

## Boat Design And Prototype For Waste Management in the Banjir Kanal Timur (BKT) Jakarta

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### Abstract

*The Ujung Menteng East Flood Canal is one of the objects that is still lacking in efforts to prevent river pollution. Therefore, to overcome this problem, an environmentally friendly waste management boat is designed by using electric power for the boat's electrical equipment needs and propulsion. By analyzing the resistance, stability using Maxsurf Software, the size of the garbage boat is obtained, namely LOA = 5.50 m, LPP = 4.825, B = 2.30 m, H = 1.10 m and T = 0.27 m, with uses 2 batteries for propulsion and conveyors, and 12 solar panels. This boat has a crew of 3 people. made a prototype boat handling environmentally friendly waste by using electric power for the needs of boat electrical equipment and propulsion. By selecting materials using the SWOT method. The purpose of making this boat prototype is to make a waste management boat based on renewable energy and to make an environmentally friendly garbage boat.*

**Keywords:** Garbage boat; solar panels; electric motor; East Canal Flood, boat prototype

## 1. INTRODUCTION

The Minister of Environment stated that of all rivers or large rivers in Indonesia, 75% are categorized as heavily polluted. Most of the causes of water pollution in Indonesia are caused by domestic waste, of course this is related to the lack of awareness of the community around the river, regarding the cleanliness of the river environment and the unavailability of waste cleaning tools in the area (Widad, 2020). The North Jakarta Regional Environmental Management Agency (BPLHD) stated that every day there is at least 14 thousand m<sup>3</sup> of waste that fills an area of 514 km<sup>2</sup> around the Jakarta River. According to existing data, approximately 54% of waste in Jakarta is plastic, 24% wood, 14% plants and leaves, and the remainder (8%) is rubber, glass bottles/cups, cloth, and cork. The amount of waste produced by Jakarta residents per day from 2017 to 2019.

One of the canals that has a significant impact on the people of Jakarta but has a similar fate in the form of a large amount of waste in the canal is the BKT (East Flood Canal). This canal requires waste management boat infrastructure, so that the waste problem can be controlled. This waste management boat is expected to be a solution in cleaning up waste in the BKT (East Flood Canal) area, so that the volume of waste in the BKT (East Flood Canal) area can be controlled. In the planning process of this waste management boat using the help of Maxsurf and AutoCad software. The planning boat capacity was carried out by comparing the boat's transport capacity with the volume of waste in the BKT (East Flood Canal) area.

The results of the study carried out for waste cleaning activities in the East Flood Canal are boats using hypalon ocracel material because the material is light and readily available. Boat dimensions: LoA = 5.50 m; Lpp = 4.825 m; B = 2.30 m; H = 1.10 m; T = 0.27 m; Vs = 4 knots and Crew = 3 persons. This garbage boat carries 50 kg of garbage. The planned boat uses renewable energy sources in the form of solar cells. The garbage collection system from the river uses a conveyor to then be sent to the final waste disposal site.

In the process of tackling pollution in the BKT (East Flood Canal) area, a pollution control boat is planned that can accommodate the volume of waste contained in the BKT (East Flood Canal) area. This control boat has a propulsion mechanism with a power source derived from

renewable energy, so it is hoped that this boat will also contribute to reducing exhaust emissions. Prototype creation was carried out using a SWOT analysis (Strength, Weakness, Opportunity, Threat) to calculate what types of materials and components can be used. After that, the design process was carried out using software to obtain the shape of the boat's hull and analysis related to the boat's strength and stability.

