Study of passenger vessels design in Berau Regency, East Kalimantan, Indonesia for public transportation

S D Utami$^{1,2}$, H Haripamudya$^2$ and S B Kurniawan$^3$

$^1$Department of Marine Engineering, Faculty of Marine Technology, Institut Teknologi Sepuluh Nopember, Sukolilo, Surabaya 60111
$^2$Study Program of Ship Design and Construction, Department of Shipbuilding, Politeknik Perkapalan Negeri Surabaya, Sukolilo, Surabaya 60111
$^3$Department of Chemical and Process Engineering, Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia

E-mail: septavyola@gmail.com

Abstract. Globalization had increased global economic activity, including production, trade and distribution activities in developing countries, especially in Asia. The increasing of trade traffic and cargo transportation in archipelago country like Indonesia, requires the utilization of sea lanes. This study was aimed to present the suitability of ship design to be passengers transportation in Berau Regency, East Kalimantan, Indonesia. The proposed design should be in accordance with the conditions of Berau which has 6 districts crossed by the river which still lack of transportation facilities. This research proposed an optimal ship design that can be used as a reference for renewable ships in Berau waters. This study produced a watershed design analysis concept as part of the reference and boundary dimensions of the ship. The obtained main size of the ship using linear regression method was total length of 12.5 meters, 3 meters wide, 1.5 meters high, and 0.6 meters full of water. Resistance analysis using the Savitsky method showed the engine capacity of 2x150 pk with a service speed of 25 knots. Maximum speed of 30 knots with a distance of 57.32 mill can be reached with 2 hours service speed and 1 hour 40 minutes at a maximum speed of 30 knots with the resistance value 12.8 kN. The total estimated budget for the production of this ship was Rp 1.773.656.800. This design may be adopted as an integrated reference for the procurement of transportation facilities for passenger ships, especially in the Berau river.

1. Introduction

Indonesia is one of the countries in Southeast Asia which has a high activity of sea transportation as compared to other countries. As an archipelago, Indonesia still has limitations in maritime infrastructure, therefore the government needs to commit to focus in maritime infrastructure development (Fikry et al., 2016). Without maritime infrastructure and transportation facilities, industry and trade in the islands, coast and offshore, will be difficult to be developed. Ports and docks are part of maritime infrastructure which function as transportation facilities connectivity (Putra et al, 2016). The availability of ships as an effective and efficient transportation facilities is also a key requirement in efforts to drive the economic sector of archipelago country (UNESCAP, 2018).
The shape of ships increasingly diverse following the oceanography condition. It can be seen from the development of the hull shape, upper building and interior design (Muthia Nur, 2016). The evolution of a technical design can therefore be considered as a component of the overall economic model. All these new findings are based on the development of knowledge in the field of shipping by academics and technicians to support the needs of society and industry.

Ship design is a planning phase with many considerations to meet the requirements of the spiral design concept. Spiral design concept is basically the conversion of the marine transport requirements into the feasible ship designs which must then be evaluated for its technical performance and economic feasibility (Abdy Kurniawan, 2018). This design study is a development plan and design in accordance with the conditions of the District of Berau which has 6 districts crossed by rivers and lack of land transportation facilities such as access roads and bridges. The government of Berau District provides transportation affirmation funds in 2020 allocated for the construction of passenger ships in territorial waters of the Berau river.

This design study refers to various aspects including the needs of the ship analysed based on condition of territorial waters of the Berau river, East Kalimantan. This study includes the main dimensions of ship referring to the location of the waters, the speed of the ship referring to the analysis of resistance from the shape of the hull, fuel tank capacity planning referring to shipping route and ship stability analysis based on IMO HSC code 2000 Annex 8 (Yuli Purwanto et al., 2014). This study was expected to get results in accordance with the needs of water transportation in the District of Berau, East Kalimantan. The obtained design results were expected to be a basic reference for the construction of passenger ships in river, especially Berau River, East Kalimantan, Indonesia.

