AAPA-EROPA-AGPA-IAPA International Conference 2024
Towards World Class Bureaucracy
ISSN Print: 2686-6242, ISSN Online: 2686-6250
https://doi.org/10.30589/proceedings.2024.1138

Grey Water and Black Water Wastewater Policy in Improving the Quality of Environmental Management in Gorontalo City, Indonesia

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Abstract

This study aims to look at the implementation process of gray water and black water wastewater management policies in Gorontalo City in the context of improving environmental quality. The method used is a descriptive qualitative approach with the Miles and Huberman model technique in the form of data collection through field observation, analysis of documents from related agencies and interviews with resource persons by providing a structured questionnaire so as to obtain research results by reconstructing policies that show that the implementation of centralized wastewater management policies in northern cities using Charles O. Jones' theory by looking at factors The following are the following: (1) The organization still faces several significant obstacles, such as the lack of adequate wastewater management infrastructure, (2) The interpretation of the government's weak commitment in monitoring and maintaining IPALT facilities made by the Directorate of Cipta Karya, In addition, the enforcement of regulations such as Mayor Regulation Number 9 of 2016 has not been effective due to the lack of supervision of the community who dump domestic wastewater into the river so that the sanctions given by violators neglected policies. (3) Application In the implementation process, it turned out that there was a lack of budget given to DLH (Environmental Service) so that it did not run properly and optimally, so that development (IPALT) did not function optimally. This study recommends more equitable infrastructure improvements, increased budget allocation, and strengthening sanctions against communities that pollute water with wastewater, Novelty for the success of gray water and black water wastewater management to improve the quality of the environment in Gorontalo City is the existence of a more appropriate wastewater management method that is clearly explained in the policy so that waste management is more effective and sustainable. to create a cleaner and healthier environment in Gorontalo City. Achievable

Keywords:

policy; wastewater management

Research Context

The intersection between environmental policy, wastewater management, and public administration is increasingly important as urbanisation and climate change intensify the challenges associated with water resource management (Baharuddin et al., 2021). Effective wastewater management is essential for public health and environmental sustainability. This requires a comprehensive approach that integrates technological advancements, regulatory

ISSN Print: 2686-6242, ISSN Online: 2686-6250
https://doi.org/10.30589/proceedings.2024.1138

frameworks, and community engagement. Recent studies highlight the importance of sustainable operations management in wastewater treatment, emphasising that the adoption of advanced technologies can significantly improve decision-making processes and resource allocation. For example, Alevizos discusses how the utilization of public datasets can optimize wastewater management systems, thereby contributing to climate neutrality and resilience in urban utilities (Alevizos, 2023).

Furthermore, the integration of economic indicators into wastewater management practices is essential to drive a circular economy, as outlined by Smol and Koneczna, who argue that effective water and waste management can result in significant environmental benefits (Smol & Koneczna, 2021). Public acceptance of the reuse of treated wastewater is another important aspect of effective wastewater management. Alzahrani's research shows that public perception plays an important role in the successful implementation of wastewater reuse policies, especially in the agricultural sector (Alzahrani, 2023).

Grey water and black water represent two different categories of wastewater generated from domestic activities, each with unique characteristics and treatment requirements. Grey water usually comes from sources such as sinks, showers, and laundry, while black water comes from toilets and contains more pathogens and organic matter. The separation of these two types of wastewater is essential for effective treatment and recycling, as grey water can often be reused with less intensive treatment compared to black water, which poses a greater health risk and requires a more complex treatment process (Ma et al., 2013; Tadros et al., 2012).

This is echoed by Gbekley, who notes that urban governance must address public health and environmental quality issues arising from inadequate sanitation systems (Gbekley, 2023). The challenge of public acceptance is exacerbated by existing historical practices and infrastructure, as highlighted by Prochaska and Zouboulis, who trace the evolution of wastewater management in Greece and its implications for public health (Prochaska & Zouboulis, 2020). In addition, the role of public administration in wastewater management is very important. Effective governance structures are needed to facilitate collaboration between the public and private sectors, as illustrated by Sarvari et al., which discusses the potential for public-private partnerships in completing abandoned wastewater projects (Sarvari et al., 2020).

