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The Role of Communal Wastewater Treatment Plants (WWTP) in Domestic Waste Management: Technology, Construction, Environmental Impact, and Community Participation

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ABSTRACT

Communal Wastewater Treatment Plant (WWTP) is a domestic wastewater management system designed to serve several households in one community. The goal is to treat domestic liquid waste centrally so that it is safe for the environment. Communal WWTP is very important, especially in dense residential areas that cannot be served by individual or centralized wastewater treatment systems. This wastewater treatment process involves pipelines connected to storage tanks and wastewater treatment units built according to technical standards to prevent leakage and environmental pollution. Domestic liquid waste, such as greywater and blackwater, which is not properly treated can have negative impacts, including health problems, environmental degradation, and aesthetic damage. Therefore, community participation in the planning, construction, and maintenance of communal WWTP is very important. Active community participation can increase awareness of sanitation, improve environmental management, and support the sustainability of the WWTP system.

Keywords:
Communal IPAL, domestic wastewater, community participation, environmental sanitation, waste management.

INTRODUCTION

The increasing population and domestic activities in residential areas, especially in urban areas, produce an increasing volume of liquid waste. Domestic liquid waste, which comes from household activities such as bathing, washing, cooking, and defecating, contains various organic and inorganic pollutants that can pollute the environment if not managed properly. In such conditions, the provision of effective and efficient wastewater treatment facilities is an urgent need.

One solution to overcome this problem is the construction of a communal Wastewater Treatment Plant (IPAL). Communal IPAL is designed to serve several households collectively, making it more economical than individual waste treatment. This system includes a network of pipes, reservoirs, and waste treatment units that aim to treat liquid waste before being discharged into water bodies or the environment.

However, the success of communal wastewater treatment plants is not only determined by technical aspects, but also by the level of community participation in planning, construction, and management. Low public awareness of the importance of environmental

sanitation is often a major obstacle in implementing this program. Therefore, efforts to increase community awareness and involvement are very important so that communal wastewater treatment plants can function optimally and sustainably.

This paper aims to discuss the importance of communal wastewater treatment plants as a solution for domestic wastewater management, the construction process required to build these facilities, and the role of community participation in ensuring their success and sustainability. This research is expected to provide insight for various related parties in designing and managing a more effective and efficient communal wastewater treatment plant system.

METHOD

This study uses a qualitative descriptive approach with data collection techniques through literature studies, field observations, and in-depth interviews. Literature studies were conducted to examine the concept, design, and benefits of communal wastewater treatment plants based on scientific references and related policies. Field observations were conducted at communal wastewater treatment plant locations that were already operating to analyze the physical condition of the facilities, wastewater treatment processes, and their effectiveness in managing domestic wastewater. In-depth interviews were conducted with related parties, including wastewater treatment plant managers, user communities, and local governments, to explore information on the level of community participation, challenges in management, and factors supporting the sustainability of communal wastewater treatment plants. The data obtained were analyzed thematically to obtain a comprehensive picture of the implementation and management of communal wastewater treatment plants.

RESULTS AND DISCUSSION

Communal Wastewater Treatment Plant (WWTP)

Definition of Communal Waste

Wastewater Treatment Plant is a facility used to treat wastewater produced from household or domestic activities. Communal wastewater treatment plant is a residential scale domestic wastewater treatment system, communal wastewater treatment plant is used or serves several heads of families (KK) (Iskandar et al, 2016).

Research according to Oktiawan et al. in 2018 entitled "Masterplan for Domestic Wastewater Management System in Urban Areas of Sukoharjo Regency". This masterplan planning aims to provide adequate sanitation facilities in domestic wastewater management and examine the technical technological aspects in domestic wastewater management planning. Based on the aspect of community participation in the planning of communal IPAL faced, namely the perception of some people that sanitation facilities, especially those related to domestic wastewater, are not yet an urgent need and public knowledge regarding domestic wastewater management, especially septic tanks that meet standards is still low.

Communal Wastewater Treatment Plant (WWTP) is a wastewater treatment system that is carried out centrally, namely there is a building that is used to process domestic liquid waste that functions communally (used by a group of households) so that it is safer when discharged into the environment, in accordance with environmental quality standards.

Liquid waste from residents' homes is channeled to the IPAL reservoir building through a network of pipes. This system is carried out to handle domestic waste in areas that cannot

be served by a centralized system or individually. Where each household that has a private MCK facility connects the drain to the wastewater piping system to be channeled to the communal waste treatment installation. For smaller systems, it can serve 2-5 households, while for communal systems it can serve 10-100 households or even more.

