International Journal of Marine Engineering Innovation and Research, Vol. 10(3), Sept. 2025. 963-970
(pISSN: 2541-5972, eISSN: 2548-1479)

Design of water Ambulance for Improving Healthcare Services in Mahakam Ulu Regency

Chris Jeremy Verian Sitorus[1*], Muhammad Uswah Pawara [2], Rahmat Hidayat[3], Hariyono[4], Harlian Kustiwansa[5]Alamsyah[6], Suardi[7], Muhammad Anjas Syam[8] Jusma Wahidah[9] Cindy Lionita Agusty[10]

(Received: 10 September 2025 / Revised: 12 September 2025 /Accepted: 17 September 2025 / Available Online: 26 September 2025)

***Abstract*— Mahakam Ulu Regency's landscape is dominated by tropical rainforest, with transportation access heavily reliant on river routes. The region is home to 245 rivers, ten of which are classified as major rivers and are distributed across all sub-districts. The Mahakam River serves as the main artery for community activities, including the emergency transport of patients. Nevertheless, serious challenges persist due to limited healthcare infrastructure and inadequate medical transport, which hinder the timely treatment of patients. Currently, there are no water ambulances specifically designed for emergency medical services, leading to delays and increased risks of patient morbidity and mortality.The aim of this study is to develop a water ambulance vessel designed to serve as a dedicated river based medical transport in Mahakam Ulu. A Parent Ship Design Approach (PSDA) was applied in the development process. The Water ambulance has principal particulars consisting of an Overall Length (LOA): 10.5 m, Breadth (B): 3.15 m, Depth (H): 1.35 m, Draft (T): 0.65 m, Service Speed (Vs): 20 knots, Accommodation: 10 crew and passengers**

Keywords— Mahakam Ulu, Mahakam River, Water Ambulance, Parent Ship Design

Corresponding Author: chris.sitorus@lecturer.itk.ac.id

I. INTRODUCTION

Mahakam Ulu Regency is geographically dominated by tropical rainforest, spanning approximately 2,413,322 hectares or around 72% of the regency's total land area.[1] This region is situated in the upper reaches of the Mahakam River, which stretches for 920 kilometres and stands as the longest river in East Kalimantan Province. The Mahakam River flows through several administrative regions, including Mahakam Ulu, West Kutai, Kutai Kar-tanegara, and Samarinda City, before emptying into the Makassar Strait. Mahakam Ulu itself contains 245 rivers, with ten major rivers distributed across all districts, where two rivers cross each district. The rivers in this area have depths ranging from 2 to 2.8 meters, and widths typically between 15 and 25 meters.[2]

For the local population, the Mahakam River plays a vital role as a livelihood source for both fishermen and farmers, as well as serving as the primary water supply and principal transportation corridor. Access to transportation in this area remains heavily reliant on waterways, resulting in relatively high travel costs. In emergencies, patient transportation is a critical concern to ensure safe referral to more advanced healthcare facilities. This highlights the urgent need for improved health infrastructure and effective coordination among medical personnel, including nurses and physicians, to ensure proper patient care.[4] Considering these factors, the implementation of a water ambulance is a necessary solution to enhance emergency medical services and support the operational effectiveness of healthcare providers in Mahakam Ulu Regency.

To improve the overall health status of the community, it is essential to develop a comprehensive healthcare system encompassing preventive, promotional, curative, and rehabilitative measures. This approach aims to enhance and expand access to high-quality healthcare services, particularly at the primary care level [5]. Hospitals play a crucial role in driving healthcare development within their respective operational areas. Therefore, optimizing service delivery and ensuring the availability of adequate facilities and infrastructure are necessary steps to achieve better access to quality healthcare services.

The concept of a water ambulance has emerged as a strategic response to the geographical barriers and limited emergency medical services in remote areas. A feasibility study conducted by [6] in Nusa Penida

[1]Chris Jeremy Verian Sitorus, Department of Naval Architecture, Department of Naval Architecture, Institut Teknologi Kalimantan, Balikpapan, 76127, Indonesia. e-mail: chris.sitorus@lecturer.itk.ac.id

[2]Muhammad Uswah Pawara, Department of Naval Architecture, Institut Teknologi Kalimantan, Balikpapan, 76127, Indonesia. e-mail: uswah.pawara@lecturer.itk.ac.id

[3]Rahmat Hidayat, Department of Naval Architecture, Institut Teknologi Kalimantan, Balikpapan, 76127, Indonesia. e-mail: rahmathidayat990@gmail.com

