,95
3.	Social	72,88	Quite Sustainable	0,15	0,95
4.	Economy	65,44	Quite Sustainable	0,16	0,94
	Average	72,79	Quite Sustainable		

Source: Analysis, Primary Data (2024)

Based on table 9, the average value obtained from all dimensional analysis is 72.79 in the quite sustainable category. The results of the sustainability value of the Anugrah Palur TPS 3R facility are better than other research by (Sukwika and Noviana, 2020), namely the Bantar-Gebang TPS rapfish analysis obtained a sustainability value of 51.71. This is because TPST-Bantar Gebang has a sustainability index value in the range of 50.02-57.15 in the environmental, social and economic dimensions. A good and appropriate stress value from rapfish analysis is less than 0.25. The analysis results obtained with the stress value were 0.14-0.16 and R^2 ranged from 0.94-0.95. Based on these results, all attributes are suitable to be used to explain the four dimensions analyzed.

CONCLUSION

The SEM-PLS analysis yields measurement and structural models suitable for identifying supporting and inhibiting factors for the development of 3R TPS. The measurement model demonstrates valid results with all variable indicators showing strong loading factors, and reliable results with satisfactory Cronbach's alpha and composite reliability values. The structural model evaluation indicates that the model is relatively good. Among the influencing factors on the Temporary Waste Disposal Sites 3R service, attitude shows the highest impact, followed by knowledge and behavior. Attitude is identified as the most significant supporting factor, whereas knowledge and behavior are found to be inhibiting factors.

The overall sustainability index of Temporary Waste Disposal Sites 3R Anugrah Palur is categorized as moderately sustainable. The sustainability status across various dimensions indicates that the management and infrastructure dimension is quite sustainable, the environmental dimension is sustainable, the social dimension is quite sustainable, and the economic dimension is quite sustainable. Key leverage points affecting sustainability are identified within the management and infrastructure, and social dimensions, particularly related to trained staff, processing capacity, socialization, education, and trust in waste management.

Government to consider improving waste processing technology at TPS 3R Anugrah Palur, TPS 3R Anugrah Palur Management to strengthen community knowledge and behavior in managing waste through socialization and education offline and online. The management of TPS 3R Anugrah Palur is considering improving the economy with the help of funds and technology by collaborating with the corporate social responsibility of private parties and non-governmental organizations (NGOs). Recommendation for other researchers to analyze supporting and inhibiting factors with adding religious factor variables and social capital (trust social, social norms, and social networks).

REFERENCES

1. Abdel, S. H. I., and Mansour, M. S. 2018. Solid Waste Issue: Sources, Composition, Disposal, Recycling, and Valorization. Egyptian journal of petroleum, 27(4): 1275-1290, doi: 10.1016/j.ejpe.2018.07.003.
2. Amin, M.A. and Ahmed, M.T., 2024. Beachgoers' Knowledge, Perceptions, and Willingness to Pay for Sustainable Waste Management in Kuakata Sea Beach, Bangladesh. Nature Environment & Pollution Technology, 23(2). 10.46488/NEPT.2024.v23i02.048
3. Demirbas, A. (2011). Waste management, waste resource facilities and waste conversion processes. *Energy Conversion and Management*, *52*(2): 1280-1287.
4. Ferronato, N., & Torretta, V. (2019). Waste mismanagement in developing countries: A review of global issues. *International journal of environmental research and public health*, *16*(6), 1060.
5. Haqq, M. 2018. Strategi Pengembangan Bank Sampah sebagai Upaya Peningkatan Reduksi Sampah di Wilayah Surabaya Selatan. Tugas Akhir, Institut Teknologi Sepuluh Nopember.
6. Johansson N, Krook J, Eklund M. 2012. Transforming dumps into gold mines: experiences from Swedish case studies. *Environ. Innov. Soc. Trans*. 5:33-48
7. Kaur, A., Bharti, R., & Sharma, R. (2023). Municipal solid waste as a source of energy. *Materials Today: Proceedings*, *81*, 904-915.
8. Khan, S., Anjum, R., Raza, S. T., Bazai, N. A., & Ihtisham, M. (2022). Technologies for municipal solid waste management: Current status, challenges, and future perspectives. Chemosphere, 288, 132403.
9. Lee, R. P., Meyer, B., Huang, Q., & Voss, R. (2020). Sustainable waste management for zero waste cities in China: potential, challenges and opportunities. Clean energy, 4(3), 169-201.
10. Malav, L. C., Yadav, K. K., Gupta, N., Kumar, S., Sharma, G. K., Krishnan, S., ... & Bach, Q. V. (2020). A review on municipal solid waste as a renewable source for waste-to-energy project in

India: Current practices, challenges, and future opportunities. *Journal of Cleaner Production*, *277*, 123227.

