Engineering and Technology Journal e-ISSN: 2456-3358
Volume 09 Issue 02 February-2024, Page No.- 3482-3491
DOI: 10.47191/etj/v9i02.06, I.F. – 8.227

Capacity Planning and Liquid Waste Management Strategy from Fishery Activities in the Samudera Belawan Fishery Port

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ABSTRACT: Fishing ports are associated with environmental issues such as waste disposal into waters and land, air pollution, and noise. One effort to minimize polluted waste is the existence of a Waste Water Treatment Plant. Wastewater Treatment Plants are one of the functional facilities at fishing ports based on the Minister of Maritime Affairs and Fisheries Regulation No. 08/MEN/2012 Concerning Fisheries Ports. This research aims to identify liquid waste management at the Belawan Ocean Fishing Port, analyze the quality of liquid waste from fishing activities at the Belawan Ocean Fishing Port, analyze the capacity planning of the Waste Water Treatment Plant and stakeholder interaction patterns in waste handling, and develop a liquid waste management strategy at the Belawan OFP. The study conducted a direct survey in Belawan by interviewing the community, fishermen, and Belawan OFP staff and taking water samples for water quality data tested in the laboratory. The research results show that water pollution in the Belawan OFP comes from industry, residential areas, fisheries, and transportation. Laboratory analysis indicates that Total Suspended Solids and ammonia exceed quality standards caused by residential waste and the disposal of dead fish. The strategy for developing liquid waste management at Belawan OFP directs economic aspects as the main priority.

KEYWORDS: Belawan Oceanic Fishing Port, pollution, strategy, waste, Waste Water Treatment Plant

I. INTRODUCTION

Port and dock operational activities significantly negatively impact the coastal zone and the surrounding environment. Port activities are one of the contributors of waste to marine waters. This condition is the same as the statement by Muninggar et al, (2018) that fishing ports are not immune from various environmental issues, such as waste disposal into waters and land, air pollution, and noise.

There is a lot of waste in port activity and dock operational activities at Belawan Oceanic Fishing Port, which pollutes the waters around the port, the port dock body, and the fish auction site. The waste produced is from fishermen and community activities, such as plastic bags, food packaging waste, food waste, wastewater from fish auctions, and fuel-filling activities. The most waste produced is rubbish found in dock ponds and fish auction. A lot of this rubbish is scattered on the road and piles up, causing unpleasant odors and environmental pollution around the Belawan Oceanic Fishing Port area. This condition is due to the unavailability of waste management facilities, such as a Waste Water Management Plant.

Nizam Zachman Ocean Fisheries Port (OFP) and Kejawanan Nusantara Fisheries Port (NFP) have wastewater management facilities, but their use could be better, so they still experience water quality pollution. According to Hakim (2013), pollution in the Nizam Zachman OFP harbor pool experienced moderate pollution levels. Likewise, the Kejawanan VAT is moderately polluted (Sudirman, 2013). Wastewater management installation facilities do not guarantee good quality at a port.

Pollution problems at Belawan OFP include a lot of rubbish on land and in the harbor pool. The problem of waste in harbor ponds has a significant impact on water quality and can negatively affect the aquatic biota around the waters. Other problems that can be seen are the large number of ship activities at the Belawan OFP, which throw waste from fishing into the port pool, the waters contain heavy metals, the condition of the availability of WWTP facilities, the port environment is muddy and dirty due to trading activities (fish hatch ice liquid and fish pieces), aspects other environments that reduce environmental quality due to activities at the Belawan OFP, and biota such as shellfish and fish containing lead and heavy metals. This condition aligns with the research results of Lubis et al, (2015), who found that heavy metal lead pollution levels in stonehead fish and Sembilang fish have exceeded the maximum threshold.

Based on the description above, the quality of the pool waters and waters of Belawan OFP can currently be polluted, so Belawan OFP needs support with good WWTP facilities. Unfortunately, Belawan OFP does not yet have WWTP facilities. This research is required to formulate a strategy for managing liquid waste using WWTP to reduce pollution caused by liquid waste channeled directly to Belawan OFP waters. This WWTP facility is hoped to help manage liquid waste at Belawan OFP.

This research aims to identify liquid waste management at Belawan OFP, analyze the quality of liquid waste from fisheries activities at Belawan OFP, analyze WWTP capacity planning and stakeholder interaction patterns in waste handling, and develop a fluid waste management strategy at Belawan OFP.

