Design and Operating System of Floating Waste Treatment Facility in Belakang Padang

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Abstract. The district of Belakang Padang consists of 108 islands. On these islands, 43 islands are inhabited and 65 islands are uninhabited. The source of pollution on this island comes from community activities on land, such as throwing garbage in the sea and so on. In this paper, Floating Waste Treatment Facility will be designed on Self-Propelled Barge (SPB) with principle dimension: Lpp = 13 m; B = 2.48 m; and T = 0.589 m. The barge can accommodate 7 tons of waste consisting of a garbage tank and a sorting process along with a plastic press machine to reduce the volume of plastic waste. In the calculation of the volume requirement for waste weighing 7 tons, that is 16.43 m³. With an estimated 9 hours of sorting work, it can meet the volume of waste needs. The total investment for the construction of this facility is Rp 362,087,076.12 and the annual operating costs are Rp 458,692,802.67. This facility is feasible to build because of the value of several economic metrics as follows: NPV Rp 488,234,793; IRR 26% and PI 2,348.

1. Introduction

Based on the population of Batam, it is known that the population growth rate in Batam in 2016-2017 is 0.68% with a population density of 10 people/ha or equal to 1016 people/km², and the population growth rate until 2021-2022 is 0.78% with a population density of 11 people/ha or around 1072 people/km² [1]. Population density also occurred in the sub-district of Belakang Padang, Batam city, in 2018 the population of Belakang Padang amounted to 20,266 people, and in 2019 the number increased to 20,469 people so that the population growth that occurred in the district of Behind Padang was 0.01% [2].

Based on the results of the 2017 Batam city sanitation profile instrument, Belakang Padang is a district that has the highest number of unprocessed waste in Batam Island with a figure of 50.87% with data on the population of household heads of 5091. Belakang Padang subdistrict three villages have a high degree of risk in the process of waste management.

The District of Belakang Padang consists of 108 islands, 43 of which have been inhabited while the other 65 islands have yet been occupied. The geography of the district, which is in the form of numerous islands, makes it very susceptible to dumping garbage into the sea. The garbage in the sea will last for more than 1,000 years, which will disturb the life of the biota that live in it. Plastic waste harms the environment, and this notion is corroborated by the opinion of scientists from CSIRO (Commonwealth Scientific and Industrial Research Organization), and the Imperial College London declares that plastics are found in the stomach of 90% of seabirds. It is estimated that this number will increase to 99 percent by 2050[3].
Based on the background above, the author of this paper wants to design a floating waste management facility to help process the waste produced on the island of Belakang Padang, which aims to reduce marine pollution and increase profits from waste recycling. In this study, the analysis is conducted on the activity of solid waste disposal by the residents of Belakang Padang.

2. Method

### 2.1. Determine of Weight and Volume of Garbage Transported Floating Waste Treatment Facility

In determining the amount of Payload at the Floating Waste Treatment Facility, the approach taken is to find the weight of household waste in the Belakang Padang sub-district which is obtained from population data from the BPS, Belakang Padang District 2019, and multiplied by the waste weight factor from the 1995 SNI [4][5].

In determining the volume of FWTF waste, the study took a volume approach by dividing household waste into 3 types of waste, namely Organic, Plastic, and Other Waste. In the city of Batam, the percentage ratio for each type of waste is Organic 45%, Plastic 20%, and other waste 35%.[6]

Journal of Generation and Composition of Municipal Solid Waste, 2014 is an approach to get the value of the density of waste in each type. For organic waste, the density is 890.63 kg/m³, the density for plastic is 202 kg/m³, and the density for other wastes is 433 kg/m³.

### 2.2. Determine Ship Route and Ship Operating Time

Ship operation is the stage to determine the size requirements of the Floating Waste Treatment Facility. In this section, we determine the amount of waste on each island in the District of Belakang Padang, determine the most optimal route for collecting waste on each island by estimating the size of the available tanks, and determine the optimal time by limiting working time by Circular 65/BKD-PP/III. /2016 The provisions of Batam city employees working hours are 16.00 [7]

The time needed to travel from one island to another, first converted to distance units, from km to Nm. The optimal ship service speed is 8 knots, the results of the inter-island time calculation already estimate load garbage time and maneuver. In this Research, load garbage time. In this study, the loading time of cart waste was obtained from conducting experiments on land, while the maneuvering time was obtained from observations of similar ships on each island.
2.3. Provide the Conceptual Design
Conceptual design is the first stage in the design process that translates mission requirements into a basic definition of the planned ship[8]. It provides the principal dimensions of the ship and a Lines Plan drawing. The principle dimensions will be taken from the data of existing ships that have the same load as the needs by considering port characteristics, such as length and depth.

