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DEVELOPMENT OF CATAMARAN SHIP DESIGN AS A HOSPITAL FACILITY FOR HANDLING COVID-19 PANDEMIC IN INDONESIAN ARCHIPELAGO REGION

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ABSTRACT

The outbreak of the novel coronavirus disease in 2019 (COVID-19) caused a significant public health crisis worldwide and challenged health care systems on six continents. Indonesia is a country with the 4th largest population globally, and 60% of the population is on the island of Java and the unequal health facilities that can handle the COVID-19 virus, the presence of the COVID-19 pandemic with a high spread rate can lead to a significant disaster. In this research, a catamaran hospital ship will be developed to help the handling of the COVID-19 pandemic in Indonesia to deal with areas affected by the COVID-19 virus especially in coastal areas. Catamaran has a few points of interest when compared to monohull ships. The deck range of the catamaran is more extensive than that of a monohull. The steadiness of catamaran vessels is superior to monohull vessels. Within the handle, this ship design uses a parent plan approach with reference to a comparator ship design that has cruised well. The research method applied is a numerical methods utilizing CAD and CFD software. The main dimensions of the ship obtained is Lwl = 35.5 m, B = 18.1 m, T = 2.54 m, H = 4.26 m, B1 = 3.83 m, CB = 0.698, and the maximum Vs = 21 knots with 341 kN total resistance. The main size of the ship is obtained from the minimum requirement for the deck area to be occupied by medical facilities such as those in special hospitals for handling infectious diseases. These facilities include isolation rooms for up to 25 people, treatment rooms, laboratory rooms, radiology rooms, polyclinics, pharmacies and autopsy rooms.

Keywords: hospital ships COVID 19, catamarans, resistance, stability.

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1. INTRODUCTION

In December 2019, the capital of China's Hubei province, the city of Wuhan, witnessed an outbreak of "pneumonia from an unknown source" attributed to its newly identified culprit: the new coronavirus [1]. It is possible that the animals could serve as reservoirs for disease, but this is not confirmed by reliable sources [2]. It was not long before droplet, and person-to-person transmission became the primary mode of transmission [3]. This has led to a rapid increase in the number of cases in China outside of Wuhan, with 31.3% of all patients having recently visited the city and 72.3% having lately been in contact with its residents [4].

Until now, Indonesia only has two hospital ships, namely K.R.I. dr. Soeharso belongs to the Navy, and the Floating Hospital Ship "Ksatria Airlangga" belongs to Universitas Airlangga. K.R.I. dr. Soeharso (990) (previously named K.R.I. Tanjung Dalpele (972)) is a Hospital Assistance (B.R.S.) type ship. This ship is classified as an L.P.D. (Landing Platform Dock) ship. Initially, this ship functioned as Personnel Transport Assistance (B.A.P.) named K.R.I. Tanjung Dalpele (972), due to a change in function, then on September 17, 2008, at Tanjung Emas Port, Semarang. Indonesia's number of hospital ships is undoubtedly not sufficient to help overcome the COVID-19 pandemic in Indonesia. Considering the vastness of the Indonesian archipelago and the current pandemic phenomenon, there is still no sign that this pandemic will end.

This research aims to apply shipping technology to help handle the COVID-19 pandemic in Indonesia by utilizing shipping technology through engineering catamaran hospital ship designs. The application of catamaran hospital ship design technology is an alternative solution in providing the current and future needs of hospital ships with a large capacity, comfort, and safety level following regulations and is environmentally friendly. The catamaran hospital ship design will be proposed and studied in-depth for good results. The study was carried out to get the right dimensions and follow the conditions of Indonesia's waters. This research is also expected to make a positive contribution to the future development of shipping technology in Indonesia.

2. LITERATURE REVIEW

2.1. Catamaran

A catamaran is a multi-hull type ship with two hulls (demihull) connected by a bridging structure. This bridging structure is advantageous for a catamaran because it increases the freeboard's height so that the possibility of deck wetness can be reduced. Catamaran type vessels are designed with twin hulls so that the two hulls are connected by a robust deck construction and stretch over it to withstand large bending moments and shear forces and work against the centerline. line) ship. The shape of a catamaran ship that shear (shear force) is large and works against the ship's centerline (centerline). [5] The catamaran has advantages over monohull ships, namely [5]:

1. On a boat with the same width, the catamaran friction resistance is smaller, so that at the same thrust, the speed is relatively greater.
2. The deck area of the catamaran is more comprehensive than that of the monohull.
3. Submerged volume and small wet surface area.
4. Better stability because it has two hulls.
5. With a rather high wave frequency but a relatively small amplitude, the comfort level is higher.
6. With a small amount of resistance, the operational costs are small.