II. METHOD

Data collection was carried out in the field, and samples were tested in the Fishery Products Chemistry laboratory, Faculty of Fisheries and Marine Sciences, Riau University, in August-November 2023. The data required is based on the objectives stated in the introduction, including the results of interviews with stakeholders, namely the community, fishermen and Belawan OFP staff regarding the management of liquid waste from fisheries at the port and current facilities for waste management, wastewater quality data in the form of wastewater quality standards, seawater quality standard data (pH, TSS, Pb, Cd, etc.), and the size of the pool area, as well as data on calculating the capacity requirements of the WWTP by measuring the area of the BAK pool (m2), wastewater volume (lt), maximum discharge, discharge used, residence time, production time and wastewater discharge. This data was obtained from the final wastewater disposal at Belawan OFP, the pool outside the port pool, and the water quality testing results in the port pool.

Data in the form of interview results were obtained from respondents selected using a purposive sampling technique. The sample size used is 25% of the population; this sample size refers to FAO (2017). The sample of traders was taken as many as seven units (n=25), the sample of the fishing/fishing fleet was 60 units (n=241), and the sample of Belawan OFP managers was represented by four people who had positions and positions at Belawan OFP. The interview data is then processed using a scoring method to identify waste management. The score used is a Likert scale to measure the attitudes and perceptions of the Belawan community, fishermen, and staff regarding liquid waste management at the Belawan OFP. The data was then analyzed using descriptive analysis.

Collecting wastewater data uses requirements regarding SNI 6989.59:2008 concerning wastewater sampling methods. These requirements lead to sampling using the composite sample method (Hendriarianti, 2016), which is used because it is yet to be known what discharge fluctuations occur at each liquid waste disposal site. Therefore, wastewater sampling is divided into three times, namely in the morning (01.00 to 08.00), during the day (09.00 to 16.00), and at night (17.00 to 24.00). In this research, morning sampling will be conducted at 06.00, in the afternoon at 13.00, and in the evening at 17.00. This time division is carried out so that samples can show the wastewater quality from each discharge for 24 hours.

Wastewater sampling points were taken at 3 (three) locations: in the receiving waters before being mixed with waste (upstream), in the wastewater drainage channel before going to the receiving waters, after being mixed with wastewater (downstream) but not yet integrated or received other liquid waste. The water samples were analyzed with an Atomic Absorption Spectrophotometer (AAS). The principle of this test is that the lead metal analyte in the air-acetylene flame is converted into its atomic form to absorb electromagnetic radiation originating from the cathode lamp, and the amount of absorption is directly proportional to the analyte content. The parameters tested refer to PERMEN LH No. 5 of 2014, namely pH, TSS, COD, sulfide, ammonia, sulfide, free chlorine, BOD, and fatty oils, as well as KEPMEN LH No. 51 of 2004, namely Lead (Pb), Cadmium (Cd), and Mercury (Hg).

Table 1. Quality Standards for Measuring Waste Water Quality

Parameter	Satuan	Kadar
Ph	-	6-9
TSS	mg/L	100
Sulfida	mg/L	1
Amonia	mg/L	5
Klor bebas	mg/L	1
BOD	mg/L	100
COD	mg/L	200
Minyak-lemak	mg/L	15
Timbal (Pb)	mg/L	0,008
Kadmium (Cd)	mg/L	0,001
Raksa (Hg)	mg/L	0,001

Source: LH Ministerial Regulation No. 5 of 2014 and Minister of Environment Decree No. 51 of 2004

WWTP planning and stakeholder patterns in waste handling are calculated by calculating the WWTP capacity requirements by measuring the BAK pool area and wastewater discharge. The planning analysis uses equalization basin calculations between the initial and final settling basins. The flow of equalization calculations can be seen in Figure 1.

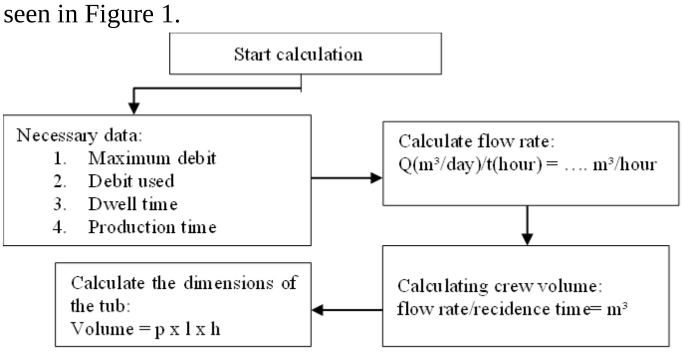

Figure 1. Flow of Equalization Calculations

The initial settling tank functions to settle mud particles, sand, and suspended organic dirt. Residence time in the tub = 2 – 4 hours (Asmadi & Suharno, 2012). The dimensions of the initial settling tank can be calculated using the formula:

Q x TPA

Where:

TPA = retention time

Q = wastewater discharge

The final settling tank functions to separate or precipitate suspended solids (TSS) in the waste water so that the wastewater processed by the WWTP becomes clear. The hydraulic residence time in the final settling tank is generally around 2-4 hours. Stay time in the tub = 2 – 4 hours (Indonesian Ministry of Health, 2011).