2. Study area and parameter description
2.1. Territorial waters of Berau Regency
Berau Regency is one of the regencies in East Kalimantan Province that has high biodiversity and natural resource potential. The various potentials of natural resources, both renewable and non-renewable make Berau District as one of the main supporters of achieving several important development targets in the Province of East Kalimantan. With a location directly adjacent to the Province of North Kalimantan, Berau Regency has a strategic role in the distribution and flow of goods and services. Closer access to the capital city of North Kalimantan Province, Bulungan Regency, is a distinct advantage in the economic development of Berau Regency, when compared to other districts / cities in the East Kalimantan Province. Berau Regency is in the northern part of East Kalimantan Province and directly borders with North Kalimantan Province. The administrative area of Berau Regency is divided into 13 districts with a total of 100 villages.

Berau Regency Statistics Agency (BPS Berau) reported that Berau has two large rivers managed as transportation and supporting facilities for economical purposes, namely the Berau river and the Kelay river. The river has more than 10 tributaries that provide access to floodgates in several districts and villages in Berau Regency. Sea transportation around community is currently in the form of canoes and motorboats that are mostly made of wood. Vessels exist in Berau river are functioned as transportation facilities with ship dimensions around 10m and width around 2m. An example of an existing ship that made of wood was passenger boat with 12 passengers boating from the Kelay river heading to the Berau river. It is not uncommon for barges and tugs to cross large rivers for the needs of the coal industry in Berau Regency. Based on data from the 2016, river water condition data in Berau Regency, East Kalimantan are:

| Parameter          | Details                      |
|--------------------|------------------------------|
| Location           | Berau, East Kalimantan       |
| Type               | Permanent River              |
| Pattern            | Dendritic                    |
| Average depth      | 9 m – 11 m                   |
| Longest bridge     | Jembatan Gunung Tabur (225m) |
| Average river width| 230m-250m                    |
| Widest river       | Muara Berau > 350 m          |
• Wide creeks: 60m – 70m
• River drainage width: 5m – 10m
• Depth of creeks: 2m – 5m
• Depth of side creeks: 1m - 2m
• The biggest port: Port Tj. Redep
• Depth of Port: 5m

In the Berau, Kelay, and Sagah tributaries, they have a width of about 8 meters to 15 meters, including the river's edge as a city drainage of about 2 meters to 4 meters. There are 3 large ports with arrows that allow large ships to be anchored and refuelled, namely Tanjung Redeb port, Lati Berau pier, and Mantaritip port, each port of which is about 30 meters apart. There is also a public port with a red dot symbol on the banks of the Lesan, Tawon, Dumaring, Bental, Birang, Pura, and Sidung rivers. Around four small ports owned by the people that are used by the surrounding community for fishing port and small boat transportation in Berau Regency, there is a famous tourism port in Berau located in the Dermawan Island which connects the small islands and diving resorts there as referring to RPJMD (Regional Medium-Term Development Plan) Berau 2016-2021 with location of ports are depicted on Figure 1.

2.2 Ship resistance
As a ship moves through calm water, the ship experiences a force acting opposite to its direction of motion. This force is the water's resistance to the motion of the ship, which is referred as “total hull resistance” (R_t). This resistance force is used to calculate a ship’s effective horsepower. The total resistance (drag) of a flat plate, R_t, is mainly composed of two components, which are the residuary resistance, R_R, and the frictional resistance, R_F, as given in Equation 1.
Once the total drag values were obtained for each plate and related speeds, they were non-dimensionalized by dividing each term with the dynamic pressure and wetted surface area of the plates. The total drag coefficient, \( C_T \), was therefore evaluated using the Equation 2.

\[
R = R_R + R_F
\]

\[
R = \frac{1}{2} \cdot \rho \cdot C_f \cdot S \cdot V^2
\]

Where \( \rho \) is the density of water, \( S \) is the wetted surface area, \( C_T \) is the total resistance coefficient and \( V \) is the speed.

2.3 Ship material
Fibre Reinforced Plastic (FRP) is a composite material by reinforcing fibres and polymer matrix to bind together with the fibres. The polymer matrix is applied as a liquid resin and chemically cured to form a solid. Constituent materials which are commonly used as reinforcements and matrix in FRP products used for marine structures are presented in Table 1.

| Reinforcing Fibre | Polymer Matrix     |
|------------------|--------------------|
| Glass fibre      | Polyester resin    |
| Carbon fibre     | Vinylester resin   |
| Aramid fibre     | Epoxy resin        |

FRP is the main type of composite material which is extensively used in building boat. Apart from the main structural advantage of high strength to weight ratio of the composite material, some physical and manufacturing characteristics make application of FRP in ship and boat more suitable. Application of FRP in ship and boat will spread wider as the identified marine fields are being developed faster in the recent years. Increasing number of boats fully fitted with FRP hull and boats with extensive FRP outfits was being introduced as the result of the activities development in the maritime field.