[4]Hariyono, Department of Naval Architecture, Kalimantan Institute of Technology, Balikpapan, 76127, Indonesia. e-mail: hariyono@lecturer.itk.ac.id

[5]Harlian Kustiwansa, Department of Naval Architecture, Kalimantan Institute of Technology, Balikpapan, 76127, Indonesia. e-mail; harlian.kustiwansa@lecturer.itk.ac.id

[6]Alamsyah, Department of Naval Architecture Kalimantan Institute of Technology, Balikpapan, 76127, Indonesia. e-mail: alamsyah@lecturer.itk.ac.id

[7]Suardi, Department of Naval Architecture, Kalimantan Institute of Technology, Balikpapan, 76127, Indonesia. e-mail; suardi@lecturer.itk.ac.id

[8] Muhammad Anjas Syam, Department of Naval Architecture, Kalimantan Institute of Technology, Balikpapan, 76127, Indonesia. e-mail; anjas.syam@lecturer.itk.ac.id

[9] Jusma Wahidah, Department of Naval Architecture, Kalimantan Institute of Technology, Balikpapan, 76127, Indonesia. e-mail; jusma.wahidah@lecturer.itk.ac.id

[10] Cindy Lionita Agusty, Department of Naval Architecture, Kalimantan Institute of Technology, Balikpapan, 76127, Indonesia. e-mail; cindy.agusty@lecturer.itk.ac.id

demonstrated that the implementation of a water ambulance could significantly reduce patient referral times [7], decrease the risk of mortality, and improve healthcare access in isolated communities. Ideally, these ambulance boats are designed with dimensions ranging from 10 to 30 meters in length, 2.5 to 3.5 meters in beam, and 1 to 1.5 meters in draft, and are equipped with facilities that comply with medical evacuation and maritime safety standards. Similar vessel designs have been successfully implemented in other Indonesian archipelagic regions, such as Raja Ampat and Sumatra [8], providing evidence that this innovation can be adapted and replicated in Mahakam Ulu.

In Mahakam Ulu, the urgent need for river ambulances is increasingly evident, as referral systems for patients are not yet optimised, especially given the region's scattered settlements and challenging access routes. The local government, through the Blood Transfusion Unit and the Gerbang Sehat Mahulu Regional Hospital [9], has made significant efforts to develop a more equitable and improved healthcare system. This includes expanding referral networks and strengthening human resources in the medical field [10]. However, there remains a critical gap for rapid and safe transport solutions, particularly in the form of specially designed ambulance boats capable of operating on shallow and narrow inland waterways. Such intervention is essential to reach remote communities and ensure timely emergency medical response, supporting both patient outcomes and the operational effectiveness of the health system in Mahakam Ulu.

From a naval architecture perspective, design-ing a river ambulance boat for Mahakam Ulu requires careful consideration of several key factors:[11] accommodation space and layout, engine power requirements, compliance with stability regulations (specifically IMO A.749(18))[12][13], fuel efficiency, and the vessel's ability to operate effectively in dynamic river currents and wave conditions [14]. Research in Kalimantan demonstrated that the Parent Ship Design method is effective for optimizing river ambulance design [15], as it leverages data from previously validated vessels to derive an optimal solution. Advanced software, such as Maxsurf, facilitates detailed modeling, resistance and stability simulations, and rapid optimization, allowing designers to accurately predict vessel performance [16][17] This approach enables the development of a river ambulance that can reliably operate at speeds up to 20 knots while providing proportional crew and patient capacities, tailored to the unique needs of Mahakam Ulu's riverine environment [18].

TABLE 1.
THE MAIN DIMENSIONS OF PARENT SHIP

Length Overall (LOA)	8.816 m
Breadth(B)	2.656 m
Height(H)	1.232 m
Draft(D)	0.458 m
CB	0.32
Speed	18 knot
Crew	2 Persons
Passangers	5 Persons

As part of the vessel's design innovation, the ambulance boat hull incorporates multiple spray strakes [19] longitudinal strips installed along the bottom of the hull. The primary function of spray strakes is to minimise the wetted surface area caused by spray as the boat moves, which translates into a significant reduction in overall hull resistance [20]. Experimental studies have demonstrated that the addition of spray strakes reduces residual resistance and increases lift at the bow, which is especially critical for vessels operating at high speeds in shallow river environments. This feature is adapted from hydrodynamic research on planing hulls, showing that optimal positioning and sizing of spray strakes can lower total resistance by up to 15% at certain speeds while maintaining operational stability during patient evacuation on the Mahakam Ulu river.