Q x TPA

Where:

TPA = retention time

Q = wastewater discharge

Objectives one and two show the need for a liquid waste management strategy. The method used to obtain the expected strategic priorities is the Analytical Hierarchy Process (AHP). The first step in the Analytical Hierarchy Process is defining the problem, determining the solution to be achieved, and then preparing a hierarchical structure starting from the general goal (level 1), followed by sub-goals or criteria (level 2) and possible alternatives at the highest criteria level Bottom (level 3). The management strategy will be effective and more efficient if it is prepared based on mapping the current management conditions and positions at the location.

III. RESULT

A. *Identification of Liquid Waste Management at Belawan OFP*

Belawan OFP operational activities include fish landing services, fish processing, and marketing services, and facilitating the provision of fishing supplies, managed by Belawan OFP and private companies who are tenants in the Belawan OFP activity area. Fish landing activities at Belawan OFP are carried out at any time, namely in the morning, afternoon, and evening, with an average of 50-100 tons of fish landed daily. The dominant fishing tools Belawan fishermen use are purse seine, hand line, and bouke ami. Fish landing activities are carried out in the port area. From loading and unloading the catch, the ship moors at the pier, and fish washing, carried out at sea (on the ship) and land (fish processing unit warehouse). Fish landing activities are not only carried out at the TPI owned by Belawan OFP because the capacity is limited, but business actors carry it out in their respective business units or Fish Management Units (FMU) at Belawan OFP.

Sources of pollution in the Belawan OFP waters generally come from industrial, residential, fishing, and transportation activities, sources of coastal water pollution consisting of industrial waste, residential liquid waste (sewage), and shipping (shipping). The main waste from fishing activities at the Belawanan OFPis divided into two. This division involves waste sources originating from activities on land in the area and in port waters or the sea. Apart from that, there is also waste that comes from activities outside the port area but enters the port waters through rivers that empty into the port waters. Activities at the fishing port mainly cause pollution in the waters of the port pool and its surroundings. This pollution includes, among other things, waste from the Fish Auction Place (FAP), which is directly thrown into the waters of the harbor pool. There are piles of rubbish on the edge of the harbor pond, and it also comes from the waste of remaining lubricating oil from fishing motorboats and the use of fuel and oil on ships, which can contribute to oil waste. Waste from land activities can include domestic waste and industrial waste. Domestic waste can come from residential areas around the port, while industrial waste can arise from industrial activities around the port. One of the industries is the Sicanang Steam Power Plant. This Steam Power Plant activity produces two main types of waste: steam waste and liquid waste. Both types of waste are disposed of directly into the area.

Based on the research results, an overview of household waste management based on interviews with Belawan OFP employees, fishermen, and community respondents can be seen in Table 2.

Table 2. Management of household waste in the Belawan OFParea

No	Answer category	Amount	%
1	burned	18	36
2	transported by cleaning service officers	11	22
3	thrown into the sea	16	32
4	no answer	5	10
	Total	**50**	**100**

Household waste in the Belawan OFP area comes from various fishing activities around the fishing port. One example is plastic food packaging waste. Fishermen often use plastic as food or drink packaging at sea or around ports. After use, this plastic is usually thrown away carelessly, causing plastic waste to accumulate in the Belawan OFP area. Damaged fishing gear such as nets, fishing rods, and other damaged or unusable equipment can become a waste source. Fishermen who throw away fishing gear unsuitable for use around the port contribute to an increase in the volume of waste in the area.

The fish auction process at Belawan OFP produces waste such as used packaging, rope, and packaging materials used to package fish catches. Waste from market activities: fishermen selling their catch at local markets can leave waste in vegetable scraps, plastic, or used packaging around the Belawan OFP area. This waste can be mixed with other waste, adding to the complexity of waste management. Garbage also comes from the activities of fishermen at sea; they bring home rubbish from their ships, such as plastic packaging, used bottles, and other items. If not managed properly, this waste can be dumped in the port area, contributing to the waste problem in the Belawan OFP area.

Table 3 shows that burning domestic solid waste (garbage) in the yard is an environmentally unfriendly practice because it produces harmful gas emissions and air pollution. In addition, dumping waste into the sea can damage marine ecosystems and life. In this context, around 36% of society's domestic solid waste is burned in the yard. Burning this waste can cause air and health pollution due to releasing toxic substances into the atmosphere. Therefore, it is essential to look for alternatives for handling waste that are more environmentally friendly, such as recycling or safer waste processing.