The need for a strong regulatory framework was affirmed by Nalle et al., who advocated the establishment of a comprehensive domestic wastewater regulation in Indonesia to improve sanitation access (Nalle et al., 2019). Such a framework is essential to ensure that wastewater management practices are effective, fair, and sustainable. Wastewater management challenges are exacerbated in developing countries, where inadequate infrastructure and limited resources

ISSN Print: 2686-6242, ISSN Online: 2686-6250
https://doi.org/10.30589/proceedings.2024.1138

hinder effective sanitation solutions. (Kazora & Mourad, 2018) emphasizing the sustainability of the IPALT wastewater treatment system in the northern city of Gorontalo city, showing the need for government support in providing safe sanitation as a public good, especially in the city of Gorontalo.

Regarding public services, it is very important to pay attention to the policies that will be implemented by the Government, as we understand that policies are a product that can regulate the course of programs implemented by the Regional Government of Gorontalo city. The public policy framework also significantly influences the water management strategy in the city of Gorontalo. The lack of technical guidance for the construction of Wastewater Treatment Plants (WWTP), as well as regulatory conditions that are no longer relevant to the current situation, also exacerbate the situation, especially when there is a shift of power that often hampers the implementation of the program.

Parameters as variables Wastewater management plant control uses indicators as a reference to find out how the situation or reality is faced by the community as well as the government, so that the Gorontalo city government has issued Mayor Regulation No. 9 of 2016 concerning wastewater management to be able to manage wastewater in order to minimize pollution that occurs in the sea, rivers and lakes, Then the indicators used are as follows:

Table 1.1.

Government Policy Indicators

in Overcoming Wastewater Management Installations in Gorontalo City

It	Indicators	Person in Charge	Goal	Data Source
1	Percentage of households that have access to decent drinking water source services	PU	People of Gorontalo City	Public Works of Gorontalo City
2	Bulk water management in Regional SPAM	PAM		TAPS
3	Increase in raw water capacity	PAM AND PU		PU and PDAM
4	Number of villages/sub-districts that carry out community-based total sanitation	PU		Public Works of Gorontalo City
5	Percentage of households that have access to decent sanitation	PU		Public Works of Gorontalo City
6	Number of villages that have built wastewater infrastructure with a regional or communal system	PU		Public Works of Gorontalo City
7	River water quality	PU		Public Works of Gorontalo City
8	Conformity of entrepreneurs' permits to water pollution	PU		Public Works of Gorontalo City
9	Community groups participating in managing the river	PU		

Based on the indicators that have been identified, the author conducted a more in-depth study related to the clean water availability program so that the water can be optimally utilized by the surrounding community. Interviews with employees of the Directorate General of Cipta

ISSN Print: 2686-6242, ISSN Online: 2686-6250
https://doi.org/10.30589/proceedings.2024.1138

Karya who visited Gorontalo to deal with water problems are the main source of data used by policy makers in planning development. These data help to understand the social and economic conditions of the community, so that they can provide a clearer picture of development achievements. In addition, this data also plays an important role for policy makers in knowing the implementation of policies in various development programs that have been implemented. The purpose of the research is to look at the Grey Water and Black Water Wastewater Policy in Improving the Quality of Environmental Management in Gorontalo City.

Methods

The research method used in the study of gray water and black water wastewater policy in Gorontalo City is a descriptive qualitative approach. This method was chosen to deeply understand the conditions and social dynamics related to the implementation of environmental management policies in the urban area. This study uses the miles and Huberman model by relying on data collection through in-depth interviews, participatory observations, and analysis of relevant policy documents from local government agencies, including implementation reports on policies and local regulations governing IPALT wastewater management in Gorontalo city. The selection of in-depth interview techniques was carried out to obtain views from key stakeholders, such as officials of the Public Works Office, the Environment Agency, and communities directly affected by waste management policies.

The research procedure is:

1. Identify problems by forming a research team consisting of experts, government officials and related stakeholders, Identify problems related to wastewater management in improving the quality of the environment in Gorontalo City, including aspects of quality, quantity, and accessibility of clean water.
2. Data collection is by collecting data related to wastewater, water use, existing wastewater treatment plants, and population statistics. And conducting field surveys to understand conditions in the field, including checking water quality and the use of IPALT in the city of Gorontalo
3. Stakeholder Engagement communicates with stakeholders, such as local communities, NGOs, businesses, and the private sector, to understand their perspectives on clean water and wastewater management issues, and holds public consultation meetings to listen to community aspirations
4. Determination of Policy Solutions and Alternatives is Analyzing possible policy options, such as the development of clean water infrastructure, improved wastewater management,

ISSN Print: 2686-6242, ISSN Online: 2686-6250
https://doi.org/10.30589/proceedings.2024.1138

environmental conservation, and conservation actions. And conduct a comprehensive impact evaluation and cost-benefit analysis for each policy alternative