The presence of river ambulance boats is a crucial element in strengthening rural health systems [21], helping to bridge the gap between community needs and available services, and directly supporting the achievement of local health related Sustainable Development Goals (SDGs). The 2024 Mahakam Ulu Regency Report also highlights the need for an integrated approach that combines improvements in physical infrastructure, enhanced human resource capacity, and optimized transportation technology [22] Such measures are essential to reduce the number of patient referrals to distant locations and to increase the self-sufficiency of local healthcare delivery.

TABLE 2
. THE MAIN DIMENSIONS OF DESIGNED SHIP

Length Overall (LOA)	10.5 m
Breadth(B)	3.15 m
Height(H)	1.35 m
Draft(D)	0.65 m
CB	0.42
Speeds	20 knot
Crew	2 Persons
Patient	2 Persons
Medical	2 Persons

II. Method

A. Selection of parent ship Dimensions

Selection of Reference water ambulance Dimensions. This study began with the collection of data pertaining to the principal dimensions of an existing vessel, which served as the reference benchmark. The purpose of this comparative stage is to ensure that the designed vessel attains appropriate size and proportions. The determination of the reference vessel's main dimensions employed the Parent Ship Design Approach (PSDA), a method that utilizes data from vessels with proven performance as a basis for new designs. For this research, specifications from an operational water ambulance previously used in Kalimantan [23] were adopted as reference data. The main particulars of the reference water ambulance are presented in the following Table 1.

B. Water Ambulance Modeling

After calculating the required main dimensions for the vessel design, the next step involved modeling the ambulance boa [24]. The process began with generating a lines plan using computer-aided design (CAD) software. Subsequently, the general arrangement was developed with the assistance of Maxsurf and SketchUp, which included configuring the internal layout according to functional requirements, such as the engine room, accommodation areas, and other essential spaces.

III. Results and Discussion

A. Main Dimensions of the Designed Water Ambulance Calculation

Prior to the modeling stage, it is essential to calculate the principal dimensions required for the ambulance boat. These dimensions include the vessel's length, beam, depth, and draft.[25] The necessary values are determined using the following equations:

$$LOA\,2 = \sqrt[3]{\frac{\Delta 2}{\Delta 1}}\ x\ LOA\,1 \tag{1}$$

$$B2 = \sqrt[3]{\frac{\Delta 2}{\Delta 1}}\ x\ B1 \tag{2}$$

$$D2 = \sqrt[3]{\frac{\Delta 2}{\Delta 1}}\ x\ D1 \tag{3}$$

$$H2 = \sqrt[3]{\frac{\Delta 2}{\Delta 1}}\ x\ H1 \tag{4}$$

Where :

LOA 2 Length Overall of Designed Ship (m)
LOA 1 Length Overall of the Parent Ship (m)
B2 Breadth Moulded of Designed Ship (m)
B1 Breadth of the Parent Ship (m)
D2 Draft of Designed Ship (m)
D1 Draft of the Parent Ship (m)
H2 Heigh of Designed Ship (m)
H1 Draft of the Parent Ship (m)
Δ2 Displacement of Designed Ship (Ton)
Δ1 Displacement of the Parent Ship (Ton)

B. Froud Number Calculation

To determine the Froude number for the water ambulance, the following equation is utilized, where the vessel speed (Vs) is measured in meters per second, gravitational acceleration (g) uses the standard value of 9.81 m/s², and L represents the waterline length in meters. By applying these parameters, the Froude number specific to this ambulance boat can be calculated :

$$Fn = \frac{Vs}{\sqrt{\mathrm{g.L}}} \tag{5}$$

Fn = 1,01368

C. Ship form Coefficient Calculation

Once the Froude number has been determined, it serves as a reference for calculating a series of key hull form coefficients. These coefficients which include the block coefficient (Cb), midship section coefficient (Cm), waterplane area coefficient (Cwp), prismatic coefficient

(Cp), displacement (Δ) and volume (∇) are essential for describing the hull geometry and are determined as oulined in the Parametric Design literature However, all ship form coefficients were determined based on calculations from the Maxsurf software.