7. The image that is impressed is that the security is guaranteed from the ship overturning to feel safer.

In operation, a ship must have good stability. Ship stability can be defined as the ability of a vessel to return to its original position (upright) after being tilted due to the work of external forces and internal forces [6]

2.2. Parametric design approach

To determine the main dimension of the monohull ship, the parametric design approach is used. The parametric design approach is a method used to design boats with parameters such as (L, B, T, Cb, L.C.B., etc.) as the main dimension, which results from regression from several comparisons ships. This method has several advantages, such as designing a more structured boat, and if the planning is successful, then the experience can be taken for different ship design methods. The disadvantages of the Parametric Design approach method is that it consumes a lot of time and often occurs human errors in calculations

2.3. Determination of catamaran main dimension

Conventional vessels have been in use for many years with a monohull hull shape. However, current development creates many different alternatives. Therefore, selecting the hull type became an essential issue at the early design stage of the ship. In research [7], monohull and catamaran ship planning is compared to the same displacement. The results can be used at the early design stage of ship design for hull type selection. This selection should be based on performance comparisons as well as other parameters, such as construction costs. The catamaran is a multi-hull ship with two demihull hulls isolated by a bridging deck. The research [8] that catamaran ships have unique characteristics, namely larger deck area, better shaking stability, less resistance, and better seakeeping than monohull at the same displacement. In research [9], the most optimum design in terms of stability is a catamaran.

The method used in this study to obtain the main dimension of the catamaran ship is to compare two ship models, namely the monohull type and the catamaran type, to determine the displacement value of the two vessels having the same amount. Then look at the difference in stability performance on the monohull and catamaran type models. The main dimension of the catamaran is obtained from the Parametric design approach regarding several ship comparisons. The main measure obtained is as the following:

1. L.O.A. (Length Overall) is the overall length of the ship measured from the stern to the bow's end.
2. Lwl (Length of Waterline) is the vessel's length measured on the ship's laden line.
3. B (Breadth) is the middle ivory's median distance as measured on the ivory outside and is not included a hull plate.
4. S (Beam Between Hull Centers) is the second distance between the centerline of each hull.
5. B.I. (Beam of Each Hull) is the maximum width of each stomach.
6. H (Height) is the vertical distance measured from baseline to deck line.

3. RESULTS AND DISCUSSION

3.1. Determination of the Main Size of the Catamaran

The method used in this study to obtain the main dimension of the catamaran ship is to compare two ship models, namely the monohull type and the catamaran type, to determine the displacement value of the two vessels having the same amount.

First of all, calculate the main dimension of the monohull ship using the regression method. Regression analysis is one of the most popular and widely used analyzes. Regression analysis is used extensively for prediction and forecasting, which uses complementary to machine learning. This analysis is also used to understand which independent variables are related to the dependent variable and determine the forms of these relationships in linear regression using the least-squares regression method [10].

Table 1 Comparison Ship

No.	Ship Name	LOA (m)	B (m)	H (m)	T (m)	Vs. (Kn)
1	Otava	34,9	9	6,1	2,7	8,7
2	Filla	35,5	9	4,2	3,15	10,9
3	Uloytind	36,02	9,64	4,2	2,75	9,2
4	Goulphar	36,8	7,75	3	1,85	8,2
5	Pionier	37,2	7	2,2	1,53	6,8
6	Linga	38,02	10,8	4,6	2,7	9,3
7	Stryno	38,2	10,8	3,5	2,2	7,3
8	Bambit	39,38	11	3,3	2,3	11
9	Kundur	39,38	11	3,3	2,2	7,5
10	Subsea Seven	39,5	9,05	4,58	3,4	10,7

Table 1 shows the linear regression method using the resulting equation, the main size of the new ship is obtained, illustrated in Table 2.