Sanitation service officers transport as much as 22% of domestic solid waste. This transportation process is a positive step in waste management because it reduces the environmental impact of burning. However, ensuring that the transported waste is managed correctly after collection is also necessary. Meanwhile, around 32% of waste is dumped into the sea. Disposing garbage into the sea can damage marine ecosystems, endanger marine animals, and pollute waters.

Overall, reducing waste burning and disposal into the sea and improving sustainable waste management systems will help maintain environmental balance and the sustainability of natural resources. The research results in the field depicting wastewater flow can be seen in Table 3.

Table 3. Wastewater flow at Belawan OFP

No	Information	Amount	%
1	sea	12	24.00
2	ditch/drainage	37	74.00
3	yard behind the house	1	2.00
	Total	**50**	**100**

Table 3 shows that as many as 74% of respondents stated that the waste at OFPBelawan was channelled into ditches or drainage, and 24% channelled it directly to the sea. It can be concluded that most of the waste was directed to the drainage system rather than directly to the sea. This condition creates opportunities to improve waste management better. Waste management through a drainage system requires practical steps to prevent groundwater and surface water pollution. Treating waste before it flows into ditches or drainage, such as through wastewater treatment plants, can be a strategy to reduce negative impacts. Wastewater flows through drainage; wastewater in the Belawan OFP area from washing activities, ship cleaning, or other activities can flow through the drainage system. If drainage is not closed correctly, wastewater can mix with groundwater or reach rivers or drains, potentially causing water pollution and harming ecosystems along the flow path.

Moreover, finally, there is the waste disposal behind the house. Some fishermen or residents who live around the Belawan OFP area throw domestic waste directly behind their homes. This waste can involve using water from daily activities such as washing clothes, cooking, or cleaning the house. This discharge can create local pollution risks if not appropriately managed, especially if the waste mixes with groundwater or nearby waterways. With an understanding of the research context and the objectives of measuring the effectiveness of industrial liquid waste management at OFPBelawan, the next step is to explore further through Table 4. This table presents an assessment scale that helps assess the extent to which industrial liquid waste management at Belawan OFP has reached appropriate standards. The desired assessment scale is in Table 4.

Table 4. Assessment scale for industrial liquid waste management at OFPBelawan

Parameter	**Reference**	**Condition**	**Score**
Environmental Damage Prevention Instruments and Their Implementation Status	Law No. 32 of 2009 concerning Environmental Protection and Management and Government Regulation No. 27of 2012 about Environmental Permit	Does not have UKL/UPL documents, Environmental Permit, and does not implement RKL/RPL	3
		Have UKL/UPL documents and Environmental Permit but do not implement RKL/RPL	2
		Have UKL/UPL documents and Environmental Permit but implementation of RKL/RPL is not optimal	2
		Having UKL/UPL	3

Parameter	Reference	Condition	Score
		documents and Environmental Permits and implementing RKL/RPL is Optimal	
Fishing Port Obligations in Maintaining the Environment (Liquid Waste Handling)	Ministerial regulation Environment Number 05 of 2014 concerning Waste Water Quality Standards	Not monitoring and reporting waste water quality	2
		We have carried out monitoring and reporting on waste water quality, but the duration of monitoring and reporting has not complied with the regulations	3
		Have monitored the quality of waste water but the time duration does not comply with the regulations, and has reported the quality of waste water in accordance with the time duration in the regulations	3
		Have monitored and reported waste water quality according to the time duration in the regulations	2

The assessment of liquid waste management at Belawan OFP involves two parameters: environmental damage prevention instruments and their implementation status by Law No. 32 of 2009 concerning Environmental Protection and Management. Meanwhile, based on environmental maintenance obligations by the Minister of Environment Regulation Number 5 of 2014 concerning wastewater quality standards. The assessment scale for industrial liquid waste management at Belawan OFP is presented in Table 4. Belawan OFP does not have a Waste Water Treatment Plant, so the fish processing industry at the port disposes of liquid waste directly into the port pond. This situation shows the potential for pollution of the aquatic environment around the port.

B. Quality of liquid waste from fisheries activities at Belawan OFP

Fishing vessel service times, from servicing to vessel repairs, need more attention to waste disposal. Garbage thrown directly into the waters of the port dock causes a buildup of rubbish in the harbour pond and its surroundings, such as the harbour jetty, service buildings and fish auction sites during high tide. Apart from that, there is fish market activity, which needs more attention and managers' awareness regarding rubbish and waste. The condition of the fish market is filthy and smelly. This buildup of rubbish produces a foul smell and black liquid, creating severe challenges regarding cleanliness and environmental impact at the Belawan Ocean Fishing Port—results of water quality samples were carried out through laboratory testing. The results of laboratory tests on seawater samples can be seen in Table 5.