2.4 Ship stability
The stability of the ship has been regulated by the International Maritime Organization (IMO). In the high-speed craft code Annex 8, stability of mono hull explains the criteria in the intact condition. The mandatory minimum criteria (maximum values are not specified) laid down by IMO for the majority of merchant ships which set out in terms of features of the basic GZ curve:

1. The area under the GZ curve shall not be less than 0.055 m radians up to 30° heel; not less than 0.09 m radians up to 40° or up to the down flooding angle (if less than 40°) and not less than 0.03 m radians between these two angles.
2. GZ must be at least 0.20 m at an angle of heel of 30° or greater.
3. The maximum GZ must occur at an angle not less than 25°.
4. The metacentric height shall not be less than 0.15m.

Possible loading conditions of a ship are calculated and information is supplied to the owner. Stability information in the form of curves of static stability is also supplied. The usual loading conditions covered are:

1. The lightship
2. Fully loaded departure condition
3. Fully loaded arrival condition
4. Ballast condition
5. Other likely service conditions.
3. Methodology

The methodology of this study consisted of several stages as presented on Figure 2.

![Research flowchart](image)

**Figure 2.** Research flowchart.

3.1 Determination of ship main dimension

Determination of the main size of the ship include the length, width, height of the hull of the ship, and height of the ship full of water. Determination of the size aspect of the ship based on data processing analysis, where the results of the analysis of water conditions considering the width of the river, depth of the river and also the condition of the dock, as well as the determination of the ship's deadweight in lifting the burden inside it (W.A Niam, 2017).

3.2 Design concepts

Making the design concept is the next step of determining the main size of the ship, in the design concept a preliminary design is formed in the form of a lines plan, a general plan that includes a safety arrangement, and a three-dimensional drawing of the shape of the hull that has been planned from the main size of the ship using Maxsurf and rhinoceros software, which then enter the analysis phase. The authors collected the shape of the existing hull on the internet and provides innovation on super structure to adjust to the needed.

3.3 Construction calculations

This study performed the construction calculations or scantling calculations referring to Biro Klasifikasi Indonesia (BKI) FRP 2016. Regulation from the construction calculation data was determined for the thickness required for each part of the ship and the formation of the fibre material.
used. The results of the drawings at this stage are longitudinal construction views, and transverse construction cross section of the ship design.

3.4 Analysis of ship resistance
Analysis of ship resistance was conducted using Bentley Maxsurf Resistance software with Savitsky method. Resistance analysis was used to find the large engine capacity needed to reach speeds of 25 knots designed in the design of the ship, and also as a reference for technical specifications. Based theory from this phase from “Maxsurf Resistance Help” wrote the criteria for Savitsky method, and that is compatible with this ship.

3.5 Analysis of ship stability
Ship stability was analysed using Bentley Maxsurf Stability software. Maxsurf has a loading modelling feature which was suitable for Berau passenger ship design analysis. The results of the Maxsurf Stability analysis were checked for eligibility using the IMO HSC code 2000 Annex 8 manually on Maxsurf because the IMO HSC code 2000 Annex 8 criteria are not yet available. IMO HSC code 2000 is a renewal of the MSC.35(63) which was adopted by Indonesia Government as the regulation of fast ship set on Keputusan Menteri no. 29, 1999.

3.6 Optimum result
The design concept is stated to be optimum if the design concept gets the engine capacity to reach speeds of around 25 knots with an engine size not more than 500pk on the grounds of engine price efficiency and effectiveness of the hull shape, and has stability criteria in accordance with IMO HSC code 2000 Annex 8. If it does not meet the researchers must repeat at the design concept stage again to get the optimum analysis results.

3.7 Estimation of cost
From the technical and production specifications data, a budget plan was made to provide an estimation of the ship cost at the final output stage. With the intention of providing a description of the allocation of ship procurement costs based on market supplier as of December 2019.

