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A Concept Design of Training Ship in Indonesia Waterway: Passenger-Container Vessel

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Abstract

The use of container ships in the world increase due to easy cargo handling through door to door. The requirements of the seafaring profession will face some tough challenges today and in the future. Therefore, this study aims to design a training vessel design with the type of container-passenger for Indonesian waters by considering important aspects and fulfilling the Standards of Training, Certification, and Watchkeeping (STCW). This study was addressed to AMI Makassar Maritime Polytechnic. The training vessel design with the type of passenger-container was carry out by developing the previous study of the passenger-cargo type and following several stages of preliminary ship design. The training vessel design has gross tonnage (GT) of 1711.0 tonnage. In addition, the power requirement under speed requirement for main engine with the assumed propulsion efficiency of 0.65 is 146.08 HP or 1090.70 kilowatt (kW).

Keywords: Training vessel; Passenger-container type; Ship design; Maritime vocational education

1. Introduction

In 2021, there was an enormous increase global container shipping freight rates. Then, it again experienced to increase on January 2022. There was the increase of 11% in global containerized trade volumes [1]. Asia region continued to play a leading role with the region's ports accounting for 62.5% of world container port [1]. The increasing need for containers in the world is a great opportunity for seafarers. It is expected that the demand for maritime shipping and seafaring personnel will continue to grow in the near future [2].

In today's seafarer market, one of the key problems is the lack of seafarers, especially experienced officers. Although the global supply of officers is increasing steadily, the demand is still higher than the supply. An additional problem is that an increased demand may lead to a decreased quality of education [2]. One of the most prominent objectives of maritime education and training (MET) is to supply manpower for the shipping industry. MET provides seafarers not only with theoretical knowledge on maritime issues but also practical training on ship duties. The sea trainings of cadets are executed in the defined periods according to national and international standards and they include all kind of on-the-job training methods for ships [3].

Meanwhile, the Republic of Indonesia is the largest archipelagic country in the world as indicated by the main characteristic that most of its territory is up two-thirds of the sea area. Under these conditions, the Republic of Indonesia requires reliable manpower resources as the benefits of an archipelagic country, especially in the maritime and transportation sectors. The most suitable and proper mode of transportation for an archipelagic country is water transportation [4], the governmenthas done various things such as increasing the status of state shipping schools and providing opportunitiesfor the community to manage and develop seafaring schools in a professional manner. Also, some programs were carried out including the provision of supporting infrastructure in improving the quality of seafarers' human resources, handing over 8 units of training vessels as floating laboratories, and demonstrations and simulations at sea [5].

As mentioned above, one kind of supporting infrastructure is to provide training ships wherein this is emphasized in the technical implementation of education which was regulated in the Decree No. 2162/HK.208/XI/DIKLAT-2010 regarding the guidelines for the implementation of marine education and training issued by the Transportation Human Resources Development Agency (BPSDM). However, several considerations should be evaluated to improve the training ship design such as the L/B ratio of 4.93 for passenger ships and the accommodation decks placed on the bottom deck or located below the waterline level. According to IMO rules, the accommodation deck is placed above the waterline, this is closely related to the comfort, noise and safety of passengers.

The modeling of the framework of training ship design for maritime vocational education was discussed [6]. In this study, the recommendation for the type of ship as a training ship is the type of passenger-cargo with the gross tonnage of 1587 GT and a propulsion engine power of 1642 kW. However, this training ship design should be also easy to be improved to anticipate the demand of other types such as a container-passenger type, etc.

This study aims to design a training vessel design with the type of container-passenger for Indonesian waters by considering important aspects such as safety, operational efficiency, and cargo capacity as stipulated in Government Regulations [7] and Standards of Training Certification and Watchkeeping (STCW) [8]. Therefore, the ship design process was conducted firstly by using the design of the type of passenger-cargo [6]. For supporting data related with maritime education and training (MET), this study was addressed to AMI Makassar Maritime Polytechnic and the possibility of the type of container-passenger of training ship design can be implemented to increase the competence of cadets as a real practice for students.

2. Methods

Here, the concept of training ship design with the type of container-passenger for maritime vocational education with consideration of several aspects were carried out into several steps that are explained below.

2.1. Data Collection

Data were collected through published researches and internet sources. The study of the conceptual design of training ship with the type of passenger-cargo was conducted [6]. From the study [6], the type of passenger-cargo was developed on the passenger-container type as well as the capacity was determined. Data of Indonesia water (wave height) in route which is passed by the training ship design were collected as well port characteristics such as loading and unloading facilities, port type, water depth, pier length, etc. The number of students who will practice using the training ship was based on the participants of the practice courses into two semester or one academic year.

2.2. Preliminary Design Process

The data were analyzed firstly on the preliminary design process wherein the requirements of training ship were determined namely ship type, capacity, and main dimensions, etc. The determination of ship type was carried out started from the type of passenger-cargo ship as obtained [6]. It was analyzed by using the Analytical Hierarchy Process (AHP) method in order to develop ship type alternative with consideration of container.