2.4. Provide the General Arrangement and Key Plan
The next step is to provide a general arrangement of facilities and key plans for some of the systems onboard. Before making the design of the General Arrangement, we calculate the ship's resistance and determine the main engine. After determining the main engine, we calculate the propeller along with the rudder and steering engine. After the calculations are complete, then the General Arrangement design will be made, the General Arrangement will explain the placement of waste processing equipment, space requirements for placing garbage from land, accommodation space, supporting machines, and others. Which key plan describes the piping and instrumentation diagrams of some systems, such as the fuel system, and electrical plan.

2.5. Provide Engineering Cost Estimation
Engineering cost estimation is obtained from the bill of quantity multiplied by the price of each material or equipment. It shows the capital cost in building the facility, but it may be different from owner cost estimation which is included with facility administration.

2.6. Provide Analysis and Conclusion
The final step is an analysis and conclusion whether the facility with a certain dimension and design is worth to be built or not by analyzing using the feasibility study above. It also provides ship particulars, the general arrangement of the facility and key plan, technical specification of any equipment and machinery needed, and engineering cost estimation.

3. Results and Discussion

3.1. Waste Load Determination
Calculation of payload needed from the 1995 SNI, using this formula below:
Weight of waste/ day = Total population of Belakang Padang Sub-district 2020 x 0.625 – 0.7 (Choosing 0.7).

\[ = 20,469 \times 0.7 \]
\[ = 14.32 \text{ Ton} \]

The target for collecting waste 7 ton every 3 days. And volume obtained from the 7 Ton payload, requires Volume = 16.1435 m³ based on the comparison of types of waste in the city of Batam.

3.2. Ship Operational
- Determination of Shipping Routes
To load household waste on each island in the district of Belakang Padang, a route design according to the operating concept must be determined first.
and machine requirements needed at the Floating Waste Treatment Facility.

![Figure 2. Route of Floating Waste Treatment Facility](image)

### Table 1. Distance Between Ports

| Code | Jetty Name                  | Distance | x | a   | b   | c   | d   | e   | f   | g   | h   | i   | Volume of Waste |
|------|-----------------------------|----------|---|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----------------|
| x    | Lokasi Belakang Padang      | x        | 0 | 7.6 | 15.04 | 16.09 | 33.28 | 39.82 | 46.22 | 48.35 | 48.35 | 13.44 | 2.5854          |
| a    | Pulau Mecan                 | a        | 7.6 | 0   | 7.44 | 8.49 | 25.68 | 29.98 | 31.22 | 38.62 | 40.75 | 49.68 | 0.8618         |
| b    | Pemping                     | b        | 15.04 | 7.44 | 0   | 1.05 | 18.24 | 22.54 | 23.78 | 31.18 | 33.31 | 42.24 | 0.90276        |
| c    | Labon Besar                 | c        | 16.09 | 8.49 | 1.05 | 0   | 17.19 | 21.49 | 22.73 | 30.13 | 32.26 | 41.19 | 0.60184        |
| d    | Kasu                        | d        | 33.28 | 25.68 | 18.24 | 17.19 | 0   | 4.3 | 5.54 | 12.94 | 15.07 | 24   | 1.6139         |
| e    | Terung kecil                | e        | 37.58 | 29.98 | 22.54 | 21.49 | 4.3 | 0   | 1.24 | 8.64 | 10.77 | 19.7 | 2.76068        |
| f    | Terung                      | f        | 38.82 | 31.22 | 23.78 | 22.73 | 5.54 | 1.24 | 0   | 7.4  | 9.53 | 18.46 | 1.82712        |
| g    | pecong kecil                | g        | 46.22 | 38.62 | 31.18 | 30.13 | 12.94 | 8.64 | 7.4  | 0   | 2.13 | 11.06 | 1.6552         |
| h    | pecong                      | h        | 48.35 | 40.75 | 33.31 | 32.26 | 15.07 | 10.77 | 9.53 | 2.13 | 0   | 8.93 | 0.4138         |
| i    | kasu kecil                  | i        | 52.44 | 49.68 | 42.24 | 41.19 | 24  | 19.7 | 18.46 | 11.06 | 8.93 | 0   | 3.2278         |