4. Result
4.1 General Requirement
Several aspects of the ratio that must be met for the design of the ship based on analysis of community and environmental needs were:
- Shipping route: Tanjung Redeb Port - Sanggam - Lati Berau Port - Tanjung Batu Port
- Shipping length: 57.32 mill
- Speed estimation: 25 knots
- Type of load: Passengers and Baggage
- LOA: <15 m

4.2 Determination of main size of ship
The comparison of ship which available as reference are presented on Table 2.

| Speed (knot) | Fr LWL | Fr Volume | Resistance (kN) | Power (Hp) |
|--------------|--------|-----------|----------------|------------|
| 23.125       | 1.144  | 2.649     | 11.8           | 188.501    |
| 23.75        | 1.175  | 2.721     | 11.9           | 195.164    |
| 24.375       | 1.206  | 2.792     | 12             | 201.792    |
| 25           | 1.237  | 2.864     | 12.1           | 208.411    |
| 25.625       | 1.268  | 2.936     | 12.2           | 215.049    |
| 26.25        | 1.298  | 3.007     | 12.2           | 221.73     |
| 26.875       | 1.329  | 3.079     | 12.3           | 228.478    |
From the comparison of ship data, a regression formula was used to get the main measurements from the existing vessel. With the constant variable of number of passengers as many as 22 people as variable X. The obtained regression results for Length Over All (LOA), Beam Over All (BOA), depth and draft were presented on Figure 3, 4, 5 and 6.

**Figure 3.** Regression calculations on LOA by comparative ship method.

\[ Y = 0.2017x + 7.7009 \]

\[ Y = 12.1383 \]

\[ \text{LOA} = 12.1383 \text{ m} \]

**Figure 4.** Regression calculations of BOA by comparative ship method.
\[ Y = 0.0478x + 1.8536 \]
\[ Y = 2.9052 \]
\[ \text{BOA} = 2.9052 \text{ m} \]

**Figure 5.** Regression calculations of depth by comparative ship method.

\[ Y = 0.019x + 0.9028 \]
\[ Y = 1.3208 \]
\[ \text{Depth} = 1.3208 \text{ m} \]

**Figure 6.** Regression calculations of draft by comparative ship method.

\[ Y = 0.0214x + 0.1195 \]
\[ Y = 0.5903 \]
Draft \( = 0.5903 \) m

The main measurement results obtained through comparison ship regression are as follows:

| Measurement | Value        |
|-------------|-------------|
| LOA         | 12.1383 m   |
| BOA         | 2.9052 m    |
| Depth       | 1.3208 m    |
| Draft       | 0.5903 m    |
| Passenger   | 22 person   |

Dimensions that have been obtained are rounded to facilitate the calculation process of construction and other analysis. The main size of the ship that has been rounded was LOA 12.5 m, LPP 11 m, LWL 11 m, B 3 m, H 1.5 m, T 0.5 m, Vs 25 knots, g 9.81 m/s\(^2\), Disp 9.21 ton, and Cb 0.45.

### 4.3 Ship design

Maxsurf modelling result based on existing general requirements are presented as lines plan with corrections to the block coefficient (Cb) and displacement. The obtained model from Maxsurf modeler was exported to AutoCAD program to improve the lines and make it more streamlined. The results of lines plan that have been streamlined are modeled again on Maxsurf. If the results are in line, the results of the lines plan were taken as the output of the three-dimensional model obtained through the Maxsurf. The results of the obtained lines plan are presented on Figure 7.

![Figure 7](image-url)

**Figure 7.** (a) Body plan, (b) Sheer plan, (c) Halfbreadth plan.
From the results of the streamlined lines plan the results of the three-dimensional modeling by Maxsurf modeler software. The streamlined design of ship is presented on Figure 8, while the general arrangement of ship is depicted on Figure 9. Fiber ship construction plan based on the results of construction calculations are presented on Figure 10 and 11.

![Figure 8](image_url)  
(a) Front view of hull, (b) Side view of hull, (c) Bottom view of hull.

![Figure 9](image_url)  
Figure 9. General arrangement of the ship.
Based on BKI regulations Volume V 2016 regarding the Fiberglass Reinforced Plastic, obtained general measurements are presented on Table 3.