Table 2 The main dimension of the monohull ship

Item	Value	Unit
B	8,06	m
H	4,26	m
T	2.57	m
Vs	8,54	m
Lpp	33,73	m
Lwl	34,74	m
Displacement	488.15	ton

The method used in this study to obtain the main dimension of the catamaran ship is to compare two ship models, namely the monohull type and the catamaran type, with the treatment of determining the displacement value of the two vessels having the same value

Table 3 The main dimension of the catamaran ship

Main Dimension	Symbols	Value
Length Overall	LoA	35.50 m
Length of Water Line	LWL	35.05 m
Catamaran Breadth	B	18.10 m

Main Dimension	Symbols	Value
Demihull Breadth	B_1	3.83 m
Height	H	4.26 m
Draught	T	2.54 m

3.2. Modeling of lineplans, 3d models, and general arrangement

A ship line plan is drawn from the ship's main dimension, illustrated in Figure 1. The rescue boat's hull is made using the V hull type, where the rescue boat is a fast boat type where the planned service speed is 10 knots.

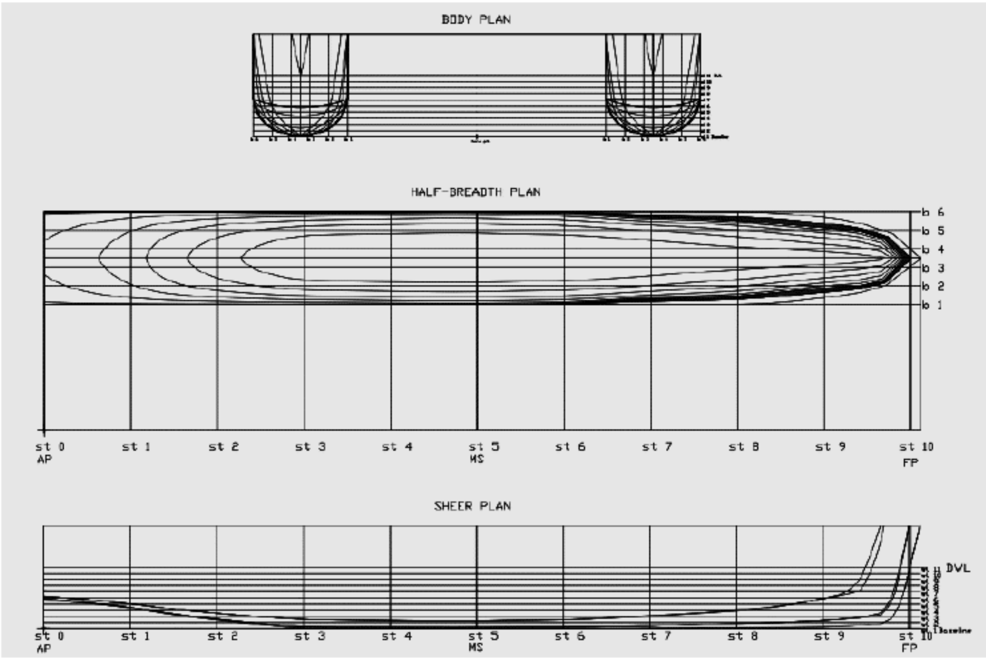

Figure 1 Linesplan of Catamaran

Hydrostatic curves show the state of the hull below the waterline for each load increase [11]. The hydrostatic data at full load are illustrated in Table 3.