TABLE 3.
THE FORM COEFFICIENT OF DESIGNED SHIP

Form Coefficient	Value
Block Coefficient	0.42
Midship Coefficient	0.604
Waterplan Coefficient	0.804
Prismatic Coefficient	0.697
Volume Displacement	7.23 m^3
Displacement	7.41 Ton

D. Lines Plan

A lines plan presents the hull geometry of a vessel by graphically depicting its shape through a combination of several standard projection views. These include transverse sections (body plan), longitudinal side profiles (sheer plan), and horizontal waterline slices (half-breadth plan) [26]. In the design process for this vessel, the lines plan was generated with the support of Maxsurf software, which facilitates detailed and accurate modeling of the hull's three-dimensional formOnce all components are mixed, the container is tightly closed and the mixture is homogenized by shaking manually for several minutes or using a magnetic stirrer to ensure even distribution of molecules. The homogenized fuel mixture is then stored in a closed container at room temperature and protected from direct sunlight until ready for use in the diesel engine characteristic and performance testing process.

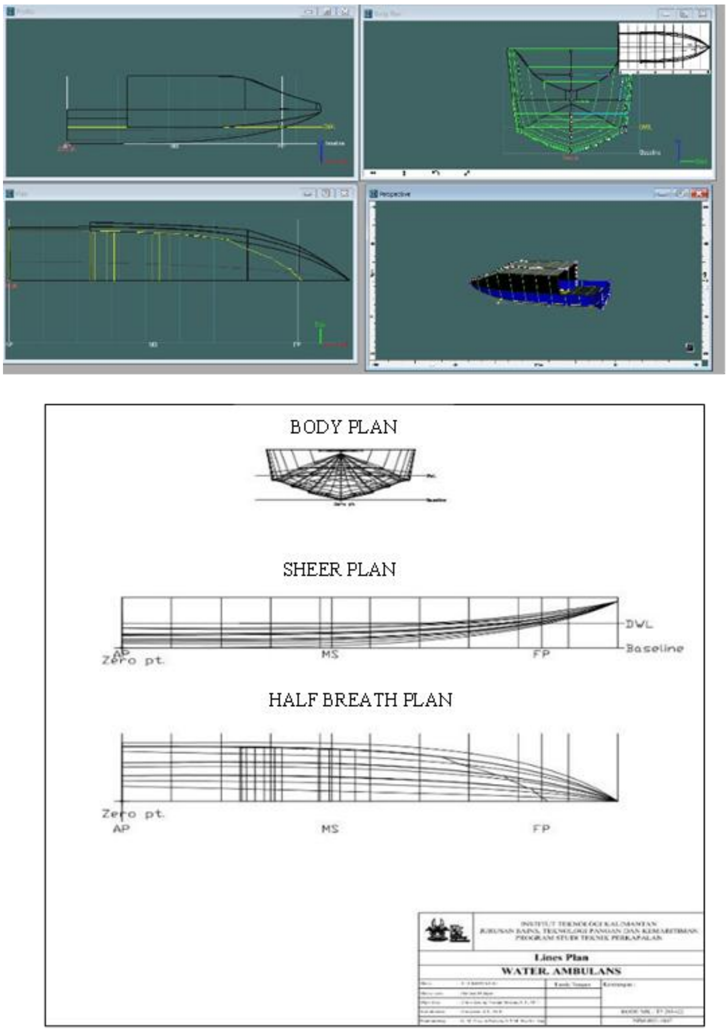

Figure. 1. Lines Design

E. Total Resistance and Main Engine Selection

To determine the resistance acting on the ship, simulations were conducted using Maxurft software under various speeds: 4, 8, 12, 16, and 20 knots. The Holtrop method provides a practical and empirical framework for estimating ship resistance across a wide range of speeds [27]. This approach relies on mathematical models tailored to the principal dimensions and hull properties of the vessel.

The calculated resistance values, which trend upward as speed increases, highlight the growing energy demands imposed by hydrodynamic effects at higher velocities. These resistance estimates play a pivotal role in specifying the power requirements for the ship's propulsion system, ensuring the vessel can operate efficiently under intended service conditions. The results of these simulations are summarized in the following Table 4.