**Table 3. Measurements of construction design.**

| Property                  | Value     |
|---------------------------|-----------|
| Frame spacing standard    | 0.5 m     |
| Tensile strength          | 98 N/mm²  |
| Modulus tensile elasticity| 6860 N/mm²|
| Bending strength          | 150 N/mm² |
| Mod bend elasticity       | 6860 N/mm²|

**Figure 10.** Transverse view.

**Figure 11.** Longitudinal view.
4.4 Analysis of engine power needs

The method used in the Maxsurf resistance program was Savitsky have an efficiency of 85% and the simulation results are presented on Table 4.

Table 4. Engine power needs simulation result.

| Speed Knot | Fr LWL | Fr Volume | Resistance (kN) | Power Hp |
|------------|--------|-----------|-----------------|----------|
| 15         | 0.742  | 1.718     | 9.1             | 93.742   |
| 15.625     | 0.773  | 1.79      | 9.4             | 101.113  |
| 16.25      | 0.804  | 1.862     | 9.7             | 108.635  |
| 16.875     | 0.835  | 1.933     | 10              | 116.249  |
| 17.5       | 0.866  | 2.005     | 10.3            | 123.894  |
| 18.125     | 0.897  | 2.076     | 10.5            | 131.514  |
| 18.75      | 0.927  | 2.148     | 10.8            | 139.063  |
| 19.375     | 0.958  | 2.22      | 11              | 146.507  |
| 20         | 0.989  | 2.291     | 11.1            | 153.823  |
| 20.625     | 1.02   | 2.363     | 11.3            | 161.003  |
| 21.25      | 1.051  | 2.434     | 11.5            | 168.046  |
| 21.875     | 1.082  | 2.506     | 11.6            | 174.965  |
| 22.5       | 1.113  | 2.578     | 11.7            | 181.776  |
| 23.125     | 1.144  | 2.649     | 11.8            | 188.501  |
| 23.75      | 1.175  | 2.721     | 11.9            | 195.164  |
| 24.375     | 1.206  | 2.792     | 12              | 201.792  |
| 25         | 1.237  | 2.864     | 12.1            | 208.411  |
| 25.625     | 1.268  | 2.936     | 12.2            | 215.049  |
| 26.25      | 1.298  | 3.007     | 12.2            | 221.73   |
| 26.875     | 1.329  | 3.079     | 12.3            | 228.478  |
| 27.5       | 1.36   | 3.15      | 12.4            | 235.317  |
| 28.125     | 1.391  | 3.222     | 12.5            | 242.69   |
| 28.75      | 1.422  | 3.294     | 12.6            | 249.354  |
| 29.375     | 1.453  | 3.365     | 12.7            | 256.59   |
| 30         | 1.484  | 3.437     | 12.8            | 263.995  |

Speed was taken up to 30 knots to avoid margin errors and errors in the selection of engine capacity. To reach the speeds of 30 knots, engine capacity of 300 HP or 300 PK are required. The following results are free surfaces at 30 knots with excellent transverse and divergent wave patterns (Figure 12).

Figure 12. Free Surface at 30 Knots.

The machine needs to be distributed into 2 machines with each capacity of 150 PK. Estimation of fuel tank calculations for daily needs with planned cruise route data with the distance of 57.32 mill and estimated one-day operational of 5 round trips are presented as follow:
Vs = 25 knots = 28.76948 mill per hour
Vmax = 30 knots = 34.52337 mill per hour

Engine capacity = 263.995 HP
Engine used = 2x150 PK = 300 PK
Cruise distance = 57.32 mill
Cruise time
Vs = 1.99239 hour = 119.5434'
Vmax = 1.66033 hour = 99.61948'

4.5 Analysis of ship stability
This study only analyzes the stability of the ship under conditions of 100% lightship load capacity, 100% passengers, and 100% tanks. Based on the full load condition of the ship, the obtained results are presented on Figure 13.