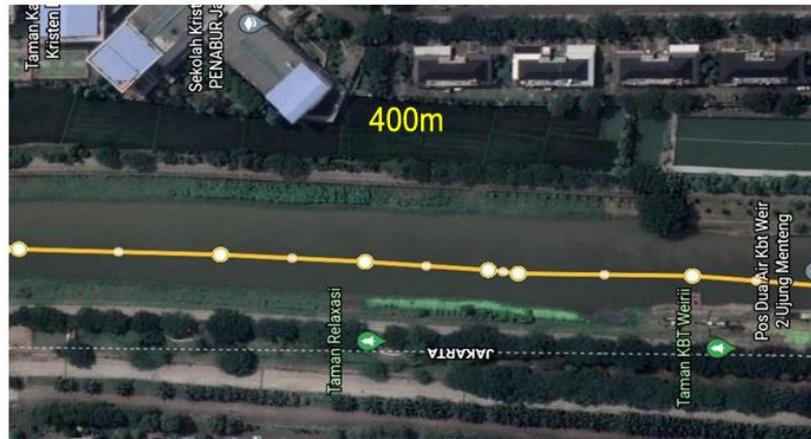


Figure 1 Research location in Bankir Kanal Timur

A pollution control boat is needed to operate at BKT (East Flood Canal) gate 2. With an operating area of 1200 m and a daily operating range of 400 m. This canal area has a depth of 2 to 3 meters. The type of waste generally found in BKT (East Flood Canal) is inorganic waste consisting of plastic, bottles, rubber and cans. BKT (East Flood Canal) gate 2 is located in Ujung Menteng, East Jakarta. For the manufacture of the prototype using Hypalon Orca material, this material is used after going through material selection using the SWOT method. The size of this prototype uses a scale of 1: 3.5 of the size of the design boat.

## 2. METHODOLOGY

In the study carried out, the parent design approach boat design method is used, which is one method in designing boats by means of comparison, existing boat's are set as a reference for the designed boat, the advantage in the parent design approach is that it can design boats faster and the performance of the boat has been tested in terms of stability, motion and resistance of the boat. The application of this design also uses Maxsurf Modeler 12 Version to obtain more precise results including the use of AutoCAD 2017 This software is used to refine the line plan drawings from Maxsurf and to draw the general plan of the trash skimmer boat.

Boat Stability Calculation Method using Germanischer Lloyd Criteria for the complete stability of long boats  $L < 10$  m. The effect of the combined centrifugal moment of the turning cycle maneuver and the personal moment does not exceed a heel angle of 12. While the Boat Resistance Calculation Method uses Holtrop (1978). While the use of the SWOT method is carried out for the selection of boat materials used, both in terms of cost, easy to obtain, easy to maintain, material weight and durability in external conditions and temperatures in the East Flood Canal flow area.

### 3. RESULT AND DISCUSSION

The results of the main dimension calculations obtained using the comparison method were followed by a lines plan drawing to visualize the shape of the boat's hull. These calculations and drawings were performed using Maxsurf and Autocad software. The resulting lines plan drawing of the boat's hull can be seen in the image below.

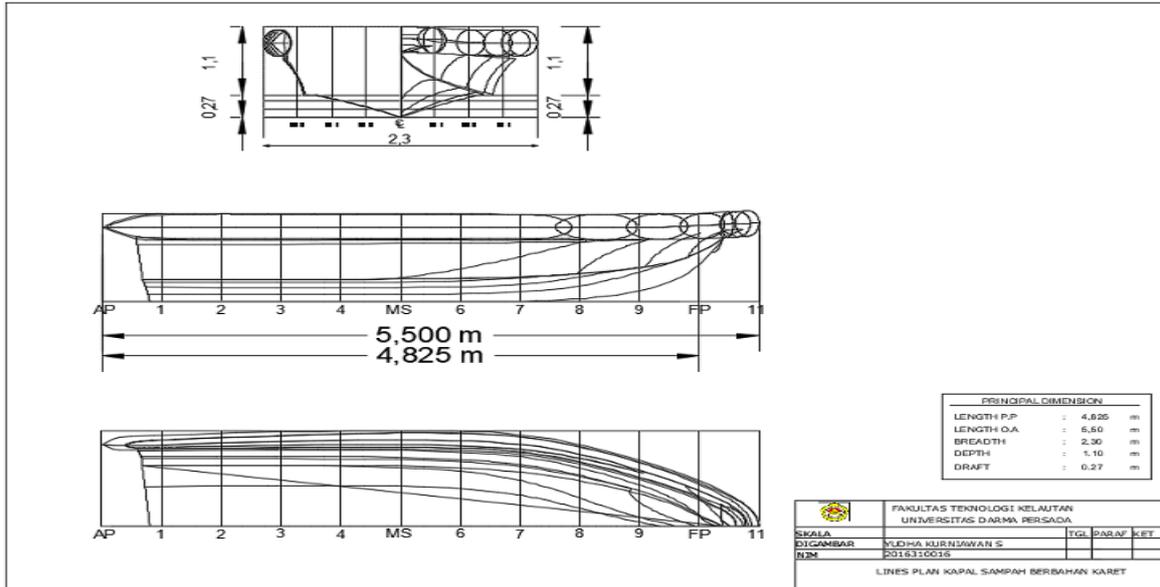


Figure 2 Lines Plan

A depiction of the boat's equipment and supplies layout, both top and side views, can be seen in the image below. The general plan shows the placement of conveyors for hauling waste, the boat's engines, and other equipment on board.