TABLE 4.
RESISTANCE RESULT

Speeds(Knot)	*Holtrop Resistance(kN)*	*Holtrop Power (kW)*
4	0.7	0.183
8	2.8	23.403
12	5.8	71.787
16	7.6	125.428
20	8.6	177.268

From the above data, it is evident that as the vessel's speed increases, both the resistance and required engine power also rise. At a speed of 20 knots, the power necessary to propel the vessel reaches 177.268 kW. To ensure suitability with actual waterway conditions, a 15% correction factor is applied, resulting in a total power requirement of 203.858 kW. Therefore, the selected main engines for the vessel must be capable of delivering more than 203.858 kW to guarantee reliable operation. After determining the brake horsepower (BHP), the next step is to select the main propulsion engines for the vessel. The chosen engines should have a compact physical size to minimize the space needed in the engine room. For this ambulance vessel, propulsion is provided by two water jet engines, each delivering a power output of 111.855 kW, ensuring sufficient performance within the available space.

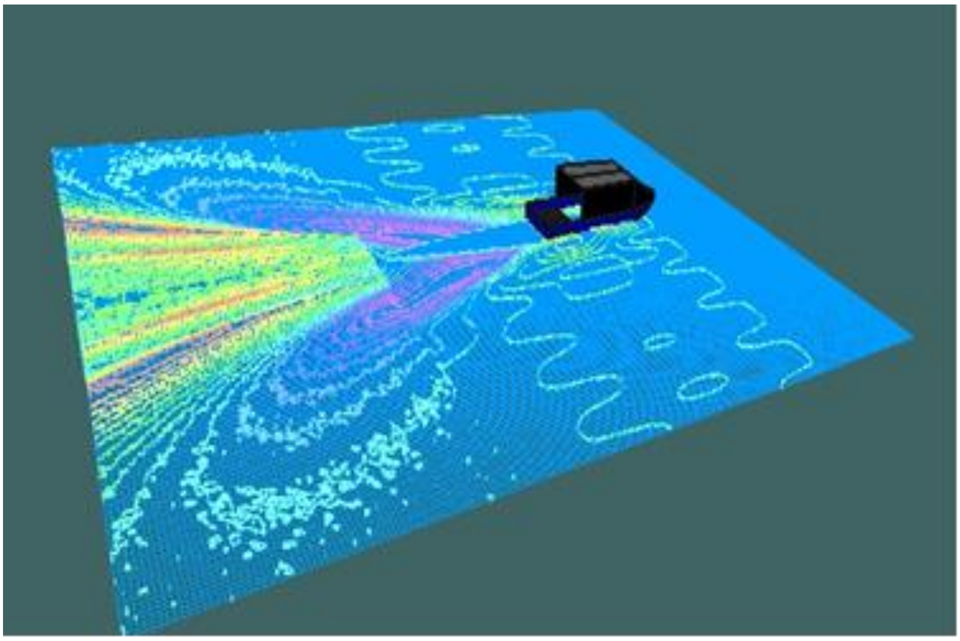

Figure. 2. Result Running Resistance

Model	Yamaha Jet Series F150JB Outboard motors
Power	111.855 kw
Lenght	843.28 mm
Breadth	424.18 mm
Height	548.64 mm
Dry Mass	220kg

Figure. 3. Engine Spesification

F. General Arangement

The Water ambulance's General Arrangement (GA) was developed utilizing specialized 2D design tools, using the pre-established lines plan as the foundational reference. The lines plan supports the creation of detailed layouts for the hull's waterline, main deck, and all other pertinent structural elements. Side elevations are based on the sheer plan, while the forward and aft depictions are derived from midship body sections. The resulting arrangement ensures a logical spatial organization for the vessel's superstructure and internal compartments.

This General Arrangement defines the strategic allocation of spaces necessary for key functions and their equipment. For example, designated areas are provided for the engine room, crew and passenger accommodations, cargo storage, and various tanks (for fuel, fresh water, ballast, etc.). Each space is integrated into the hull and superstructure to maximize operational efficiency, safety, and accessibility.