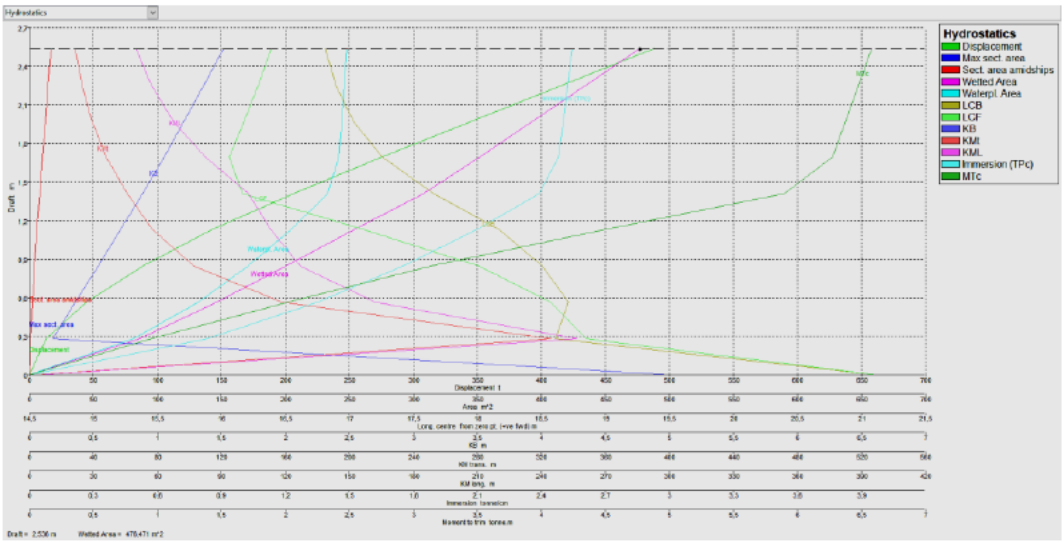

Figure 2 Hydrostatic of Catamaran

Hydrostatic curves are curves that show the state of the hull below the waterline for each load increase [11]. The hydrostatic data at full load are illustrated in Figure 2.

The data lines plan requires a three-dimensional model before analysis on the Maxsurf software. I was making a 3D model of the ship using the Rhinoceros software. Figure 3 shows the monohull ship's 3D model, which will be analyzed in the maxsurf software. Figure 4 shows a 3D model of a catamaran.

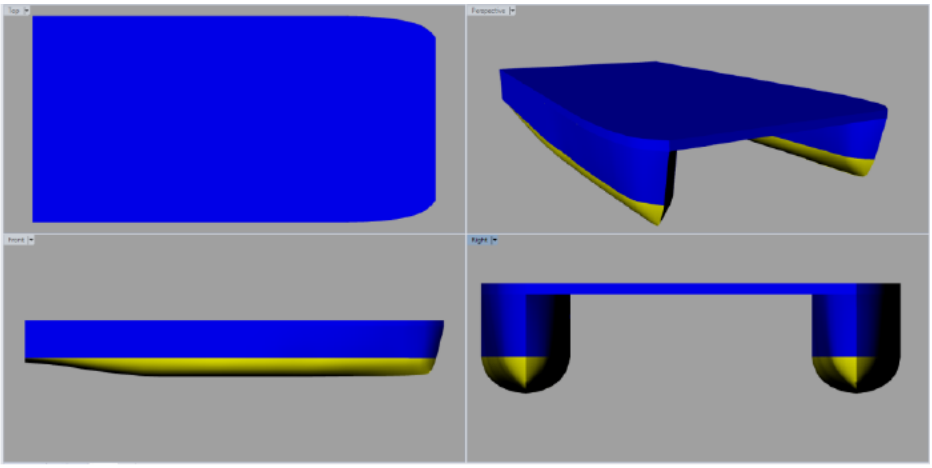

Figure 3 Catamaran ship 3D model

There are 3 decks on this hospital ship, namely, the main deck, the poop deck, and the navigation deck. On the main deck, there are patient isolation rooms, amounting to up to 25 rooms, a reception room, a guard room, a nurse's room, an oxygen room, and an accommodation room. on the poop deck there is a laboratory room, a pharmacy room, an administration room, a doctor's break room, a nurse's rest room, a rest room for captains and other crew members, a cafeteria, an accommodation and laundry room and a toilet. on the navigation deck there is a navigation space.