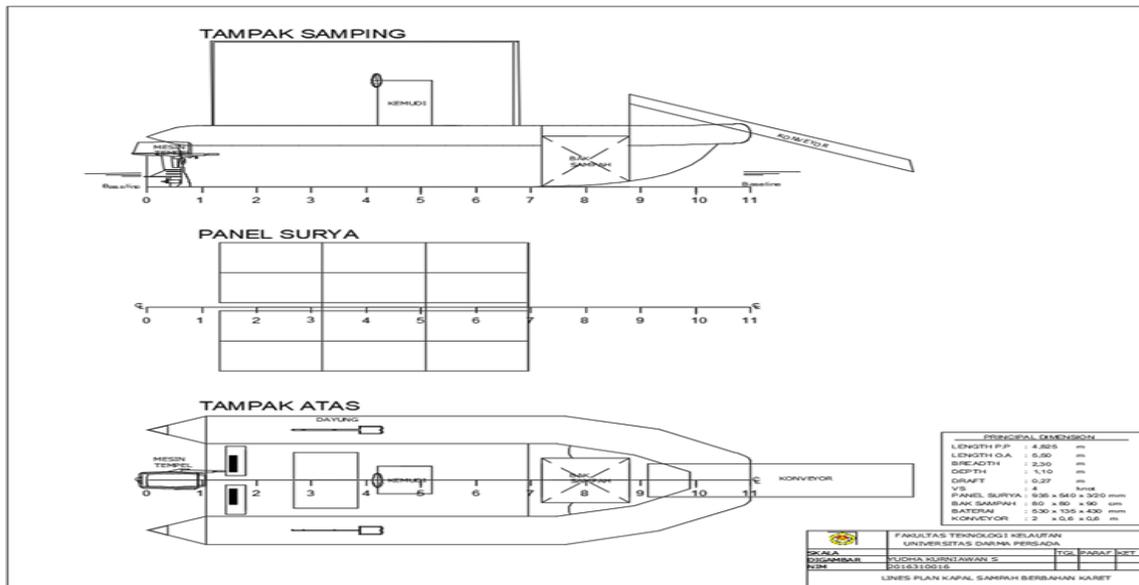


Figure 3 General Arrangement

SWOT (Strength, Weakness, Opportunity, Threat) from the data collected using the SWOT method, the potential of the best material can be examined. There are several requirements and requirements for selecting a material type, such as: readily available materials, durable materials,

lightweight and elastic materials, and quick and time-saving manufacturing. Based on all the requirements above and the data obtained, the type of material that is suitable for meeting these four needs is selected.

Table 1 SWOT Comparison of Material Selection

No.	Material Type	Strength		Weakness	Opportunity	Threats
1.	Steel	Strong and durable	•	<ul style="list-style-type: none"> <li>• Expensive and heavy</li> <li>• long time in manufacture</li> <li>• Difficult to move</li> </ul>	<ul style="list-style-type: none"> <li>• Material easy to get</li> <li>• There are enough workshops available</li> </ul>	<ul style="list-style-type: none"> <li>• Requires special skills</li> <li>• need lifting equipment</li> </ul>
2.	Hypalon	light and elastic		Extra maintenance	Easy and fast maintenance	Prone to leaks
3.	Fiberglass	Can be built quickly		Difficult to repair	The mold can be used repeatedly	Easy to crack

Boat Stability Analysis Design Boat Stability Calculation using Maxsurf Stability software. With reference to the Intact Stability (IS) Multihull criteria and IMO A.749 (18) Chapter 3. This calculation was carried out on two load case conditions with the analysis results showing that the results of the boat stability test have met the required criteria. The results of the stability calculation can be seen in the following figure.