11. Malinauskaite, J., Jouhara, H., Czajczyńska, D., Stanchev, P., Katsou, E., Rostkowski, P., ... & Spencer, N. (2017). Municipal solid waste management and waste-to-energy in the context of a circular economy and energy recycling in Europe. *Energy*, *141*, 2013-2044.
12. Meidiana, C., Sekito, T., and Sasongko, W. 2021. Determining Factors of Community Participation in Waste Bank. In IOP Conference Series: Earth and Environmental 1315/940/1/012085
13. Mohammed, M., Shafiq, N., Elmansoury, A., Al-Mekhlafi, A. B. A., Rached, E. F., Zawawi, N. A., ... & Ibrahim, M. B. (2021). Modeling of 3R (reduce, reuse and recycle) for sustainable construction waste reduction: A partial least squares structural equation modeling (PLS-SEM). Sustainability, 13(19), 10660.
14. Mulyati, T., Mutawaqqil, M., & Sastra, H. Y. (2019, June). Planning A village waste management system using system dynamics modelling and simulation: Temporary Waste Disposal Sites 3R case study in aceh, Indonesia. In IOP Conference Series: Materials Science and Engineering (Vol. 536, No. 1, p. 012072). IOP Publishing.
15. Mulyatna, L., Yustiani, Y. M., Andisa, R. R., Ramadhan, R. F., & Hidayanti, D. (2021). Sustainability analysis of the application of waste bank in elementary school with a multidimensional scaling approach. *Journal of Community Based Environmental Engineering and Management*, *5*(2), 103-110.
16. Muslim, A., Fitri, A. D. P., & Purnomo, P. W. 2019. Analisis Keberlanjutan Perikanan Hiu di Kabupaten Cilacap Jawa Tengah. Jurnal Perikanan dan Kelautan, 9(1): 1-14
17. National Standardization Agency. 1994. SNI 19-3964-1994 concerning Methods for collecting and measuring samples of urban waste generation and composition.
18. Novian, W., dan Herlina, M. 2022. "Faktor-faktor yang Mempengaruhi Perilaku Masyarakat terhadap Penggunaan Internet pada Desa Digital Sukaraja," Jurnal Riset Statistika, 161–168. doi: 10.29313/jrs.v2i2.1466.
19. Purwaningrum, P. 2016. Upaya Mengurangi Timbulan Sampah Plastik di Lingkungan. *Indonesian Journal of Urban and Environmental Technology*, *8*(2): 141-147
20. Raharjo, S. (2017). Development of 3R waste treatment facilities for mitigating greenhouse gas emission: A case study of Padang city, Indonesia. ARPN Journal of Engineering and Applied Sciences, 12(12), 3789-3794.
21. Regulation of the Republic of Indonesia Number 18 of 2008 concerning Waste Management.
22. Reno, J. (2015). Waste and waste management. *Annual Review of Anthropology*, *44*, 557-572.
23. Rossi, A. M. 2022. Analisis Keberlanjutan dan Manfaat Circular Economy Bank Sampah Induk (Studi Kasus: BSI "Satu Hati", Jakarta Barat). Tesis, Institut Pertanian Bogor.
24. SIPSN, S. I. 2023. *Waste Management Performance Achievements*. Jakarta: Minister of Environment and Forestry.
25. Subramani, T., & Murugan, R. (2014). Generation of electricity using solid waste management in Krishnagiri Municipalty. *International Journal of Engineering Research and Applications*, *4*(6), 222-232.
26. Sukwika, T., dan Noviana, L. 2020. Status Keberlanjutan Pengelolaan Sampah Terpadu di TPST-Bantargebang, Bekasi: Menggunakan Rapfish dengan R Statistik. Jurnal Ilmu doi:10.14710/jil.18.1.107-118
27. Sun, X., Li, J., Zhao, X., Zhu, B., & Zhang, G. (2016). A review on the management of municipal solid waste fly ash in American. *Procedia Environmental Sciences*, *31*, 535-540.

28. Vassiliadou, I., Papadopoulos, A., Costopoulou, D., Vasiliadou, S., Christoforou, S., & Leondiadis, L. (2009). Dioxin contamination after an accidental fire in the municipal landfill of Tagarades, Thessaloniki, Greece. *Chemosphere*, *74*(7), 879-884.
29. Warningsih, T., Hendrik, H., and Suaseh, Y. 2020. The Status of Sustainability of Anchovy Resources in the Labuhanbatu Territorial Waters, North Sumatra Province. In IOP Conference Series: Earth and Environmental Science, 430(1): 1-14. doi:10.1088/1755-1315/430/1/012021
30. Wielgosiński, G., Czerwińska, J., & Szufa, S. (2021). Municipal solid waste mass balance as a tool for calculation of the possibility of implementing the circular economy concept. Energies, 14(7), 1811.