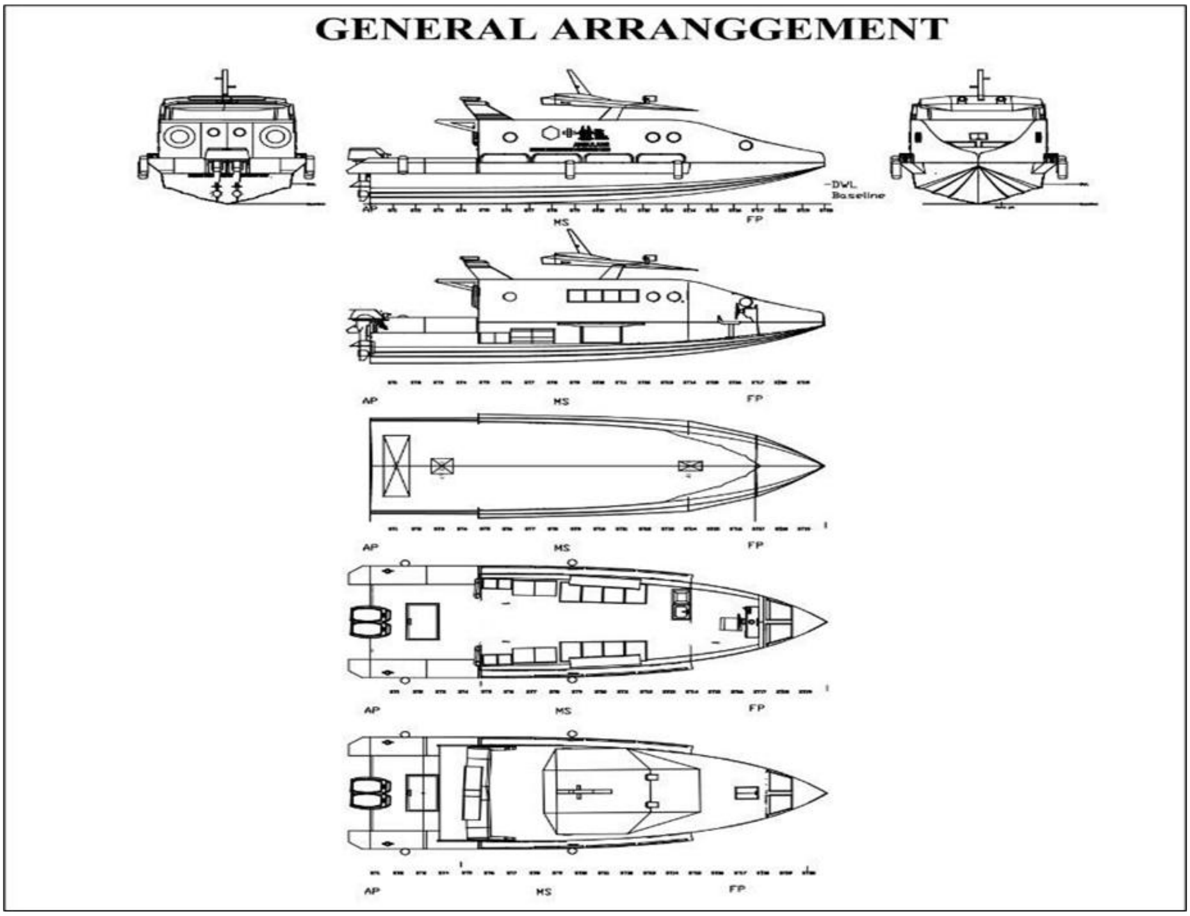

Figure. 4. 2D General Arrangement of water ambulance

Figure. 5. 3D Isometric View of Water Ambulance a). Side View b) Back View c) Top View d) Interior View

IV. CONCLUSION

This study successfully developed a river ambulance boat design to support emergency healthcare services in Mahakam Ulu, East Kalimantan. The principal dimensions of the vessel are as follows: Length Overall (LOA): 10.5 meters, Beam (B): 3.15 meters, Depth (H): 1.35 meters, Draft (T): 0.65 meters, with a service speed (Vs) of 20 knots, and an accommodation capacity for up to 10 crew members and passengers. The design is tailored to address the geographic challenges of the Mahakam Ulu region, which relies heavily on river transport due to its limited road infrastructure. Simulation results show that the proposed design is capable of providing timely, reliable transport for medical emergencies, thereby supporting faster referral and potentially reducing morbidity and mortality among isolated communities.

However, this study has several limitations that should be considered. The current design and simulations are based on ideal river conditions and standardized operational assumptions; variations in river currents, depth fluctuations, or extreme weather were not included in the analysis.The power and propulsion system was selected based on technical simulations and catalog specifications but not subjected to full-scale field trials in the actual operational environment.Operation costs, long-term maintenance requirements, and sustainability in actual field deployment especially in remote areas with limited service infrastructurewere not fully analyzed.