5. Policy Drafting Designing policies that can address the problems of clean water availability and wastewater management in the hills, and creating an action plan that includes specific steps for policy implementation
6. Public Consultation . Involve the community and stakeholders in the policy design process and get their input. And facilitate open dialogue and discussion to build community support
7. Policy Implementation Develop an implementation plan that includes resource allocation, timeline, and responsibilities. and ensure transparency and accountability throughout the implementation process.
8. Evaluation and Monitoring is to measure the impact of policies and actions taken on the availability of clean water and wastewater management in the hills. And conduct periodic evaluations to determine whether policies need to be adjusted or updated.
9. Reporting and communication Preparing a research report that includes findings, recommendations, and next steps. b. Communicate research results to stakeholders and the general public
10. Policy Decision Development is using the results of research and recommendations to develop new policies or update existing policies.

The collected data was analyzed using an interactive approach that involved three main steps: data reduction, data presentation, and conclusion drawn. In the data reduction stage, the researcher sorts and groups relevant data based on policy themes, such as policy effectiveness, organizational roles, and community responses to gray water and black water management policies. The presentation of data is carried out in the form of descriptive narratives and tables describing infrastructure conditions and community environmental awareness. Furthermore, conclusions are drawn with reference to the public policy theory used, namely Charles O. Jones' policy implementation theory, to identify the determinants that affect the success or failure of this policy. The results of this analysis are expected to provide comprehensive recommendations for policymakers in improving wastewater management strategies in Gorontalo City.

Results and Discussion

The results of the study by reconstructing the policy show that the implementation of the Centralized Wastewater Management Policy in the northern city uses Charles O. Jones' theory by looking at the following factors: (1). The organization lacks adequate infrastructure and the lack of public awareness of the importance of effective domestic waste management. From field

ISSN Print: 2686-6242, ISSN Online: 2686-6250
https://doi.org/10.30589/proceedings.2024.1138

observations, it was found that most people do not have a structured waste management system, especially in hilly areas and densely populated settlements. This condition causes a lot of domestic waste to be directly dumped into rivers or open waterways without proper treatment. This not only pollutes water bodies but also threatens public health due to the high risk of contamination of groundwater used as a source of clean water. (2). The interpretation of the government's weak commitment in monitoring and maintaining IPALT facilities made by Dirgen Cipta Karya is illustrated in the following figure.

Figure 1.

Wastewater treatment sites

The Gorontalo City wastewater site has no monitoring so that this place is not maintained which should be a community wastewater reservoir to manage gray water and black water wastewater from the waste of the Gorontalo City Community. In addition, the enforcement of regulations such as Mayor Regulation Number 9 of 2016 has not been effective because of the lack of supervision of people who discharge domestic wastewater into the surrounding rivers so that the sanctions given to policy violators do not run well.

The main obstacle faced in the implementation of this policy is the weak commitment of local stakeholders in ensuring the sustainability of an effective wastewater management system. Although there have been regulations that regulate domestic wastewater management, such as Gorontalo Mayor Regulation Number 9 of 2016, the implementation is still not optimal, (3) Application In the implementation process, it turns out that there is a lack of budget given to DLH (Environmental Service) so that it does not run properly and optimally, so that the development (IPALT) does not function optimally.

The discussion in terms of centralized wastewater management in the northern city of Gorontalo City focuses on Chares O. Jones' theory in terms of (1). The local government

ISSN Print: 2686-6242, ISSN Online: 2686-6250
https://doi.org/10.30589/proceedings.2024.1138

organization of Gorontalo city focuses on infrastructure development without involving the community in the planning and implementation stages. This makes the sanitation program unsustainable because after the construction is completed, the community does not have a sense of ownership and is less involved in the maintenance of the facilities that have been built. This is because the public does not understand the use of IPALT. (2). The interpretation of the study shows that the injustice of access to sanitation services is still a major issue in Gorontalo City. Low-income communities, especially those living in hilly and periphery areas, often do not have adequate access to proper sanitation facilities. Many of them still use traditional waste disposal systems that do not meet health standards, which ultimately negatively impacts their health and quality of life. This inequality needs to be addressed immediately with policies that are more inclusive and based on the needs of the local community. (3) Application. This study found that the high cost of construction and maintenance of WWTP is one of the factors that hinder the sustainability of sanitation programs. Local governments often face difficulties in allocating sufficient budgets for sanitation projects, especially amid fiscal constraints. As a temporary solution, the government relies on assistance from the central government and international organizations to fund the construction of new WWTP. However, without sustainable financial support, WWTP that has been built tends to be abandoned or not operate optimally.