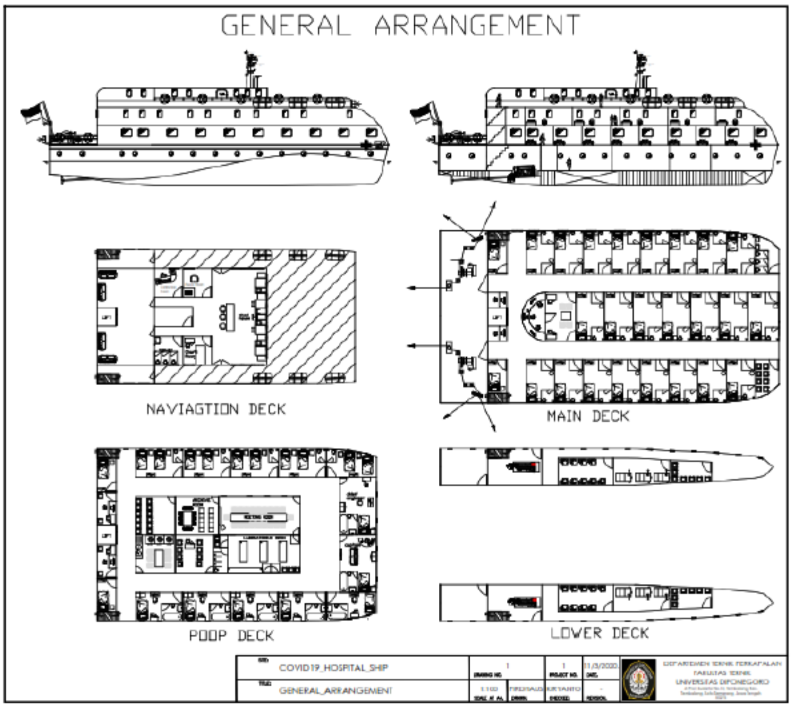

Figure 4 General Arrangement

3.3. Ship Resistance

Based on the results of the CFD simulation carried out on a catamaran, then it is accumulated in table 4 below. CFD simulation of total ship resistance with various speed variations of 12, 16, 20, 24, and 28 knots.

Table 4 Ship Resistance

V (knot)	*V* (m/s)	F_R	R_T (kN)
8	4.16	0.2	59
11	5.38	0.3	90
14	7.17	0.4	142
18	8.97	0.5	218
21	10.76	0.6	341

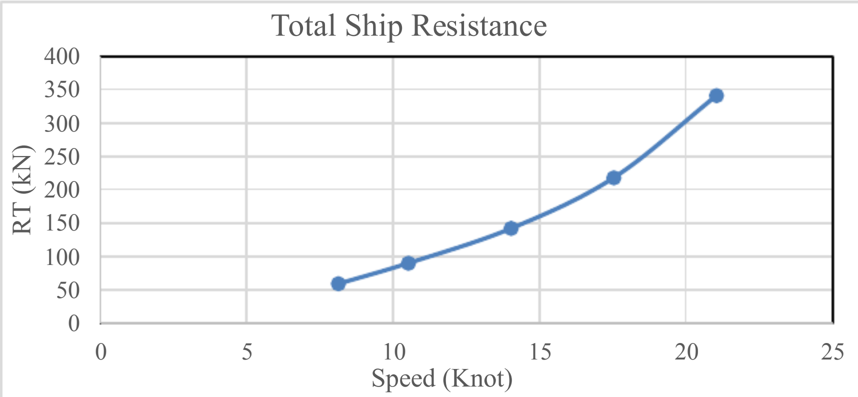

Figure 5 Total Ship Resistance Graph

In the results of the total resistance in accordance with table 4 which then we plot it into the graph, resulting in Figure .The total resistance of the catamaran ship at full speed (Fr 0.6) is 341 kN. Figure 5 shows a visualization of the wave elevation of a catamaran when traveling at a speed of Fr 0.2 seen from above

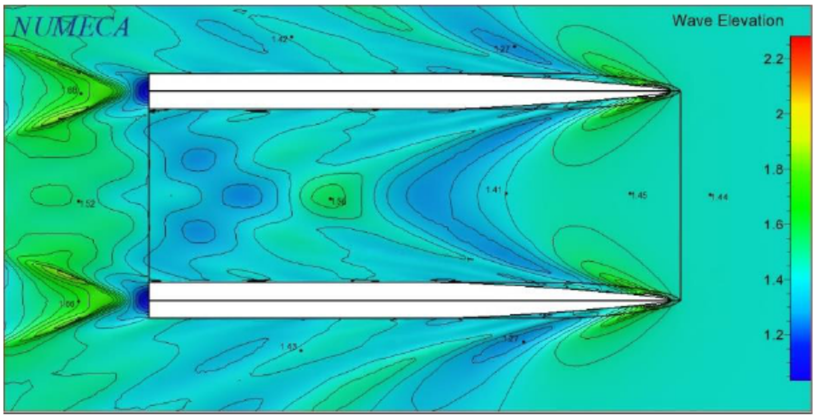

Figure 6 Wave elevation of the catamaran at speed Fr 0.2

The determination of the power / propulsion of the ship is based on the analysis of ship resistance as shown in the graph in Table 13 for a catamaran hospital ship with an inboard engine at a speed of 21 knots, a power requirement of 7800 HP will be obtained, so the propulsion engine is selected according to Figure 15 The 21 knots ship speed will be used as a reference to determine the power for the ship at maximum speed. The engine of the ship is placed in the hull at the stern of the ship (3 meters in front of the AP). The engine has a slope of 15° with the propeller shaft in the middle of the ship.