For Future Research is recommended to investigation should involve prototype construction and sea trials to evaluate vessel performance and usability under real river conditions, including during adverse weather and in areas with heavy river traffic or debris.Studies should be conducted on the optimal layout and ergonomics for patient care and medical intervention within the vessel's interior, including integration of advanced life support systems.Economic assessments covering operation, maintenance, and funding models (including public private partnerships) are necessary to ensure long-term viability and efficient service coverage.

ACKNOWLEDGEMENTS

We would like to express our deepest gratitude to the institute for research and community service (LPPM) itk for their assistance in funding this internal itk research under the research contract implementation of university research grant Institut Teknologi Kalimantan number: 13243/IT10.L1/PPM.04/2025. We also extend our appreciation to the itk integrated laboratory for their invaluable assistance during the data collection process. their contributions were crucial to the success of this research

REFERENCES

[1] Badan Pusat Statistik Kabupaten Mahakam Ulu, "Mahakam Ulu Dalam Angka 2024," Ujoh Bilang, Feb. 2024.

[2] N. Aulia, N. Annisa, A. Hakim, R. Diah, and N. Setyowati, "Analisis Status Mutu Air Sungai Mahakam Kota Samarinda Menggunakan Metode Indeks Pencemaran," vol. VII, no. 4, 2022.

[3] L. D. Sri Ayu Sianturi, F. Emiliana Long, G. Sandjaja, and dan R. Hokbyan Angkat, "Analisis Penggunaan Transportasi Sungai Di Wilayah Mahakam Ulu," *JMTS: Jurnal Mitra Teknik Sipil*, vol. 8, no. 3, pp. 909–918, Aug. 2025.

[4] D. Z. R. Syah, J. Sahar, and K. Yetti, "Pelayanan Prima Keperawatan di Pelayanan Primer: Perspektif Perawat dan

Pasien," *Journal of Telenursing (JOTING)*, vol. 4, no. 1, pp. 59–70, Mar. 2022, doi: 10.31539/joting.v4i1.3349.

[5] J. Jusmaldi, N. Hariani, and N. Doq, "Diversity, potentiality, and conservation status of fish fauna in the upper Mahakam's tributaries, East Kalimantan," *J Iktiologi Indones*, vol. 19, no. 3, p. 391, Oct. 2019, doi: 10.32491/jii.v19i3.471.

[6] P. Aryani *et al.*, "Water Ambulance Service Provision to Improve Healthcare Access for Community in Nusa Penida Island, Bali: A Qualitative Feasibility Study," *Public Health and Preventive Medicine Archive*, vol. 10, no. 2, pp. 160–170, Dec. 2022, doi: 10.53638/phpma.2022.v10.i2.p07.

[7] R. Zain, W. Sutomo, A. F. Zakki, and D. Chrismianto, "Jurnal Teknik Perkapalan Studi Perancangan Passenger Craft Hydrofoil Untuk Daerah Pelayaran Sanur-Nusa Penida," *Jurnal Teknik Perkapalan*, vol. 12, no. 4, 2024, [Online]. Available: https://ejournal3.undip.ac.id/index.php/naval

[8] F. Kalbuadi, "Desain Amphibious High Speed Ambulance Craft (Hsac) Sebagai Penunjang Fasilitas Kesehatan Di Kepulauan Raja Ampat," Institut Teknologi Sepuluh Nopember, Surabaya, 2020.

[9] Kementerian Kesehatan, "Laporan Pemantauan Pusat Krisis Kesehatan," May 2024.

[10] F. F. Rahman, F. Haris, and K. Irawati, "Equate access to primary health care in rural Kalimantan: What basic health services should be available locally?," *Journal of Holistic Nursing Science*, vol. 10, no. 2, pp. 96–102, Jul. 2023, doi: 10.31603/nursing.v0i0.8460.

[11] S. A. Darmasaputra, "Perencanaan Armada Kapal Ambulans Modern Untuk Wilayah Kepulauan: Studi Kasus Kabupaten Pangkajene Dan Kepulauan," Institut Teknologi Sepuluh Nopember, Surabaya, 2020.

[12] M. Aldi Maulana, M. Basuki, J. Arief Rachman Hakim, K. Sukolilo, and K. Surabaya, "Analisis Teknis Dan Ekonomis Perancangan Kapal Ambulance Boat Untuk Fasilitas Kesehatan Pulau Terluar Di Kabupaten Donggala, Sulawesi Tengah," *Jurnal Sains dan Teknologi Maritim (JSTM)*, vol. 26, pp. 66–85, 2025, doi: 10.33556/jstm.