Table 5. Sea Water Laboratory Results

No	Parameter	Test Result			Quality Standards	Unit	Method Reference
		AL-1	AL-2	AL-3			
1.	pH	7,58	7,15	7,39	7-8,5	-	SNI 06-6989.11.2004
2.	TSS	221	40	29	80	mg/L	SNI 06-6989.3-2004
3.	Sulfida	0,32	0,08	0,18	0,1	mg/L	SNI 06-6989.3-2004
4.	Amonia NH_3	1,95	1,76	0,83	0,3	mg/L	SNI 06-6989.3-2004
5.	Free chlorine	6,9	8,2	6,76	1	mg/L	SNI 06-6989.3-2004
6.	BOD	15	13	15	20	mg/L	SNI 06-6989.3-2004
7.	COD	2,94	8,33	4,41	200	mg/	SNI 06-

No	Parameter	Test Result			Quality Standards	Unit	Method Reference
		AL-1	AL-2	AL-3			
						L	6989.3-2004
8.	Oil-fat	<1	<1	<1	1000	mg/L	SNI 06-6989.10-2004
9.	Lead (Pb)	0,018	0,019	0,012	0,05	mg/L	SNI 06-6989.3-2004
10.	Cadmium (Cd)	0,006	0,005	0,005	0,001	mg/L	SNI 6989.16-2009
11.	Mercury (Hg)	<0,0001	<0,0001	<0,0001	0,001	mg/L	SNI 6989.78-2009

Source: Laboratory Analysis Results, 2023

Quality standards refer to Minister of Environment Decree No. 51 of 2004 concerning Sea Water Quality Standards for Harbor Waters
a) AL-1 Wastewater that has been mixed with sea water (Port Pool)
b) AL-2 Wastewater that has not been mixed with sea water (Sewerage Channel)
c) AL-3 Sea Water outside the Port pool

The determination of seawater sampling locations at the Belawan Ocean Fisheries Port (OFP) is based on SNI 6989.57.2008, considering surrounding activities that tenants, transportation and mobilization influence. The laboratory analysis results show that several seawater quality parameters exceed the quality standards according to Minister of Environment Decree No. 51 of 2004. TSS and Ammonia parameters at the AL-1 location exceed quality standards, mainly due to high sedimentation from land and tenants carried by seawater to the estuary. Ammonia levels in three locations (AL-1, AL-2, and AL-3) were high due to the dumping of dead fish into the sea and the absence of a Waste Water Treatment Plant (IPAL) at the Belawan OFP so domestic liquid waste was directly discharged into the sea. Industrial activities, paint, wood preservatives, lubricating oils, engine components and fuel in shipping activities, and domestic activities cause the high levels of Pb in the waters of Belawan OFP. The metal content in water can vary depending on the environment and climate. In the rainy season, the content is smaller due to the dissolution process, while in the dry season, the content is higher because the metals in the water are more concentrated.

The source of waste pollution at the Belawan OFP comes from industrial activities and the contribution of communities involved in fishing activities. Pollution can occur intentionally or unintentionally, significantly impacting the quality of the aquatic environment. Fishing activities at the Belawan OFP, such as boat services, landings, fish auction sites and fish markets, are the primary sources of pollution. Fishery waste, including oil from ship engines, spilt ship cargo, and waste from human activities such as loading and unloading catches and dumping rubbish, is routinely dumped into Harbor ponds. Even though it can be overcome technologically through wastewater management installations, it still occurs due to the habit of throwing waste directly into the water. The final disposal of waste originating from fishing activities is

1. Waste from the ship itself, which can come from materials from the ship's engine room such as fuel oil from the engine, pipes or tanks, seawater seepage from the propulsion system or a cooling system where all these materials are mixed with bilge water in the engine room;
2. Originating from ship cargo, which can occur due to leaks or spills during refuelling, discharge of cargo containing waste, cargo falling from the ship, and also due to washing of cargo hold and ballast water systems;
3. It originates from human activities, such as loading and unloading of catches, fish auction activities, and market activities, which can occur due to the dumping of rubbish, waste and sewage into the waters.

Based on the results of the analysis, it was found that the average water usage at Belawan v reached 100,000 litres per day or the equivalent of 100 m^3 per day. Apart from that, the average water usage for each tenant is around 98,000 litres per day or the equivalent of 98 m^3 per day. Therefore, the total need for clean water to meet the needs of 18 facilities at Belawan OFP is 198,000 litres per day, converted to 198 m^3 per day.