### Determination of Ship Operating Time

#### Table 2. Estimate Ship Voyage Time Between Island with 8 Knot

| Point | Nm | Hours | Minutes | Code | Jetty Name                  | Number of Cart | Time 6 Minutes/Cart | Spare time 3 Minutes | Maneuver Time | Total time |
|-------|----|-------|---------|------|-----------------------------|----------------|---------------------|----------------------|---------------|------------|
| X-A   | 4.10 | 0.5 | 31      | x    | Lokasi Belakang Padang      | 3              | 18                  | 9                    | 5             | 32         |
| A-B   | 4.02 | 0.5 | 30      | a    | Pulau Mecan                 | 1              | 6                   | 3                    | 5             | 14         |
| B-C   | 0.57 | 0.1 | 4       | b    | Pemping                     | 1              | 6                   | 3                    | 5             | 14         |
| C-D   | 9.28 | 1.2 | 70      | c    | Labon Besar                 | 1              | 6                   | 3                    | 5             | 14         |
| D-E   | 2.32 | 0.3 | 17      | d    | Kasu                        | 2              | 12                  | 6                    | 5             | 23         |
| E-F   | 0.67 | 0.1 | 5       | e    | Terung kecil                | 3              | 18                  | 9                    | 5             | 32         |
| F-G   | 4.00 | 0.5 | 30      | f    | Terung                      | 2              | 12                  | 6                    | 5             | 23         |
| G-H   | 1.15 | 0.1 | 9       | g    | pecong kecil                | 1              | 6                   | 3                    | 5             | 14         |
| H-I   | 4.82 | 0.6 | 36      | h    | pecong                      | 1              | 6                   | 3                    | 5             | 14         |
| I-X   | 7.26 | 0.9 | 54      | i    | kasu kecil                  | 3              | 18                  | 9                    | 5             | 32         |

### 3.3 Ship Design

In this section, we will design the design of the Floating Waste Treatment Facility from the needs that we have calculated in the previous stage. From making Lines plans and dimensions to the electricity and machine requirements needed at the Floating Waste Treatment Facility.
• Lines Plan and Ship Dimension

Table 3. Data of Sistership

| No. | Name of Ship | LoA (m) | Draught (m) | Breadth (m) | DWT (Tons) | Cargo Capacity (Kt) | Speed (Km/h) | L/B | B/T | L/T | LBT | Estimate CHF 2004 | Percent of LWT |
|-----|--------------|---------|-------------|-------------|------------|---------------------|--------------|-----|-----|-----|-----|------------------|----------------|
| 1   | Amethyst 99  | 46      | 2           | 10          | 753        | 600                 | 6            | 4.6 | 5.0 | 23.0 | 920 | 0.85             | 78.59          |
| 2   | Petro Ocean | 41      | 1.92        | 12.2        | 772        | 375                 | 7.4          | 3.4 | 6.4 | 21.4 | 960 | 0.75             | 119.10         |
| 3   | Petro Ocean | 43.9    | 1.9        | 8           | 352        | 280                 | 8.5          | 5.5 | 4.2 | 22.1 | 667 | 0.70             | 146.88         |
| 4   | Bionergo VII| 42.8    | 2          | 8.5         | 500        | 500                 | 3.3          | 5.0 | 4.3 | 21.4 | 728 | 0.88             | 143.13         |
| 5   | Petro Ocean | 37.4    | 2          | 7.3         | 315.9      | 500                 | 8            | 5.1 | 3.7 | 18.7 | 546 | 0.69             | 178.40         |
| 6   | Petro Ocean | 47.99   | 3          | 10          | 952.5      | 500                 | 8            | 4.8 | 3.3 | 16.0 | 1440| 0.75             | 1388           |
| 7   | Haihui 99  | 43      | 2.4         | 9.3         | 583        | 531                 | 5.1          | 4.6 | 3.9 | 17.9 | 960 | 0.90             | 277.00         |

To determine the dimensions of the Floating Waste Treatment Facility, it is necessary to compare the ratio with the sister ship and the principle of naval architecture. Vol. 1, Page 19 [9].