[13] Biro Klasifikasi Indonesia, "Rules For Fibreglass Reinforced Plastic Ships," 2021. [Online]. Available: www.bki.co.id

[14] G. Hamdana, R. T. Soelistijono, and P. D. Setyawan, "The Stability and Seakeeping Analysis of Hospital Ship Design in Karimunjawa Waters H) Check for," *Kapal:Jurnal Ilmu Pengetahuan dan Teknologi Kelautan*, vol. I, pp. 23–30, Apr. 2024, doi: https://doi.org/10.14710/kapal.v21il.60839.

[15] A. Pusaka, Y. A. Dewanto, and F. Octaviany, "Study of ambulance ship design for island services in Indonesia," in *Journal of Physics: Conference Series*, Institute of Physics Publishing, Feb. 2020. doi: 10.1088/1742-6596/1469/1/012139.

[16] S. Adis, "Perancangan dan pengujian prototipe kapal ambulance Covid-19 tipe monohull elektrik untuk Kompetisi Kapal Cepat Tak Berawak Nasional," 2022.

[17] T. Irmiyana *et al.*, "Preliminary Design Water Ambulance untuk Pemindahan Oasien Covid-19 di Wilayah Kepulauan Indonesia (Studi Kasus di Kepulauan Madura)," *Jurnal Techno Bahari*, vol. 9, no. 1, 2022.

[18] P. D. Setyawan, R. T. Soelistijono, and G. H. Putra, "Perancangan Kapal Ambulans Air Kepulauan Karimunjawa Sebagai Sarana Pelayanan Kesehatan dan Penanganan Pasien Gawat Darurat," Politeknik Perkapalan Negeri Surabaya, Surabaya, 2023.

[19] M. Lakatoš, T. Sahk, H. Andreasson, and K. Tabri, "The effect of spray rails, chine strips and V-shaped spray interceptors on the performance of low planing high-speed craft in calm water," *Applied Ocean Research*, vol. 122, May 2022, doi: 10.1016/j.apor.2022.103131.

[20] M. Lakatos, T. Sahk, K. Tabri, H. Andreasson, and M. Kõrgesaar, "Spray rail preformance in off-design conditions," 2018. [Online]. Available: https://www.researchgate.net/publication/336406439

[21] S. Wiratno Satoto *et al.*, "Desain Rencana Umum Klinik Apung Generasi Ii Sebagai Sarana Pelayanan Kesehatan Masyarakat Lintas Hinterland Batam Design of General Arrangement Ambulance Generation II as Health Service for Batam Hinterlant Community," 2022.

[22] S. W. Satoto *et al.*, "Studi Kelayakan Pemindahan Area Pelayaran Batam Marine Ambulance (Bma) Dari Pelabuhan Tanjung Punggur Ke Area Sekupang Kota Batam," *Jurnal Inovtek Polbeng*, vol. 12, pp. 110–118, Nov. 2022.

[23] Alamsyah, W. Setiawan, T. Hidayat, and A. Alfianto, "Design of Water Ambulance for Inland Waterways of Regency East Kalimantan," Scitepress, May 2020, pp. 84–93. doi: 10.5220/0009406000840093.

[24] R. A. Guguraty, W. Amiruddin, A. Wibawa, and B. Santosa, "Desain Kapal Ambulans Berlambung Katamaran Sebagai Penunjang Fasilitas Kesehatan," *Jurnal Teknik Perkapalan*, vol. 12, no. 2, Apr. 2024.

[25] Alamsyah *et al.*, "Stability Study of Water Ambulance in East Kalimantan Inland Waterways," *WAVE: Jurnal Ilmiah Teknologi Maritim*, vol. 17, no. 1, pp. 01–06, Jul. 2023, doi: 10.55981/wave.2023.186.

[26] N. A. Prasetyo, R. Hakim, S. Wiratno Satoto, M. Nur Abiyad, and Yogantara, "Uji Performa Model Batam Marine Ambulance Sebagai Armada Pendukung Medis dan Logistik," *Infotekmesin*, vol. 14, no. 2, pp. 337–344, Jul. 2023, doi: 10.35970/infotekmesin.v14i2.1922.

[27] F. Kalbuadi and H. A. Kurniawati, "Desain Amphibious High Speed Ambulance Craft (HSAC) sebagai Penunjang Fasilitas Kesehatan di Kepulauan Raja Ampat," *Jurnal Teknik ITS*, vol. 9, no. 1, pp. 157–163, 2020.