![Figure 13. Results of stability calculation at full load conditions.](image)

4.6 Optimum Result
From the calculation of obstacles, to reach the official speed of 25 knots a passenger ship requires an engine capacity of 208.41 PK and 300 PK at a maximum speed of 30 knots. A distance of 57.32 mill can be reached by 2 hours at official speed and 1 hour 40 minutes at a maximum speed of 30 knots. With a tank capacity of 1000 litres, this ship can operate up to five times round trip without refuelling with a safety fuel load of 10% for the need of emergencies. The following results (Table 5) from the analysis of the condition of loading stability, the obtained design of this ship is suitable for use as referring to the IMO HSC code 2000 regulatory standards.

| Code | Criteria | Value | Units | Actual | Status | Margin % |
|------|----------|-------|-------|--------|--------|----------|
| HSC 2000 Annex 8 Monohull. Intact | 1.1 Weather criterion from IMO A.749(18) | 16.0 | deg | 2.1 | Pass | +86.79 |
| | Angle of steady heel shall not be greater than (<=) | 80.00 | % | 7.8 | Pass | +90.28 |
### Code Criteria Value Units Actual Status Margin %

| Code                        | Criteria                           | Value | Units | Actual     | Status | Margin % |
|-----------------------------|------------------------------------|-------|-------|------------|--------|----------|
| HSC 2000 Annex 8 Monohull. Intact | immersion angle shall be less than (<) | 100.00 | %     | 202.02     | Pass   | +102.02  |
|                            | Area1 / Area2 shall not be less than (>=) | 3151.00 | mm.deg | 10756.24   | Pass   | +241.36  |
| HSC 2000 Annex 8 Monohull. Intact | 1.2 Area 0 to 30 or GZmax         | 1719.00 | mm.deg | 6328.38    | Pass   | +268.14  |
| HSC 2000 Annex 8 Monohull. Intact | 1.3 Area 30 to 40                 | 200.0  | mm    | 727.0      | Pass   | +263.50  |
| HSC 2000 Annex 8 Monohull. Intact | 1.4 Max GZ at 30 or greater       | 15.0   | deg   | 50.0       | Pass   | +233.33  |
| HSC 2000 Annex 8 Monohull. Intact | 1.5 Angle of maximum GZ           | 150.0  | mm    | 2083.0     | Pass   | +1288.67 |

#### 4.7 Estimated Cost

Estimation of total costs including several considered items are presented on Table 6.

**Table 6. Budget plan.**

| Number | Item                      | Total Price  |
|--------|---------------------------|--------------|
| 1      | Construction              | Rp 950,892,300 |
| 2      | Machinery and Installation| Rp 407,600,000 |
| 3      | Electrical and Installation| Rp 33,000,000 |
| 4      | Navigation Equipment      | Rp 46,400,000 |
| 5      | Safety Equipment          | Rp 13,000,000 |
| 6      | Communication Equipment   | Rp 14,400,000 |
| 7      | Mooring Equipment         | Rp 35,450,000 |
| 8      | Accommodation Equipment   | Rp 145,850,000 |
| 9      | Delivery                  | Rp 34,064,500 |
| 10     | Trial and Certification   | Rp 1,773,656,800 |
| **Total** |                        | **Rp 1,773,656,800** |

#### 5. Conclusion

Main dimension approach of the ship using the linear regression method result a total length of 12.5 meters, 3 meters wide, 1.5 meters high, and 0.6 meters full of water. Resistance analysis using the Savitsky method showed the requirement of engine capacity of 2x150 pk with a service speed of 25 knots. A maximum speed of 30 knots with a distance of 57.32 mill can be reached with 2 hours service speed while 1 hour 40 minutes at a maximum speed of 30 knots with the resistance value 12.8 kN. Calculation of stability was carried out with the condition of a full ship (full load) to get maximum results without any specific warning in any planned conditions. The design of the hull was proven to meet the IMO High Speed Craft code 2000 annex 8 regulations. With a tank capacity of 1000 litres, Berau Regency passenger ships can operate five times round trip without refuelling with a safety fuel load of 10% for the need for emergencies. Ship construction costs ranging from construction, ship equipment, finishing and shipping was estimated to be of Rp 1,773,656,800.