Table 4. Ratio of Dimension

| Ratio of Dimensions                     | Accepted | Principles of Naval Architecture Vol. 1, page 19, published by The Society of Naval Architects and Marine Engineers, edited by Edward V. Lewis, 1988 |
|-----------------------------------------|----------|---------------------------------------------------------------|
| Lpp - Length to Breadth                 | Accepted | KRI Vol. II, sec. 1.4.1 pg. 1-1                                |
| LoA - 13.59                             |          |                                                                |
| Lwp/B - 3.5                             |          |                                                                |
| Length to Draught                       | Accepted |                                                                |
| Lwp - 13                               |          |                                                                |
| Length to Draught                       |          |                                                                |
| Lwl - 13.02                             |          |                                                                |
| Length to Draught                       | Accepted |                                                                |
| B - 2.48                                |          |                                                                |
| Breadth to Draught                      | Accepted |                                                                |
| T - 0.589                               |          |                                                                |
| B/T - 1.8                              | Accepted |                                                                |
| Restricted Ocean Service                |          |                                                                |
| V, 8 Knot                               |          |                                                                |
| Cb - 0.702                              | Accepted |                                                                |
| H > Lwp/16                              |          |                                                                |
| Fn - 0.32                               | Accepted |                                                                |
| 1.00 > 0.81                            |          |                                                                |

Figure 3. Lines Plan in AutoCad

• Resistance-Power Calculation

To determine the required power installed at the Floating Waste Treatment Facility (FWTF), the calculation of resistance is needed to be carried out first. In this case, the resistance of FWTF is calculated by using Holtrop Method. For getting total resistance, we need added friction resistance \((R_f(1+k_1))\), adding resistance \((R_{app})\), wave resistance \((R_w)\), resistance for bulbous bow, resistance for transom, and model ship correlitive resistance \((R_m)\).

Calculation of Friction Resistance, using this formula below:
Calculation of Adding Resistance, using this formula below:

\[ R_{\text{add}} = 0.5 \times \alpha S V^2 \times (1 + k_1) \]

\[ = 0.5 \times 1025 \times 36.002 \times 4.112^2 \times 1.22 \times 861.69 \text{ N} \]

Calculation of Wave Resistance, using this formula below:

\[ R_w = \rho g \sqrt{\frac{\text{m}}{\rho g}} \exp \left\{ m_1 F_{ad} + m_2 \cos \left( \lambda F_{ad}^2 \right) \right\} \]

\[ = 3.058 \times 1 \times 1 \times 13.35 \times 1025 \times 9.8 \times 1025 \times 9.8 \times 0.3876 \times (2.176 \times 0.3876 + 0.392 \times 0.3876^2) \]

\[ = 1255.55 \text{ N} \]

Calculation of Model Ship Correlative Resistance, using this formula below:

\[ R_{\text{m}} = 0.5 \rho V^2 S C_A \]

\[ = 0.5 \times 1025 \times 4.112^2 \times 36 \times 0.00077 \]

\[ = 238.037 \text{ N} \]

The result of Total Resistance is 2785.207 N

- **Required Power Calculation and Selecting Engine**

Ship resistance is an initial value to determine the Effective Power (PE) in which it is needed for determining the required Brake Horsepower (BHP).

Calculation of Effective Power, using this formula below:

\[ P_E = R_{\text{total}} \times V_s \]

\[ = 2.7852 \times 4.112 \times 15.35 \text{ HP} \]

With Effective Power is 15.35 HP, Delivered Power is 23.97 HP with the formula below:

\[ PD = \frac{P_E}{P_c} \]

\[ = 15.35 / 0.6403 \]

The Shaft Power with formula \( PD / n \) transmission (98%) is 29.98 HP, Brake Horse Power at Service Continuous Rating (BHP SCR) with formula \( PS / n \) Gearbox (96%) is 25.48 HP, Brake Horse Power at Maximum Continuous Rating (BHP MCR) with formula \( BHP_{MCR} / 85\% \) is 29.98 HP. After we get the BHP MCR, we choose the Mini Sole 33 for Floating Waste Treatment Facility main engine with 30.96 HP, and 3000 Rpm, and we choose reduced gearbox MRV 075-100 with a 7.5 Ratio for 400 Rpm out.

- **LWT, DWT, and Consumable Weight**

LWT is a lightweight tonnage, and forgetting the LWT, we need added structure weight (WST) and this formula below:

\[ W_{ST} = K.E \times 1.36 \]
Outfit and accommodation weight ($W_{OA}$) and this formula below:

$$\text{WOA} = 0.05 \times \text{Lpp} \times \text{B}$$

$$= 1.93 \text{ Ton}$$

Engine installation estimation weight is 0.3 Ton, and reserve weight ($W_{res}$) with formula below:

$$W_{res} = 2-3\% (W_{ST}+W_{OA}+W_{MT})$$

$$= 0.105 \text{ Ton}$$

And we get 5.68 tons for LWT from $W_{ST}+W_{OA}+W_{MT}+W_{RES}$. while DWT is deadweight tonnage and forgetting the DWT from displacement minus LWT is 8.01 ton. While consumable weight can be calculated by considering the weight of fuel both for the main engine and auxiliary engine, lube oil, freshwater, and provision for the 6 crew. We get consumable weight with 0.9882 tons. And payload is DWT minus Consumable Weight is 7.02 tons. After we know the LWT, we can get ship empty draught with 0.3 m.