3.4. Ship Stability

In this study, the calculation of stability uses calculations in the Stability software and is reviewed on 3 conditions that represent the load conditions when the ship is operating. Meanwhile, the stability requirements refer to the standard requirements set by IMO.

In calculating the stability of the hospital ship, we have to vary several ship conditions so that the stability of each condition is known.

Table 5 Ship Conditions

Item	Condition 1 (%)	Condition 2 (%)	Condition 3 (%)
Load Space	100	0	100
FOT	100	100	20
Provision	100	100	20
Ballast	0	100	50

Table 5 above shows the variation in ship conditions and consumables from the four conditions. For more details, it will be explained as follows:

1. The first condition is the condition when the ship departs from the port, where the patient room, fuel, and provisions are fully filled and the ballast is empty
2. The second condition is a condition when the ship is traveling to certain areas where ballasts, fuel, and provisions are fully filled and the patient room is empty.
3. The third condition is a condition where the ship is at its destination. Ballast conditions adjust, FO and provisions are reduced to 20%

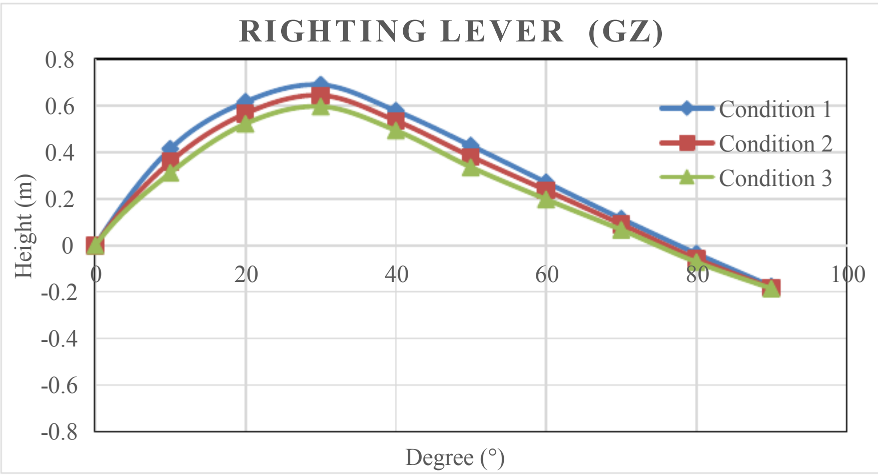

Figure 7 Righting Lever Graph (GZ)

This means that this condition can be declared stable because it has a positive MG value. With the assumption that if the points G (gravity) and M (metacenter) coincide (G = M) then it will not form a coupling moment so that the stability of the ship is declared indifferent. To maintain stability, it is necessary to know the factors that affect the stability of the ship, including:The value of MG, the greater the value of MG, the better the ability to return to its original position after the ship experiences a tilt.

1. The bigger the moment arm, the greater the righting moment that occurs. So that it has a bigger back arm.

2. The form factor is influenced by the location of point G (center of gravity), the lower the center of gravity of the ship, the greater the value of MG.

The weight factor is influenced by the location of point B (the upward pressure point of the volume of water displaced by the part of the ship that is in the water). So point B is influenced by the shape of the ship below the water surface, the greater the WSA value the better because it is an upward pressure point which causes the location of the metacenter to be higher.

4. CONCLUSIONS

Based on the results of research conducted on the redesign of the monohull hospital ship into a catamaran, it can be concluded that with the same displacement, the size of the catamaran hospital ship has a larger size with a ship width 1.5 times the width of the monohull ship, for further research a study on performance is needed. vessels such as ship resistance and stability as well as the layout and cargo space of catamaran hospital ships

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