Communal IPAL treatment accommodates and processes wastewater from several individual (family) toilets that are channeled through pipes to the treatment built underground. The treatment location is placed on land that is mutually agreed upon and can be reached by each adjacent house but must be at a safe distance from the nearest water source. To avoid blockages, control tanks are placed after the family toilets every 20 m and are placed at the meeting points of the channels. Take into account the diameter and slope of the pipes used so that wastewater can flow smoothly.

Community involvement in the development of environmental infrastructure is important because in several cases, environmental infrastructure built by the government eventually no longer functions due to lack of maintenance. Community participation in environmental management can be done by increasing public awareness of the importance of a good and healthy environment and strengthening local community initiatives in maintaining, preserving and improving environmental functions.

Construction of IPAL Building

One of the requirements for IPAL buildings is that they must not allow any leaks, so they must use a strong and watertight structure.

1. Concrete Construction
   The construction material of IPAL (other than the manufacturer) is concrete construction. Consisting of:
   a. Cement
      The type and grade of cement is the type of cement for general use (market)
   b. Fine aggregate (sand)
      The fine aggregate to be used must meet the following requirements:
      1) Consists of hard and eternal grains.
      2) It must not contain more than 5% sludge, determined by dry weight.
      3) It should not contain too many organic ingredients.
      4) Sand from the sea may not be used.
   c. Coarse Aggregate
      1) Coarse aggregate must consist of hard or non-porous and permanent grains.
      2) The sludge content should not exceed 1%, determined by dry weight.
   d. Water
      Water to be used for making concrete must not contain oil, salt, organic materials or other materials that can damage the concrete/reinforcing steel.
   e. Reinforcing steel
      1) The reinforcing steel that will be used is that which is available on the market.
      2) The form of reinforcing steel can be plain reinforcement or profiled reinforcement.
   f. Workshop floor
      Reinforced concrete should not be placed directly on the ground surface, so a work floor must be made at least 5 cm thick (class three crushed concrete) above the

ground before the concrete reinforcement is placed/installed.

g. Leakage testing of IPAL units
   1) To prove that the completed IPAL does not leak, hydraulic structure testing must be carried out before casting the upper plate.
   2) After the formwork is removed, all the walls of the wastewater treatment plant must be free of any build-up, so that leaks in the walls can be clearly identified.
   3) Prior to this test, no painting was carried out.
   4) Each compartment unit to be inspected is filled with water up to the outlet level.
   5) Close it and let it charge for at least 24 hours.
   6) This test is carried out per two compartments sequentially.
   7) The water level during the test period must be observed and the water level must not decrease.
   8) The maximum decrease permitted during 24 hours is 1 cm.
      If the water level drops by more than 1 cm within 24 hours, it means that the wastewater treatment plant is leaking and the leaking location must be found and then repaired.

Household Wastewater

Household liquid waste is one of the waste materials from human daily activities. This waste comes from households and is produced all the time with increasing volume. The waste material is waste from bathrooms, toilets, laundry, and cooking places. Basically, Household Wastewater consists of three important fractions, namely:

1. Feces have the potential to contain pathogenic microbes (for example: e. coli bacteria).
2. Urine generally contains nitrogen and phosphorus, as well as a small possibility of microorganisms.
3. Greywater isdomestic wastewater from the kitchen (dishwashing area), used laundry water (water from the washing machine drain for example), and bath water (not from the toilet). The mixture of feces and urine is called excreta. The mixture of excreta with toilet flushing water is called blackwater. Pathogenic microbes are abundant in excreta.
   *Excreta*This is the main means of transport for waterborne diseases. Blackwater is the term used forwater containing human waste. This group of wastewater must be treated first because it contains pathogenic bacteria. Blackwater is also known as sewage.

The Bad Impact of Wastewater

Household waste can affect water quality, resulting in water pollution, for example used bath water and washing water. Wastewater is a residual object, so of course wastewater is an object that is no longer used, but it does not mean that wastewater does not need to be managed. Wastewater that is not managed properly can have a negative impact on living things and their environment. Some of the negative effects of wastewater are as follows:

1. Disorders of health
   Wastewater is very dangerous to human health considering that many diseases can be transmitted through wastewater. Some wastewater can only function as a carrier such as cholera, worm disease, typhoid, colitis, infectious hepatitis, and shistosomiasis and in addition to being a carrier of disease in the wastewater itself there are many pathogenic bacteria that cause disease. Diseases caused by hazardous waste are acute and chronic.

Especially toxic hazardous waste, which has a very complex reaction. The acute effects of liquid waste are: damage to the nervous system, damage to the digestive system, damage to the neurological system, damage to the respiratory system, and damage to the skin. The chronic effects produced are: carcinogenic effects (causing cancer), mutagenic effects (gene/chromosome mutations) and teratogenic effects and damage to the production system. These diseases are not only a burden on the community (seen from the number of illnesses, deaths and life expectancy) but also become obstacles to achieving progress in the social and economic fields.