- **Propeller, Rudder, and Deck Machinery**

Propeller principle for this Floating Waste Treatment Facility with type propeller is B3-40, blade number ($Z$) is 3, Diameter is 0.147 m, Pitch Ratio ($P/D$) is 0.3, and efficiency is 58% with shaft propeller. [10]

Rudder calculations are used to determine the amount of torque needed to change the course of the ship when the ship, as well as to determine the large power of the steering engine, and the formula of Engine Steering Power this below:

$$N_{Fs} = (Q_{r} \times w_{rs}) / 75$$

$$= 0.043 \text{ HP}$$

with torque on the steering wheel formula below:

$$Q_{r} = C_{r} \times r$$

$$= 0.064 \text{ kNm}$$

For the anchoring, According to the Non-Convention Vessel Standard Indonesian Flagged (NCVS), ships with a length of up to 24 meters, use the table (NCVS) and with Floating Waste Treatment Facility LPP is 13 m and H is 1 m, it is found that the anchor needs with a weight of 27 kg, and 2 anchors are needed with the Stockless Anchor type. And for bower anchor requirement according to NCVS must have a length of 100 meters with a diameter of 10 mm which are of the type Short-Link Chains, with 1 Mooring ropes with a length of 50 meters.

- **General Arrangement**

General Arrangement is a general plan drawing to project the existence of loading space, machine room, and other required space. The need for supporting machines or generators as well as the needs for machinery and cargo tanks are also taken into account in this section. First, we calculate the Gross Tonnage (GT). GT is the total volume of the ship, including the volume under the deck (freeboard and displacement volume), and the superstructure and GT formula there below are 7.19 tons. After that we know the GT, we can draw the tank requirement for the Floating Waste Treatment Facility. The list of volume requirements is below.
After we know the tank requirement, we can draw the general arrangement. Drawings of the general arrangement design have been made and have been adapted to the calculation of the needs of the prime mover equipment, and the tank capacity requirements of workers and tanks of Floating Waste Treatment Facility cargo.

**Table 5. Tank Arrangement With its Capacity**

| Name Of Tank                     | Volume Units |
|---------------------------------|--------------|
| Volume of Main Household Waste Tank | 11.652 m³  |
| Volume of Lindi Water Tank      | 1.743 m³    |
| Volume of Fuel Oil Tank         | 0.1096 m³   |
| Volume of Fresh Water Tank      | 0.423 m³    |
| Volume of Sludge Tank           | 0.004 m³    |
| Volume of Sewage Tank           | 0.418 m³    |
| Volume of Sorting Plastic Waste Tank | 1.205 m³  |
| Volume of Sorting Organic Waste Tank | 1.205 m³  |
| Volume of Sorting Other Waste Tank | 0.256 m³  |
| Volume of Press Plastic Waste Tank    | 0.358 m³    |

**Figure 4. General Arrangement Drawing**

- **Key Plan of Machinery System**

The total capacity of the Lindi water tank is 1.743 m³ that is planned to be discharged to the sewage tank in 45 minutes, total capacity is 2.32 m³/h. The selection pipe is 20A with an outer diameter of about 26.7 mm with a thickness is 2.87 mm. While, the required head of the pump is 14.9 m and we choose CDX 70/05 Ebara water pump for Lindi water system with capacity 3 m³/h, head 18.4 m, and 0.37 kW. While the total capacity of fire fighting formula below:

\[
Q = \frac{4}{3} \times 9.49
\]

\[
= 12.7 \text{ m}^3/\text{h}
\]

The Calculation of fire main pipe, using this formula below:
The selection pipe is 32A with an outer diameter of about 42.3 mm with a thickness is 3.56 mm. While, the required head of the pump is 19.88 m and we choose Yinjia 2DK30 centrifugal pump with a capacity is 15 m$^3$/h, Head 26.5 m, and power 2 kW. The drawing below explains Lindi and the fire fighting system:

![Figure 5. Lindi Water System Plan](image)

![Figure 6. Fire Fighting System Plan](image)

The fuel oil system and domestic system researchers do not use a pump to push the gasoline fluid from the tank to the engine and freshwater to the toilet but will use the force of gravity to reduce costs. The total capacity of the fuel tank is 0.109 m$^3$ using a level indicator to help when supplying fuel into the engine. While the total capacity for the freshwater tank is 0.379 m$^3$ and the total capacity for the sewage tank is 0.418 m$^3$ without using special treatment. It's planned that the residual substances from the sewage tank will be sucked up directly at the port with a short connection.