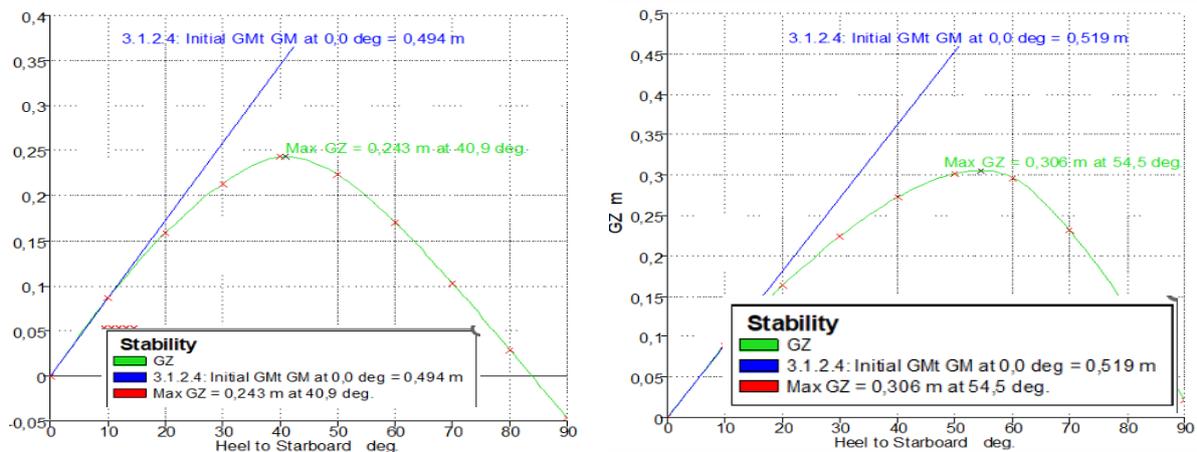


Figure 4 Angle Stability Loadcase 1 dan Loadcase 2

Analysis of Designed Boat Resistance In calculating the design resistance of the garbage boat using Maxsurf software with the Holtrop method. The following are the results of the resistance analysis.

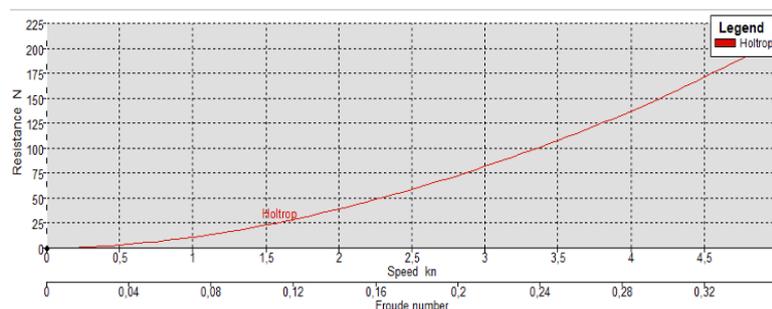


Figure 5 Grafik Resistance vs Speed

Engine Selection Based on the results of the calculation of the resistance and the required driving power, the selection of the electric motor used is as follows. The electric motor used in the designed boat has the following specifications: Product Specifications: Brand: INTEX; Model: Trolling Motor; Mode for escaping from entanglement with garbage; Voltage: 12 V DC; Power: 480W; Thrust: 40lb / 178 (n); Approximately 0.5-0.8 HP; Speed: 5 forward / 3 reverse; Weight: 18 Kg.



Figure 6 3D Front and Back View

The image above shows the moldloft process applied from AutoCAD to cardboard, which is then printed onto the material to achieve perfect results, which will then be applied to the material. The gluing process involves gluing each part to ensure a perfect fit. Gluing is also applied twice to ensure a perfect bond.



Figure 7 Proses pemotongan dan penyambungan

Development process In this process, the prototype is developed/pumped to find out whether there are any leaks or not on the connection side of the boat.



Figure 8 Prototype Hull Installation Process

The process of installing the boat's mast The installation of the boat's mast aims to protect the driver from the hot sun, and also to place the solar panels so that they can absorb the sun's heat optimally.