2. Environmental Deterioration
   Wastewater that is directly discharged into the water surface, for example: rivers and lakes without prior treatment causes pollution of the water surface. For example: organic materials contained in wastewater if discharged directly into rivers can cause a decrease in dissolved oxygen levels in the river. Thus, it will disrupt life in the water that requires oxygen, thus reducing its development as a result of the death of bacteria, so the natural water purification process that should occur in wastewater is also hampered. With wastewater becoming difficult to decompose.
3. Disturbance to Beauty
   Sometimeswastewater contains pollutants that do not harm health and ecosystems, but interfere with beauty. Wastewater can also contain decomposed materials that produce odorous gases. If this type of wastewater pollutes water bodies, it will disrupt the beauty of the water body. The problem of oil or fat waste can reduce aesthetics. In addition to the smell, the waste also causes the surrounding area to become slippery. As for detergent or soap waste, it will cause a lot of foam to accumulate. This can also reduce aesthetics.
4. Disturbance to Damage to Objects
   There are times whenwastewater contains substances that can be converted by anaerobic bacteria into aggressive gases such as H2S. This gas can accelerate the rusting process on objects made of iron (eg wastewater pipes) and other dirty water discharges. The faster the water is damaged, the greater the maintenance costs will be, which means it will cause material losses.

Community Participation

In general, participation is defined as participating or taking part. "The taking part in one or more phases of the process" or participation means taking part in one or more stages of a process, and the process referred to here is of course development. Participation is the ability of citizens directly or indirectly to understand and speak out or influence the decision-making process (political). Participation starts from a low level, namely various information, consultation, then to a higher level, collaboration of various roles in decision-making and resources and empowerment provides authority for decision-making and resources. (Ari, 2013)

According to several experts, low community participation is also caused by the limited capabilities they have, such as education and limited access to information.

Community Participation in Development

Participation is defined as the full participation of all citizens or communities. Citizen participation starts from planning, construction to maintenance. The successful implementation of community-based environmental sanitation activities depends on active participation.from all

stakeholders, both government, private sector and community, during planning and implementation. Participation is an absolute requirement for the success of community-based sanitation, the majority of community members are actively involved and responsible for the planning and implementation of community-based sanitation activities. The participatory method used in community-based environmental sanitation encourages the participation of women and other disadvantaged community members.

The steps for developing the general community are as follows:

1. Gathering support from policy makers, regional leaders, cross-sectors and various health organizations carried out through dialogue, seminars, workshops, in the context of communication, information and motivation by utilizing mass media and health information systems.
2. Preparation of organizing officers through training, orientation, or leadership seminars in the health sector
3. Community preparation, through a series of activities to improve community capacity in recognizing and solving health problems, by recognizing and mobilizing existing resources.
4. Implementation of health activities by and for the community through trained cadres (therapeutic actions by the community). The series of activities consist of:
    a. Approach to community leaders
    b. Community self-survey to explore health issues
    c. Village health deliberations to jointly determine the health problems faced (determining recipes for solving problems by the community) and training cadres.
5. Development and preservation of health activities by the community.

Community Participation in Environmental Management

Community participation in environmental management is still low. This is caused by several factors, namely:

1. The low level of public awareness and understanding of the relationship between the environment and population is still inadequate. Meanwhile, various traditional wisdoms that are oriented towards maintaining the balance of ecosystem interactions have been increasingly abandoned, due to economic factors, technology and so on.
2. Public awareness of the importance of resource managementnatural resources pay attention to the rules of spatial utilization and the rules of sustainable utilization in the development process are still weak so that their involvement in ensuring the continuity of natural resource productivity and maintaining the quality of space and the environment is still felt to be suboptimal.
3. The rights and obligations of the community and the mechanisms for their participation in efforts to utilize and preserve natural resources and spatial planning have not been respected in accordance with existing laws and regulations.
4. The level of environmental awareness in urban communities has developed sufficiently, but has not yet reached the level of active participation.
5. Low community income causes the capacity for participation to reach an optimal point.

Factors Influencing Community Participation

Some factors that influence community participation include:

1. Community Figure Factor

If it is known that respected community or local government figures are involved in activities organized by the community, they will also be interested in taking part.

2. Benefits of the activities carried out
   If the activities carried out provide real and clear benefits to the community, the community's willingness to participate will be greater.
3. There is an opportunity
   Willingness is also influenced by the existence of opportunities or invitations to participate and the community sees that there are indeed useful things in the activities to be carried out.
4. Have skills
   If the activity being carried out requires certain skills and people who have skills that match those skills, then people will be interested in participating.

Determinants of Behavior

Predisposing Factors

Predisposing factors are factors that facilitate, underlie, or motivate an action, perceived values and needs, or in other words, these factors are related to the motivation of individuals or groups to act on certain behaviors.