- **Key Plan of Electrical**

The electrical system on the ship is needed to activate/turn on the equipment on the ship, all main equipment and supporting equipment on average require an electricity supply. In Floating Waste Treatment Facility (FWTF), electricity needs are used for lighting needs such as lights on decks and gangways, as well as sockets for crew electricity needs. The list of generator requirements is stated below. The total load generated is in sailing conditions with a load of 2.75 kW. And from the largest load for consideration in choosing the generator required by the FWTF.

| No. | Item                      | Sailing | Cargo Handling | At Port |
|-----|---------------------------|---------|----------------|---------|
| 1   | Machinery Part (A - B)    | 0.00    | 1.81           | 0.00    |
|     | Deck                      |         |                |         |
| 2   | Machinery               | 0.23    | 0.00           | 0.23    |
|     | (C)                      |         |                |         |
| 3   | Electrical Part (D - E)   | 0.00    | 0.00           | 0.00    |
|     | Continuous Load          | 1.00    | 0.94           | 0.94    |
|     | Intermittent Load        | 0.05    | 0.00           | 0.05    |
| 4   | Total Load Pwr           | 1.22    | 2.75           | 0.94    |
|     | Continuous Load          | 1.86    | 0.00           | 1.90    |
|     | Intermittent Load        |         |                |         |
| 5   | Diversity Factor (0.6 x Intermittent Load) | 1.12 | 0.00 | 1.14 |
| 6   | Number of Load           | 2.34    | 2.75           | 2.08    |
| 7   | Generator Work           | 3 x 1   | 3 x 1          | 3 x 1   |
| 8   | Working Capacity         | 3.00    | 3.00           | 3.00    |
| 9   | Load Factor              | 0.78    | 0.92           | 0.69    |
| 10  | Shore Connection (1.15 x Number of Cargo Handling) | - | 3.17 |
From the results of the calculation of the electricity demand on the FWTF which is 3kW, the author chooses to use a generator that has a load in the range of 3 kW. And choose the generator JP5000 with a load of 3 kW.

**Drawing of Electrical Plan**

Schematics and electrical lines are needed in classifying electrical lines according to their needs and places and anticipating a drop in electricity called Junction. In FWTF, it is divided into 4 Junctions, namely Junction Power which consists of a Fire Fighting pump, general service pump, and air conditioning. Next is the Junction Monitor which consists of navigation lights such as mast Head Light, Starboard, and portside light, and stern light. Next is Junction Lighting which consists of deck navigation lights, gangway, and room outlets. And the last one is Junction Navigation, which consists of communication tools and ship safety devices that require an electricity supply such as a fire detector unit. The drawing below explains each junction.

3.4. *Mechanism For Handling Waste at the Floating Waste Treatment Facility*

In this study, the press machine takes 3 minutes in a 1-time plastic press process, with an initial capacity of 0.216 m³, with the machine can reduce the volume by 40% of the original volume, then the result of one press is 0.0864 m³ according to the brochure from the Press Machine. And in this study, researchers experimented with sorting waste by 4 garbage officers to sort waste. The results obtained are different volumes that can be transported from each type of waste, but the authors take the result that 1 officer can sort waste by 5 liters per 10 seconds or 0.003 m³/minute.

With the results of the time needed to sort and press waste on the Floating Waste Treatment Facility, the researchers tried to optimize it to get the number of employees needed, with travel and loading time limits and an additional 30 minutes for sorting garbage, requiring a total of janitor employees 4 people. The details are as follows:
Table 7. Time of Operational Waste Treatment

| Time  | Event                                      | Description                                                                 |
|-------|--------------------------------------------|-----------------------------------------------------------------------------|
| 0     | 03:00 AM                                  | Wash waste for 2 hours                                                       |
| 0     | 06:00 AM                                  | Wash waste for 2 hours                                                       |
| 0     | 09:00 AM                                  | Wash waste for 2 hours                                                       |
| 0     | 12:00 AM                                  | Wash waste for 2 hours                                                       |
| 0     | 03:00 PM                                  | Wash waste for 2 hours                                                       |

3.5. Bill of Quantity and Engineering Cost Estimation

Based on the previous design calculations, from the design process, namely the determination of the lines Plan to the Key Plan, where all the main equipment from supporting the ship, namely the main equipment and its installation, are calculated as initial capital for shipbuilding. Engineering cost estimation can be done based on the bill of quantity above by considering the specifications. This will be used to determine the Capital Expenditure to build this facility. The following table lists the equipment and equipment specifications.