Grey water treatment and recycling has gained significant attention due to its potential to address the problem of water scarcity. Grey water makes up about 50-80% of the total household wastewater and is characterized by lower levels of contaminants compared to black water (Tadros et al., 2012; Więckowski et al., 2023). This makes gray water a viable candidate for reuse in non-potable applications such as irrigation, toilet flushing, and even laundry, thereby reducing the demand for drinking water (Essa et al., 2018; Box, 2019). For example, studies have shown that treated grey water can be used effectively for irrigation without posing significant health risks, as concentrations of harmful substances are generally lower than those found in black water (Ellis, 2023; Leal et al., 2010).

Advanced treatment technologies, such as membrane bioreactors (MBR) and ozonation, have been developed to improve the quality of grey water for reuse (Ali et al., 2023; Pompa-Pernía et al., 2022). Furthermore, the implementation of a decentralized water management system that incorporates grey water recycling can result in significant energy and cost savings, as well as increased resilience in urban water supply systems (Abbas et al., 2023; Leigh & Lee, 2019). For example, integrating a gray water recycling system within a building can reduce the overall water footprint and lower the operational costs associated with water supply (Al-Kodmany, 2022;

ISSN Print: 2686-6242, ISSN Online: 2686-6250
https://doi.org/10.30589/proceedings.2024.1138

Kamal et al., 2021). In contrast, the treatment of Black Water is more challenging due to its higher burden of pathogens and organic content.

Black water treatment typically involves anaerobic digestion, composting, or advanced biological treatment processes to ensure the safe disposal or reuse of treated waste (Boiocchi et al., 2023; Torretta et al., 2020). As a result, while grey water can be recycled relatively easily, black water requires more sophisticated treatment solutions and careful management to reduce health risks (Boiocchi et al., 2023; Ma et al., 2013; Torretta et al., 2020). In summary, effective management of Grey and black water is essential for sustainable water use and resource conservation. Grey water presents significant opportunities for recycling and reuse, contributing to water conservation efforts and reducing pressure on drinking water supplies.

In contrast, Black Water poses greater treatment challenges and requires a more stringent management strategy to ensure public health and environmental safety. The integration of advanced treatment technologies and decentralized water management systems can improve the sustainability of urban water systems, making them more resilient to the challenges posed by water scarcity and climate change (Abbas et al., 2023; Leigh & Lee, 2019). Overall, this study researchers obtained novelty so that the policy of gray water and black water wastewater management to improve the quality of the environment in the city of Gorontalo should include wastewater management methods that decompose barley written in the wastewater management policy in the city of Gorontalo. This finding is expected to be a reference for the formulation of new policies that are more effective and sustainable to overcome wastewater management problems in Gorontalo City.

Conclusion

The conclusion of this study shows that the management of gray water and black water wastewater in improving the quality of the environment in the city of Gorontalo using the theory of Charle O. Jones can be seen from several factors (1). Organization Lack of adequate infrastructure built by the creation of the city of Gorontalo. (2) Interpretation. Although there are already regulations that govern, such as Mayor Regulation Number 9 of 2016, its implementation has not been optimal due to weak coordination between agencies and lack of supervision. This condition is exacerbated by the lack of capacity of stakeholders in carrying out the monitoring function of the community for the sanction and monitoring of IPALT in the northern city of Gorontalo city. As a result, various wastewater management facilities (IPALT) and communal sanitation channels do not function properly or even tend to be abandoned. (3) The application of this study identifies that wastewater management lacks a budget in the wastewater

ISSN Print: 2686-6242, ISSN Online: 2686-6250
https://doi.org/10.30589/proceedings.2024.1138

management implementation process. This resulted in a lack of maintenance of facilities from IPALT in the northern city of Gorontalo city.

This research has the advantage of a multidimensional approach that combines policy analysis, field observation, and in-depth interviews, thus providing a comprehensive understanding of the challenges of grey water and black water wastewater management in Gorontalo City. By involving various stakeholders, this research can describe social and technical dynamics holistically and produce contextual recommendations. It's just that this study focuses on the Gorontalo City area, so the results cannot be generalized to other regions.

Overall, the success of grey and black water management in Gorontalo City is highly dependent on three main factors: strong policy commitment, equitable infrastructure improvement, and active community participation. The government needs to reformulate its policy strategy by strengthening rule enforcement, increasing budget support, and integrating sanitation programs. This effort will ensure that wastewater management is not only technically but also sustainable, so that it can create a cleaner and healthier environment in Gorontalo City.

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