In evaluating wastewater generation at Belawan OFP, it is necessary to understand the factors that influence wastewater generation. According to the Ministry of Public Works (2011), wastewater generation can reach 80% of users' clean water consumption, ranging from 45-150 litres per person daily. According to SNI standards, clean water usage per person per day is 120 litres. This estimate shows the significant contribution of clean water consumption activities to forming wastewater at Belawan OFP. Based on an analysis of Belawan OFP wastewater discharge data, it was found that the wastewater discharge reached 158,400 litres per day. For practical purposes and to facilitate monitoring, the wastewater discharge is rounded to 3 m^3 per day, accommodating possible increases in load or demand, even though they are not significant.

Belawan OFP waste has high average characteristics such as TSS with a value of > 221 ppm, COD around 8.33 ppm, Ammonia around 1.95 ppm, and Lead around 0.019 ppm. The liquid waste contained in Belawan OFP contains high amounts of organic compounds. Liquid waste with high organic content and heavy metals is generally processed using biological, physical, or chemical processing. At Belawan OFP, with the characteristics of liquid waste with high organic content, the more commonly used processing system is biological.

Biological wastewater treatment removes and stabilizes dissolved organic pollutants using microorganisms such as bacteria, mold, algae, protozoa, and others. This process involves using supporting media as a place for microorganisms, both attached and suspended, to live and decompose organic substances in the wastewater. Biological processes can be carried out under three conditions: anaerobic (without air), aerobic (with air), and anoxic (with bound oxygen). Anaerobic treatment is generally used for wastewater with high BOD loads, while aerobic treatment is more suitable for lower BOD loads. With strict wastewater quality standards, the choice of processing technology must meet waste quality standards to meet the particular needs and conditions at Belawan OFP. The selection of liquid waste processing technology at Belawan OFP that will be used is based on several criteria, including:

a) The WWTP system must be able to process all wastewater produced by the Belawan OFP
b) Processing efficiency can reach environmental quality standards by the Minister of Environment and Forestry Regulation Number P.68 / Menlhk /Setjen/Kum.1/8/2016.
c) Management must be accessible.
d) The land required for WWTP is a manageable size.
e) Low energy consumption.
f) Low operating costs.
g) Maintenance is easy.
h) The sludge produced should be as small as possible.
i) Can be used for wastewater with a reasonably large BOD load.
j) Must resist fluctuations in discharge and concentration of pollutants in wastewater.
k) Can remove suspended solids (SS) well.
l) The technology used is a technology that uses local components.
m) Cheap construction/investment costs.
n) Availability and ease of replacement of spare parts.

Based on the considerations above, for the liquid waste processing process at small to medium Belawan OFP, the most appropriate process is using a combination system of anaerobic and aerobic biofilters. Good quality treated water can be produced using the anaerobic-aerobic biofilter process with lower energy consumption.

The calculation for the volume of the equalization tank is = 5/24 days x 180 m^3/day = 37.5 m^3. The dimensions of the tub in the form of length (4.5 meters), width (4.5 meters), water depth (2 meters), free space (0.5 meters), adequate volume (40.5 m^3) construction (K300 Concrete), and wall thickness (20 cm).

The design sketch of the Equalization tank can be seen in Figure 2.

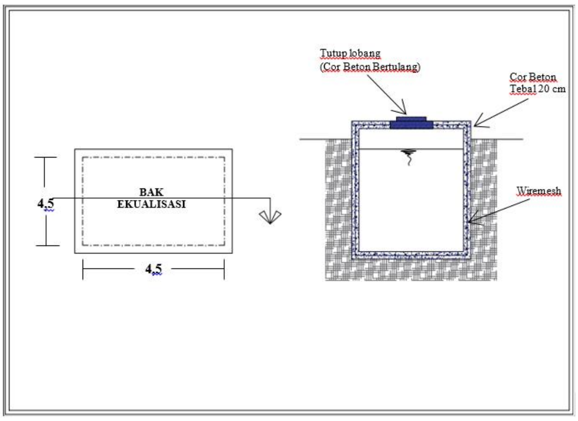

Figure 2. Equalization Tank (Top View and Cut)

The volume of the initial settling tank is 22.5 m^3, with a residence time in the tank of 3 hours and a wastewater discharge of 180 m^3/day. The dimensions of the initial settling tank are Length (2.5 meters), width (4.5 meters), water depth (2 meters), free space (0.5 meters), adequate volume (22.5 m^3), construction (K300 Concrete), wall thickness (0.2 m), surface load (10 m^3/m^2 day), surface load at peak time (20 m^3/m^2 day). The inlet body is 300 mg/I, and the outlet is 225 mg/I. A sketch of the Equalization tank design can be seen in Figure 3.