In general, it can be said that predisposition factors are personal considerations of an individual that influence the occurrence of a behavior. Included in the group of predisposition factors are knowledge, attitudes, cultural values, perceptions, several individual characteristics, such as age, gender, education level and occupation.

1. Knowledge
   Knowledge is information or information that is known or realized by someone. In another sense, knowledge is the result of someone knowing an object through their senses (eyes, nose, ears, and so on) about the situation or event they observe. A person's knowledge of an object has different intensities or levels. Broadly speaking, it is divided into 6 levels of knowledge, namely:
   a. Know
      Knowing is remembering previously learned material.
   b. Understanding (Comprehension)
      Understanding an object is not just knowing about the object, not just being able to mention it, but the person must be able to interpret correctly about the known object. For example, a person who understands how to eradicate dengue fever, not just mentioning 3M (burying, covering, and draining), but must be able to explain why they must cover, drain, and so on, the water reservoirs.
   c. Application
      Application is defined as the ability to use the material that has been learned in real conditions or conditions or to apply the known principles to other situations. For example, someone who has understood the process of planning a health program at his place of work or anywhere. People who have understood the laws, formulas, principles, research methodologies, etc. will easily make a research proposal anywhere, and so on.
   d. Analysis
      Analysis is a person's ability to describe funds or separate, then find the relationship between the components contained in a problem or known object. An indication that

a person's knowledge has reached the level of analysis is when the person has been able to differentiate. For example, being able to differentiate between Aedes Agepty mosquitoes and ordinary mosquitoes, being able to make a diagram (flow chart) of the life cycle of pinworms and so on.

1) Synthesis
   Synthesis refers to a person's ability to summarize or put into one relationship that is owned. In other words, synthesis is an ability to compose a new design from an existing design. For example, being able to create or summarize in your own words or sentences, about things that have been read or heard, and being able to draw conclusions based on existing theories or articles.
2) Evaluation
   Evaluation is related to a person's ability to prove or assess a particular object. This assessment is based on self-determined criteria or norms that apply in society. For example, a mother can assess or determine whether a child is suffering from malnutrition or not, a person can assess the benefits of participating in family planning for the family, and so on (28).

2. Attitude
   Attitude is a determinant of behavior because it is related to perception, character and motivation, involving factors of opinion and emotions concerned (happy-unhappy, agree-disagree, good-bad, and so on).
   As with knowledge, attitudes also have levels based on intensity, as follows:
   a. Receiving
      Accepting means that the person or subject is willing to accept the stimulus given (object).
   b. Responding
      Responding here means providing an answer or response to a question or object being faced.
   c. Valuing
      Appreciation means that a subject or person gives a positive value to an object or stimulus, in the sense of discussing it with other people, even inviting, influencing or encouraging other people to respond.
   d. Responsible
      The highest level of attitude is to be responsible for what one believes.
3. Economic Status
   The construction of the Communal Wastewater Treatment Plant (IPAL) program in the Siboas Environment is one of the stages of the implementation of the program in Indonesia, namely the Slum-Free City Program (Kotaku), which is one of a number of strategic efforts by the Directorate General of Human Settlements of the Ministry of Public Works and Public Housing to accelerate the handling of slums in Indonesia and support the 100-0-100 Movement, namely 100 percent universal access to drinking water, 0 percent slums, and 100 percent access to proper sanitation.

   The direction of development policy by the Director General of Cipta Karya is to build a system, facilitate local governments, and facilitate communities (community-based). The Kotaku program will handle slums by building a collaboration platform through increasing the role of local governments and community participation.

Enabling Factors

Enabling factors are factors that facilitate behavior or actions of facilities and infrastructure or facilities for the occurrence of health behavior. Which is manifested in the physical environment, the availability or unavailability of health facilities or means, for example: health centers, integrated health posts, hospitals, water disposal sites, garbage disposal sites, sports facilities, nutritious food, medicines, contraceptives, toilets and so on.

Reinforcing Factors

Which is manifested in the attitudes and behavior of health workers or other officers, community figures who are reference groups for community behavior. Sometimes even though someone knows and is able to behave healthily, they do not do it and ignore the healthy behavior.

CONCLUSION

The results of the study indicate that communal wastewater treatment plants are an effective solution in managing domestic waste in densely populated residential areas. With appropriate design and good management, communal wastewater treatment plants are able to reduce environmental pollution, especially in water bodies, and improve the quality of community sanitation. The success of implementing communal wastewater treatment plants is highly dependent on active community participation, government support, and operational sustainability through routine maintenance and transparent financial management. Therefore, synergy is needed between all related parties to ensure the effectiveness and sustainability of these facilities in order to achieve a clean and healthy environment.

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