Table 8. Bill Quantity and Engineering Cost

| No   | Item Description | Brand/Type | Specification | Qty | Total Price |
|------|------------------|------------|---------------|-----|------------|
| 1    | Banjo Die        | Structural B. Oitung/Work | 8 x 13.59 | 1 | IDR 32,787.62 |
| 2    | Main Engine      | Mini Sco 33 | 23.1 kW 3000 RPM | 1 | IDR 95,117,378.00 |
| 3    | Gearbox          | MRW 753 /110 B | 7.5:1 | 1 | IDR 2,795,000.00 |
| 4    | Main Generator   | L.S Power JP5000 Generator | 3,500 Hz 2300 rpm | 1 | IDR 2,029,720.00 |
| 5    | Fire Fighting Pump | Vtst. 25KN | 15 m3/hr, head: 26.5 m 2 V | 1 | IDR 855,062.32 |
| 6    | General Service Pump | Ebena CDX 70/05 | 3 m3/hr, head: 18.4 m 0.73 kW | 1 | IDR 4,600,000.00 |
| 7    | Steering Engine  | RWO GmbH Schott. 5-DEB 0.5 | 0.5 m3/hr, 2.7 kW | 1 | IDR 160,072,672.98 |
| 8    | Press Machine     | Runkuh Maxmon | 400 x 400 x 400 mm | 1 | IDR 10,000,000.00 |
| 9    | Air Conditioning  | Mitsubishi SKR100CR-S3 | 1/2 PK 0.49 kW | 1 | IDR 3,255,000.00 |
| 9    | M/F/H Radio Phone | Furuno FS 150 | 10.20 kHz | 1 | IDR 40,000,000.00 |
| 11   | Local Heater      | Standard Horizon 220 SW | Audio Output 30 watt peak | 1 | IDR 400,787.62 |
| 12   | Magnetic Compass  | Richite B-81 | 3" Comb/Dipper | 1 | IDR 2,029,575.62 |
| 13   | Horn              | Sermott and Ongaro SOMA-1003 | 105 dB @ 1 meter | 1 | IDR 494,032.00 |
| 14   | Fire Alarm Bell   | Hochiki FFB-150V | 75.6 dB at 10 feet | 2 | IDR 700,000.00 |
| 15   | Emergency Lamp    | Marine Lighting 60 w | Range 12 Nm | 1 | IDR 427,328.00 |
| 16   | Marine Side Light | IMC 00025 | LED 50000 Hours lifetime | 1 | IDR 450,000.00 |
| 17   | Marine MastLight  | DHMSS/CHX3-20P | LED 50000 Hours lifetime | 1 | IDR 204,000.00 |
| 18   | Life Jacket       | Atoll | Size L | 6 | IDR 330,000.00 |
| 19   | RingBuoy         | Naveco SS55E XING | OD 72 cm, 10.45 cm | 1 | IDR 255,000.00 |
| 20   | Ajar Dry Chemical Powder | PSP-45 | kapudan 4.5 kg | 1 | IDR 395,000.00 |

3.6. Feasibility Study

A feasibility study is a stage to determine whether this design can be recommended to be implemented or revised or not procured. Feasibility study, first we calculate the CapEx and OpEx. The CapEx needed IDR 561,767,554.93 and OpEx needed IDR 465,746,504. [11]

3.7. Payback Period

After determining total expenditure and revenue each year, then the charge for services, both transport of waste, and the sale of waste can be defined. Can be defined by dividing the type of waste and its weight, then multiplied by the price of waste per type, such as plastic waste IDR 1,000 per kg, Organic
waste IDR 500 per kg. Other waste IDR 1,500 per kg, and annual income can also attract retribution from the head of the family as much as IDR 5,000 per month.

3.8. Cash Flow
Cash flow, net cash for accounting net income flowing into (or out of) the project for a certain period (return on capital), can be determined after determining the amount of expenditure and annual income. In this case, the balance amount can also be determined. Cash The flow and total balance for this facility up to the 20th year of operation is shown.