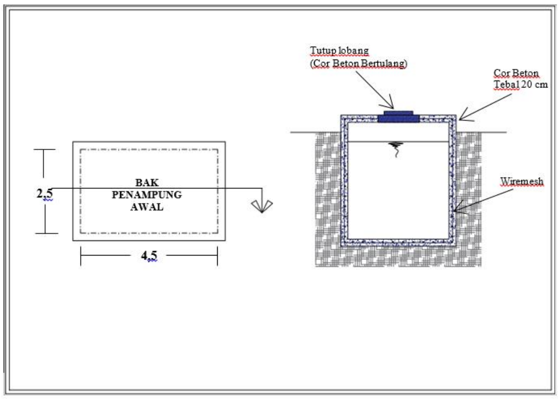

Figure 3. Initial storage tank (Top View and Section)

The volume of the initial settling tank is 22.5 m^3, with a residence time in the tank of 3 hours and a wastewater discharge of 180 m^3/day. The dimensions of the initial settling tank are length (2.5 meters), width (4.5 meters), water depth (2 meters), free space (0.5 meters), construction (K275 concrete), and wall thickness (0.2 m). Inlet and outlet bodies are 20 mg/I. A sketch of the Equalization tank design can be seen in Figure 4.

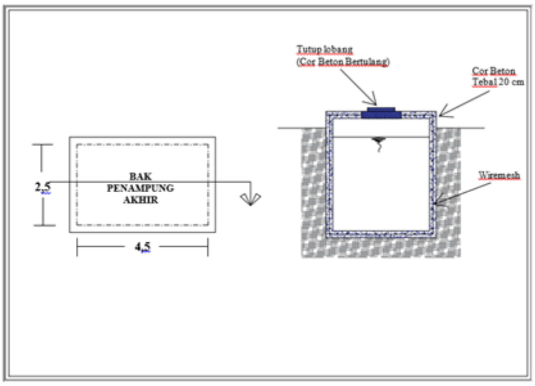

Figure 4. Final storage tank (Top View and Cut)

C. Liquid waste management strategy from Belawan OFPactivities

This research identifies five crucial hierarchical levels in liquid waste management at the Belawan Ocean Fishing Port. Level 1, the Main Goal, emphasizes the highest focus on fluid waste management. This goal is designed to achieve various aspects of environmental sustainability, community welfare, and economic aspects related to fisheries. This goal is to reduce the negative impact of liquid waste by involving effective handling and environmentally friendly management. Level 2, namely actors, refers to parties who have a crucial role in making decisions related to fluid waste management, with Belawan OFP Management considered the critical actor. Level 3, namely Environmental Management objectives, determines specific targets and objectives that support the main goals. Level 4, Criteria, involves increasing locally-generated revenue, community welfare, business opportunities, WWTP prices, and high operations. Level 5, Alternative management strategies, refers to concrete options that can be taken to achieve liquid waste management goals. The proposed alternative strategy involves developing various options for sustainability in fluid waste management at the Belawan Ocean Fishing Port. The alternative strategies presented are a) application of modern technology in waste management, b) improving waste management procedures, c) habitat, and d) law enforcement and strict sanctions for waste handling violations. The weight of factors at each level of waste management at Belawan OFP can be seen in Figure 5.

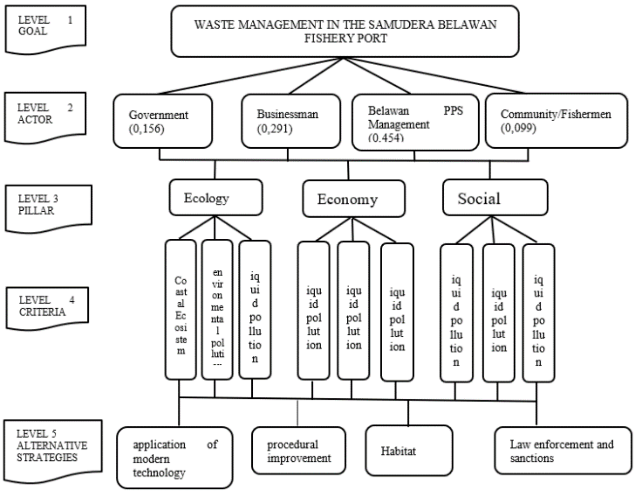

Figure 5. Factor weights at each level of waste management at OFPBelawan

Level 1 is this research's focus level or main goal (ultimate goal), namely designing a waste management model at Belawan OFP. At Level 2 (actors), Belawan OFP management (weight 0.454) plays the most crucial role in sustainable waste management. The second priority actor is the entrepreneur (0.29), as the determinant of factory operations and waste processing technology, determining when and how long the WWTP will be operated. These conditions will ultimately be the primary determinant of whether pollution occurs in the study area. The highest priority is the Government (0.156), and the fourth priority is the community (0.099), which has a role in the implementation stage of waste management. The involvement of both starts from planning and implementation monitoring and evaluation. This improvement is possible because the Government holds the authority in planning and building ports; apart from that, it also plays a role in ensuring environmental sustainability and, at the same time, is tasked with improving community welfare.