For the determination of capacity, the deadweight approach and space or capacity approach were used. The capacity was determined based on ship type, cargo kind and weight, frequency of service, minimum requirement of SCTW, and number of cadets (students, instructors, and crew). The number of students and instructors was based on the practice courses. Furthermore, the capacity was formulated as the function of length and width of the ship as well as the arrangement of container space.

In addition, the main dimensions were determined by using deadweight approach and space or capacity approach. The number of students, instructors, and crew was based on the previous study [6]. The number of containers was determined by using trial and error with the consideration of cargo kind and weight as well space and area for the containers related with other compartments. The trial and error means the arrangement of containers wherein the total cargo with minimum weight was based on previous study [6]. By the arrangement of all space needed, length and width of training ship could be obtained.

Furthermore, for determination of the width of ship, the berth space on port and the space of gangway on ship deck were considered. This obtained width would be checked by the length/breadth (L/B) ratio wherein it is 6 to 8 for passenger ships. For the determination of the ship height, the arrangement of the deck layout, the height of double bottom, and the minimum height of accommodation deck were considered. Then, the height was checked wherein it is in the range of the length/height (L/H) ratio of 10 to 15. For the determination of the ship draft, the deadweight ton (Dwt) and lightweight ton (Lwt) of the ship were calculated to obtain the ship displacement and draft. The ship draft was also checked to meet the breadth/draft (B/T) ratio of 3 to 5. All obtained main dimensions were checked by the ratio of main dimension. If the main dimensions did not meet the ratio, the process of the determination of main dimensions was repeated at the initial design stage.

After determining the main dimensions, a ship lines plan of the training vessel was designed. In addition, the general arrangement and the gross tonnage (GT) were designed and calculated respectively, with the considerations of regulation, access, placement of cargo and consumption, placement of equipment, machinery systems, and safety reason.

Moreover, ship resistance, power, and ship stability were calculated. Ship stability was calculated by using the Maxsurf Stability application [9] wherein the ship stability calculation was check in fulfilling the IMO requirements. For the calculation of ship resistance, it was calculated by using the Holtrop method through the Maxsurf Resistance application [9] wherein the ship resistance that was calculated was used for predicting the power of the training vessel design in the requirement of ship speed.

2.3. Design Control Stage according to SCTW 2010

As the final stage of the training ship design process, the specification of the training ship design were checked in order to fulfil the requirements of STCW [8] and also to be future built and operated wherein the requirements are the minimum propulsion power of 750 kW as well as the minimum gross tonnage of 500 GT.

3. Results and Discussion

The conceptual training ship design that was obtained in the previous study [6] was developed. The conceptual design includes the training ship type, capacity, main dimensions, ship hydrostatic, general arrangement and tonnage, ship resistance and propulsion, ship stability, ship motion. Therefore, the development of the type of training ship to be passenger-container is discussed as follows.

3.1. Determination of Passenger-Container Type

In previous study, the ship type selection for the training ship was modelled by using the Analytical Hierarchy Process (AHP) method [6] wherein the type of passenger-cargo vessel was selected with the score of 37.20 %. In addition, the type is in line with the development of the National Logistics System framework as stipulated in Presidential Regulation No. 26, 2012. Containers can guarantee integrated cargo transportation from door to door in an efficient and minimal risk manner. In addition, the function of conventional transportation ports has changed to container transportation due to the development of container ship capacity that has increased every year [10]. Therefore, ship type was developed to be a multipurpose container-passenger vessel [11]. Furthermore, the development of a passenger ship design into a multipurpose container-passenger vehicle was carried out [12].

In accordance with the determination of ship type above, the competencies of the operational level in the education and training process regulated by the STCW standards regarding the master and deck department must be achieved through providing the type of container-passenger vessel.

3.2. Training Ship Capacity

The capacity of the training ship with the type of the passenger-container vessel was obtained in consideration of the number of students based on the curriculum demands (practical courses), cadets, container loads. Also, the capacity considered the activity scenario of the service time for cadets, operation area, and destination port. The following is the discussion of the determination of training ship capacity.

The number of passengers was obtained by counting the number of students who will do the practice using the training ships in one-year study period. Three Study Programs use the training ship for practice namely Nautical Study Program (Level 3 Diploma), Ship Engineering Study Program (Level 3 Diploma), and Sea Transportation Study Program (Level 4 Diploma). The time allocation for one shipment or one group for practice is 14 days with several considerations such as a). The target number of cadets is 589 people who can be accommodated; b). Two months is prepared for the level 3 diploma within 3 years, each group achieves the competence in 14 days; c). Shipping route is determined 1 round trip of 7 days and 2 round trips of 14 days (Makassar Port - Pare-pare Port - Balikpapan Port – Batulicin Port - Balikpapan Port - Pare-pare Port - Makassar Port). Therefore, the number of students is 150 people.