Table 9. Cash Flow Table

| Tahun | Tahun | Total Net Cash Flow | Present Value |
|-------|-------|---------------------|---------------|
| 0     | 2022  | -Rp.574,644,785     | -Rp.574,644,785|
| 1     | 2023  | -Rp.501,529,897     | -Rp.440,285,456|
| 2     | 2024  | -Rp.429,889,299     | -Rp.330,781,240|
| 3     | 2025  | -Rp.363,495,578     | -Rp.245,349,161|
| 4     | 2026  | -Rp.302,327,619     | -Rp.179,002,221|
| 5     | 2027  | -Rp.245,974,876     | -Rp.127,791,643|
| 6     | 2028  | -Rp.194,063,810     | -Rp.88,412,861|
| 7     | 2029  | -Rp.146,249,534     | -Rp.58,446,772|
| 8     | 2030  | -Rp.102,213,639     | -Rp.35,831,917|
| 9     | 2031  | -Rp.67,662,172      | -Rp.18,961,608|
| 10    | 2032  | -Rp.45,323,780      | -Rp.6,561,189 |
| 11    | 2033  | -Rp.10,052,014      | -Rp.2,378,481 |
| 12    | 2034  | Rp.41,696,399       | Rp.6,546,467 |
| 13    | 2035  | Rp.70,622,751       | Rp.12,954,655|
| 14    | 2036  | Rp.97,627,988       | Rp.15,992,165|
| 15    | 2037  | Rp.122,293,832      | Rp.17,132,936|
| 16    | 2038  | Rp.144,987,963      | Rp.17,817,810|
| 17    | 2039  | Rp.165,665,098      | Rp.17,680,207|
| 18    | 2040  | Rp.186,067,984      | Rp.17,602,359|
| 19    | 2041  | Rp.202,728,306      | Rp.16,815,981|
| 20    | 2042  | Rp.218,967,545      | Rp.15,932,456|

Figure 10. Graph of Cash Flow

3.9. Economic Parameter
NPV is one of the economic parameters that can be determined by subtracting the project initial investment of the present value of the cash inflows discounted at the same rate as capital costs. In this case, the NPV shows Rp. 218,967,545 i.e means this project is feasible to build because the value is more than 0. Meanwhile, IRR is also one of the economic parameters that be defined by calculating the interest rate that equated with the investment present value and present value in next years. In this project, the IRR shows 15% which means this project is feasible to be built because the value is higher than the discount factor. Meanwhile, PI is also known as the benefit-cost ratio is a comparison between the present value of future cash flows with the value of the investment. In this project, the PI shows 1.381 which means this project is also feasible to be built because the value is higher than 1.0.
4. Conclusion

This bachelor thesis “Design of Floating Waste Treatment Facility in Belakang Padang” has following results: According to the Central Bureau of Statistics of Belakang Padang 2020, the population of Belakang Padang reached 20,469 people. The Floating Waste Treatment Facility will take 50% of the total, which is 7 tons of waste. By calculating the volume produced from 7 tons of waste based on the distribution of waste types, it requires a volume of 16.43 m³ to accommodate waste. The operational of Floating Waste Treatment Facility passes through Mecan Island, Pemping, Labon Besar, Kasu, Kasu Kecil, Kasu, Pecong kecil, Pecong, Kasu, and back again to Belakang Padang. The trip has a mileage of 38.19 nm. And from that distance, the Floating Waste Treatment Facility takes 9 hours and 30 minutes for the voyage time, the time to load garbage from each island, the length of the ship's maneuver, and the need for sorting garbage along with a garbage press to reduce the volume of waste. From these results, the Floating Waste Treatment Facility requires a ship speed of 8 knots to optimize operational time. Based on the needs above, the size of the SPB can be explained as follows: Length between Perpendicular (L_pp) is 13 m, Length Overall (LoA) is 13.59 m, Breadth (T) is 0.589 m, Height (H) is 1 m, and Coefficient of Block (Cb) is 0.702. The capacity of the main household waste tank is 11,659 m³, the plastic waste sorting tank is 1,205 m³, the organic waste sorting tank is 1,205 m³, and the other waste sorting tank is 0.256 m³. Based on the Feasibility Study, the Floating Waste Treatment Facility is feasible because it has an NPV of IDR 218,967,545; IRR 15%, and PI 1.381. and requires a return on investment in the 10th year.

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