Level 3 identifies environmental management objectives, with economic aspects (0.494) being the main priority, followed by ecological aspects (0.369) and social elements (0.137). The social aspect is the final choice for stakeholders. This choice is because what currently needs to be prioritized first is the economy and the environment, so if both are strong, the social aspects will be easier to improve.

At Level 4 (criteria), achieving waste management objectives includes increasing PAD (0.102), increasing community welfare (0.044), increasing business opportunities (0.098), high prices of WWTP and temporary dumping site, as well as their operations (0.102), completeness of infrastructure (0.148). Infrastructure is considered essential to increase economic growth. Considering the high costs of building an WWTP, operational costs will hinder sustainable waste management at the Belawan Ocean Fishing Port. Therefore, we must look for cheap and cheap technology to operate. A parameter also in the same position because the values are the same is the local original income (PAD) increase. This condition is considered necessary by stakeholders, considering that high PAD will help local governments realize their noble desires, such as improving community welfare, increasing natural sustainability, and learning sustainable development, namely development balanced between ecology, economy, and society.

Level 5, the first alternative waste management strategy, namely habituation to waste (0.395), states that if you want waste management to run well, then habituation or getting used to disposing of both liquid and solid waste (garbage) appropriate is the primary determinant successful waste management (Amin, 2009). The second alternative that must be considered is the implementation of zero-waste technology. This alternative should direct organic waste to be processed into organic fertilizer. Waste that is difficult to decompose is sorted first and then reused (reused or recycled). However, if the waste cannot be reused, it is thrown into the landfill. There is a zero master to minimize waste thrown into the ocean.

The third alternative is law enforcement and sanctions. The policies that have been made have yet to overcome environmental pollution because there are many violations on various matters. Apart from this, according to Riani (2012), it is also due to the orientation of law enforcement. These sanctions generally still take the form of relatively high amounts of money, thus allowing violators and officers to both seek mutual benefits. Apart from that, the obedience and discipline of the law enforcement officers themselves. The fourth alternative must receive attention from the Government by developing incentive-disincentive instruments. Institutions that carry out waste and waste management correctly and adequately must be rewarded by being exempt from certain obligations, such as taxes that should be imposed on the institution (Riani, 2012).

CONCLUSIONS

From the results of the analysis and discussion, the following can be concluded:

1. Water pollution in the Belawan OFP comes from the industrial, residential, fisheries, and transportation sectors, involving industrial waste, residential liquid waste, and the impact of shipping activities. The majority of waste management at Belawan OFP is carried out using the incineration method (36%), transported by Cleaning Service officers (22%), or thrown directly into the sea (32%). Most wastewater flow is discharged into ditches/drainage (74%), direct discharge into the sea reaches 24%, and a small amount of waste flows through the yard behind the house (2%).
2. Sea water quality parameters at the sampling location, especially Total Suspended Solids (TSS) and Ammonia, exceed the quality standards set by the Decree of the Minister of the Environment Number 51 of 2004 concerning Sea Water Quality Standards. TSS at the AL-1 location reached a value of 221 mg/L, exceeding the quality standard of 221 mg/L, related to the influence of tides and residential waste. Ammonia parameters at locations AL-1 (1.95 mg/L), AL-2 (1.76 mg/L), and AL-3 (0.83 mg/L) also exceed the quality standard of 0.3 mg/L, caused by the removal of dead fish which triggers the process of putrefaction and eutrophication.
3. Design planning for a wastewater treatment plant (WWTP), which is planned with an anaerobic-aerobic biofilter system, combining an initial sedimentation stage (anaerobic) and a further processing stage (aerobic).
4. Liquid waste management at Belawan OFP develops a waste management model emphasizing Level 2, which shows that Belawan OFP management has the most crucial role in waste management at the port. Level 3 confirms that economic aspects are the main priority in environmental management objectives at Belawan OFP. Level 4 shows that increasing economic growth requires prioritization of increasing locally-generated revenue, community welfare, business opportunities, high prices for WWTP and temporary dumping site, and complete infrastructure. Finally, Level 5 includes alternative waste management at Belawan OFP to achieve sustainability in waste management at the port.

ACKNOWLEDGMENT

The author would like to thank the Belawan ocean fishing port for providing research data.

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