#### References

[1] Amalina, M. N., & Kristianto, T. A. (2017). Desain interior kapal navigasi S-126 untuk meningkatkan kualitas keamanan, kenyamanan, dan memenuhi standard kode kapal yang berlaku. *Jurnal sains dan seni pomits.*

[2] Ari, I., Aksakalli, V., Aydogdu, V., & Kum, S. (2013). Optimal ship navigation with safety distance and realistic turn constraints. *European Journal of Operational Research.*

[3] Cassidy, F. et al. (2016). Diplomasi Poros Maritim: Keamanan Maritim dalam Perspektif Politik
Luar Negeri. *Badan Pengkajian dan Pengembangan Kebijakan.*

[4] Cerveny, L. K., Miller, A., & Gende, S. (2020). Sustainable cruise tourism in marine world heritage sites. *Sustainability (Switzerland).*

[5] Ferreiro Garcia, R., Antonio, C., & Ameal, F. (2001). Ship Stability Monitoring by Motion Frequency Analysis. *IFAC Proceedings Volumes.*

[6] He, J., Wu, H., Ma, C., Yang, C. J., Zhu, R., Li, W., & Noblesse, F. (2019). Froude number, hull shape, and integral representation of ship waves. *European Journal of Mechanics.*

[7] Karlikov, V. P., & Sholomovich, G. I. (1998). Some features of body-flow interaction in the presence of transverse jets. *Fluid Dynamics.*

[8] Kim, J. (2019). Maneuvering target tracking of underwater autonomous vehicles based on bearing-only measurements assisted by inequality constraints. *Ocean Engineering.*

[9] Kurniawan, A. (2018). Design solution ideal for landing craft utility ship for pioneer routes and sea toll. *Journal of Transportation Research.*

[10] Li, Y., Landsburg, A. C., Barr, R. A., & Çasal, S. M. (2005). Improving ship maneuverability standards as a means for increasing ship controllability and safety. *Proceedings of MTS/IEEE OCEANS.*

[11] Na, S. S., & Karr, D. G. (2016). Development of pareto strategy multi-objective function method for the optimum design of ship structures. *International Journal of Naval Architecture and Ocean Engineering.*

[12] Niam, W.A. (2017). Desain kapal ikan di Perairan Laut Selatan Malang. *Ocean Engineering.*

[13] Ozdemir, Y. H., Bayraktar, S., Yilmaz, T., & Guner, M. (2008). Determining optimum geometry for a bow thruster propeller. *Royal Institution of Naval Architects - 8th Symposium on High Speed Marine Vehicles.*

[14] Papanikolaou, A., & Eliopoulou, E. (2008). On the development of the new harmonised damage stability regulations for dry cargo and passenger ships. *Reliability Engineering and System Safety.*

[15] Parunov, J., & Guedes Soares, C. (2008). Effects of Common Structural Rules on hull-girder reliability of an Aframax oil tanker. *Reliability Engineering and System Safety.*

[16] Purwanto, Y., Iskandar, B.H., Imron, M., & Wiryawan, B. (2014). Safety aspects pole and liner from ship stability and regulation point of view in Bitung, North Sulawesi. *Journal of Marine Fisheries Technology and Management.*

[17] Putra, A. A., & Djalante, S. (2016). Development of port infrastructure in support for sustainable. *Journal of Scientific Media Engineering.*

[18] Sabet, M. T., Fathi, A. R., & Mohammadi Daniali, H. R. (2016). Optimal design of the Own Ship maneuver in the bearing-only target motion analysis problem using a heuristically supervised Extended Kalman Filter. *Ocean Engineering.*

[19] Surendran, S., & Venkata Ramana Reddy, J. (2003). Numerical simulation of ship stability for dynamic environment. *Ocean Engineering.*

[20] Ueno, M., Yoshimura, Y., Tsukada, Y., & Miyazaki, H. (2009). Circular motion tests and uncertainty analysis for ship maneuverability. *Journal of Marine Science and Technology.*

[21] United Nations Economic and Social Commission for Asia and The Pacific. (2018). Study on strengthening capacity to plan and develop efficient coastal shipping in southeast asia.

[22] Wang, Y., Bilegan, I. C., Crainic, T. G., & Artiba, A. (2014). Performance indicators for planning intermodal barge transportation systems. *Transportation Research Procedia.*

[23] Yang, C., & Huang, F. (2016). An overview of simulation-based hydrodynamic design of ship hull forms. *Journal of Hydrodynamics.*