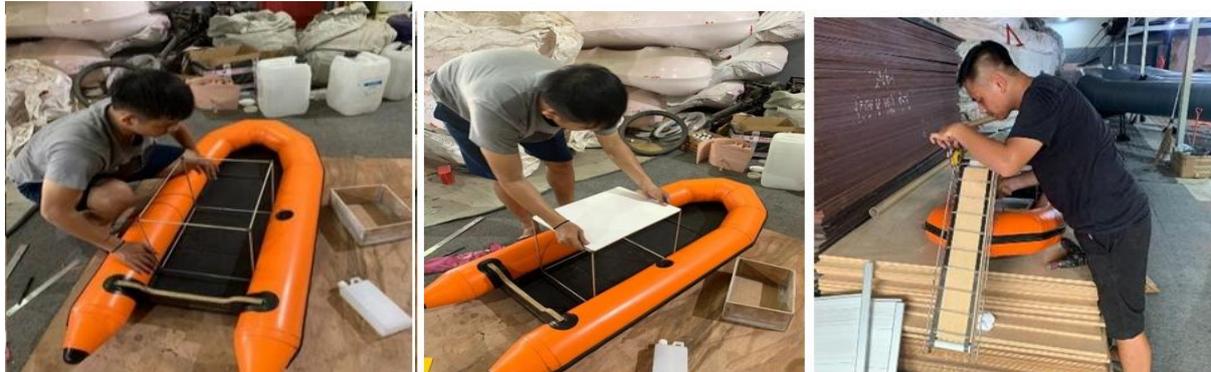


Figure 9 Installation Of Hull And Ship Equipment

The final result of the implementation of the waste management boat design in the form of a boat prototype can be seen in the image below. The boat has been tested both for garbage collection and maneuvering trials using a remote control in the East Flood Canal, East Jakarta, specifically in front of Darma Persada University. The next step is to implement the research results into a real boat and can be used for waste management activities in the East Flood Canal, Jakarta or in locations with similar environmental conditions to the research location.



Figure 10 Boat Prototype for Waste Management in the Banjir Kanal Timur (BKT) Jakarta

#### 4. RESULT

In determining the primary dimensions of the waste management boat designed for the Ujung Menteng Waste Management Center (BKT), the following dimensions were obtained:  $Loa = 5.50\text{ m}$ ;  $Lpp = 4.825\text{ m}$ ;  $B = 2.30\text{ m}$ ;  $H = 1.10\text{ m}$ ;  $T = 0.27\text{ m}$ ;  $Vs = 4\text{ knots}$ , and  $Crew = 3\text{ persons}$ .

The Hypalon Ocracel material was chosen due to its light weight, allowing the boat to be used during both the rainy and dry seasons, when water levels in the East Flood Canal are very limited.

This garbage boat carries 50 kg of waste and is placed in the East Flood Canal in Ujung Menteng, East Jakarta. The waste is disposed of using a conveyor after the waste is collected on the boat. Finally, the waste is transported by garbage trucks to the final disposal site.

Based on the analysis and stability calculations, the stability of loadcases 1 and 2 has been met according to IMO criteria. Based on the analysis, the results of the resistance calculation are as follows: From the table above, for a boat speed of 4 knots, the total resistance is 169.63 N with a power of 0.349 kW. The use of renewable energy can reduce the impact of greenhouse gas emissions so that it does not cause new problems from pollution in Jakarta.

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### **REFERENCES**

- [1] Peraturan Presiden Republik Indonesia Nomor 83 Tahun 2018 Tentang Penanganan Sampah Laut.
- [2] Idham Aulia Muhammad. Titis Wahyu Pratiwi. Sabella Nisa Saputra. Windy Kamesworo. dan Ardiansyah. (2013). "THE GANERS" Kapal Pembersih Sampah Dengan Sistem Lambung Tiga Sebagai Solusi Pembersih Sampah di Teluk Jakarta. Institut Teknologi Sepuluh Nopember Surabaya.
- [3] Daniel, D. Dan Daud S.A. Sianturi. 2013. Uji Performa Baterai Untuk Beban Motor DC Perahu Pulang Hari. Jurnal Kelautan Nasional. Volume 8 No. 2.
- [4] Herlambang, Ikbal. Rancang Bangun Trasher Boat Sebagai Moda Sarana Pembersih Sampah Di Sungai Kalimas Surabaya, Jurusan Teknik Perkapalan, FTMK ITATS.
- [5] Imron, As Ali, Ruddianto & Budianto (2017). " Perancangan Kapal Pembersih Eceng Gondok di Sungai Rowo Tirto Probolinggo", Politeknik Perkapalan Negeri Surabaya, Seminar MASTER 2017 PPNS.
- [6] Apas, I. (2015). Analisis Sistem Transportasi Angkutan Sampah Kota Meulaboh (Studi Kasus: Kecamatan Johan Pahlawan) (Doctoral dissertation, Universitas Teuku Umar Meulaboh).
- [7] Josua, 2013 Dampak Pencemaran Lingkungan dan Usaha-Usaha Pengendaliannya. Andi Offset. Surakarta.
- [8] Putu Arta Wibawa, Aang Wahidin Dkk. 2018. Pelatihan Pembuatan Perahu Berbahan FRP (Fiberglass Reinforced Plastic) Untuk Pengrajin Perahu Nelayan Di Desa Gersik Cemandi, Sidoarjo, Jawa Timur. Politeknik Perkapalan Negeri Surabaya.
- [9] Puji Ratno, Etika. 2017. Survei Manajemen Perawatan Perlengkapan Arung Jeram Explore Sumatera. Jurnal Ilmu Keolahragaan 16(1):73-83.
- [10] Swastitanaya, Pathyastri Veronika & Hesty Anita Kurniawati (2020). "Desain Kapal Pengangkut dan Pengolah Sampah Plastik untuk Kepulauan Seribu, Institut Teknologi Sepuluh Nopember (ITS), Jurnal Teknik ITS Vol. 9, No. 2.
- [11] Sanny Ardhy, Meiki Eru Putra, Islahuddin. 2019. Pembuatan Kapal Nelayan Fiberglass Kota Padang Dengan Metode Hand Lay. Teknik Mesin, Universitas Dharma Andalas, Padang.
- [12] Sunardi, R Sapto Pamungkas. 2019. Studi kapal kecil Dengan Tenaga Penggerak Listrik Untuk Pengawasan Kawasan Konservasi Sungai. Fakultas Perikanan dan Ilmu Kelautan, Universitas Brawijaya, Malang.
- [13] Tri, Ali Azhar & Agung Kristiyono (2020), Stabilitas Kapal Kecil, Ahlimedia Press Malang.
- [14] Widad, Romzatul dan Erifive Pranatal (2020). "Perancangan Kapal Pembersih Sampah (Trash skimmer) Untuk Wilayah Perairan Teluk Sumenep." Prosiding Seminar Teknologi Kebumihan dan Kelautan (SEMITAN II) Institut Teknologi Adhi Tama Surabaya (ITATS) Vol 2, No.1 Juli 2020.
- [15] Widodo, B.I Hentri & Eni Tri Wahyuni (2020). " Manajemen Penanggulangan Tumpahan Minyak Di Laut Akibat Dari Pengoperasian Kapal", Politeknik Bumi Akpelni, Majalah Ilmiah Gema Maritim, Vol 22 No 1 Tahun 2020.
- [16] Wulandari, Amalia Ika, Wira Setiawan, Taufik Hidayat1 & Arman Fauzi1 (2020). Desain Skimmer Boat (Kapal Pengambil Sampah) Daerah Perairan Sungai Di Kalimantan Timur, Institut Teknologi Kalimantan, Jurnal Ilmiah Teknologi Maritim Volume 14 Nomor 1, Juli 2020: Hal: 9-18.

- [17] Wardana, Wisnu Arya. 1995. Dampak Pencemaran Lingkungan. Yogyakarta: ANDI Offset
- [18] Yusep Sugianto, Rangkuman Langkah-langkah Desain Kapal Menurut Desain Spiral (Intisari Desain Kapal Tanker Dengan Payload 5000 ton), Fakultas Teknologi Kelautan/Jurusan Transportasi laut.
- [19] Zulhaz Ismail, Muhammad Ikhsan Nur. 2019. Perancangan Perahu Listrik Bertenaga Surya Teknik Elektro Fakultas Teknik Unismuh Makassar.