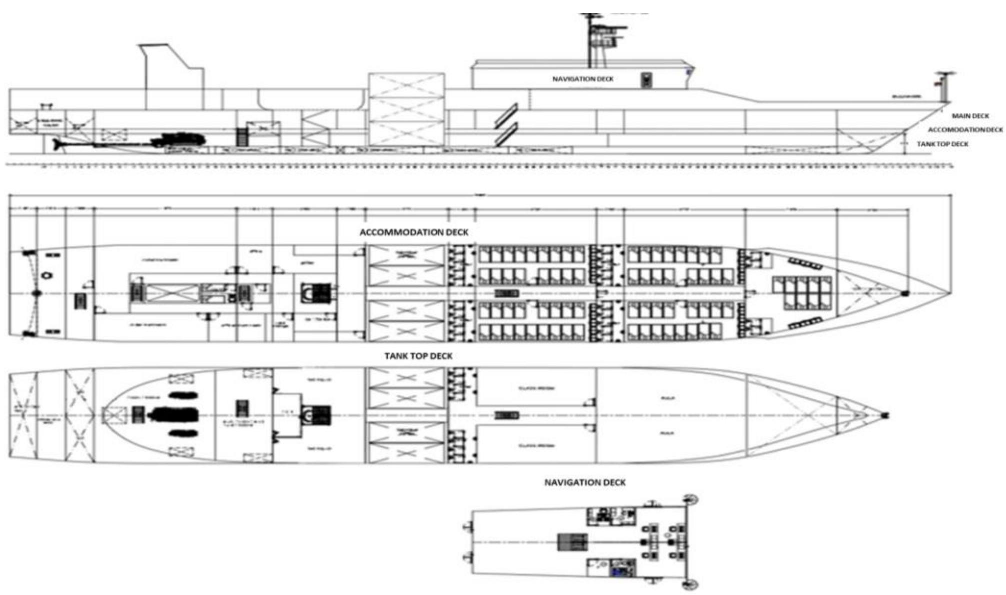

Figure 1. The arrangement of student accommodation deck and container hold.

For cargo load, the volume of loading space considered the amount of cargo to be loaded. Then, the amount of cargo to be loaded is carried out by arranging a number of container units with transverse arrangement of one row of ships with four units of the width of the ship with 3 tiers. The container size was assumed to hold in a 20 feet equipped with a cooling system. Therefore, the number of containers is 12 TEUs.

Through the capacity of student number and container number, the training vessel was arranged by the trial to place with considering the space, function, and access. Form the previous study [6], the general arrangement of the training vessel with the type of passenger-cargo was developed to be the type of passenger-container. The student bedroom is placed in the accommodation deck wherein the height of accommodation deck from base line is the same with draft line. The classroom is placed on the below the accommodation deck. Therefore, the width of accommodation deck requires 12 meters. These arrangements can be seen in Figure 1.

Furthermore, the container hold is placed in around the midship area. The cargo hold in the previous general arrangement is in the ship bow area and it was changed to be student accommodation deck and classroom. The container hold also can be seen in Figure 1.

3.3. Main Dimensions

3.3.1. Breadth (B)

The width of the training vessel design was also determined by using space approach. Based on Figure 1, the accommodation deck and main deck have the same width wherein the space need in accommodation deck including bedroom of double-decker beds for student of 150 people. Bedroom was arranged into four rows separated with gangway. In addition, four column for containers were arranged through the container hold with the gangway space in centerline. Therefore, the space need for breadth is 12 meters.

3.3.2. Draft (T)

The draft of the training vessel design was determined by using the width/draft (B/T) ratio. The estimated draft ranges from 2.4 meters to 4.0 meters. Also, the draft was obtained by using the displacement calculation of main dimensions. Meanwhile, the displacement was estimated by using the weight calculation (Dwt +Lwt) as provided in Table 1. With the consideration the range of width/draft (B/T) ratio and the displacement, the draft (T) was obtained 2.54 meters in the B/T ratio of 4.72.

3.3.3. Length of waterline (Lwl) and length between perpendicular (Lbp)

The length space need in accommodation deck (Lad) were considered by using refer to the bow stem type that is raked bow with the acute angle less than 45 degree [13]. Referring the acute angle [14], the bow angle was determined around 30.52 degrees. With the consideration of the draft (T), Lad, and the displacement, the length of waterline (Lwl) and length between perpendiculars (Lbp) were calculated and obtained 72.95 meters and 69.23 meters respectively.

3.3.4. Height (H)

The height (H) of the training vessel design was measured vertically from baseline to main deck wherein the height (H) included the height of double bottom space, classroom, and accommodation room. The height of double bottom (Hdb) is 0.35+0.045B [14], therefore, Hdb is approximately 0.9 meter. The height of classroom was assumed 2.20 meters and the height of accommodation room was 2.40 meters. By the sum of space heights, the height (H) of 5.50 meters.

3.4. Lines Plan

Based on the obtained main dimensions, the lines plan of the raining vessel design was made as shown in Figure 2. This lines plan was made by referring the previous study [6] and benchmarking the lines plan of the cargo ship and container ship in the same with the block coefficient (Cb).

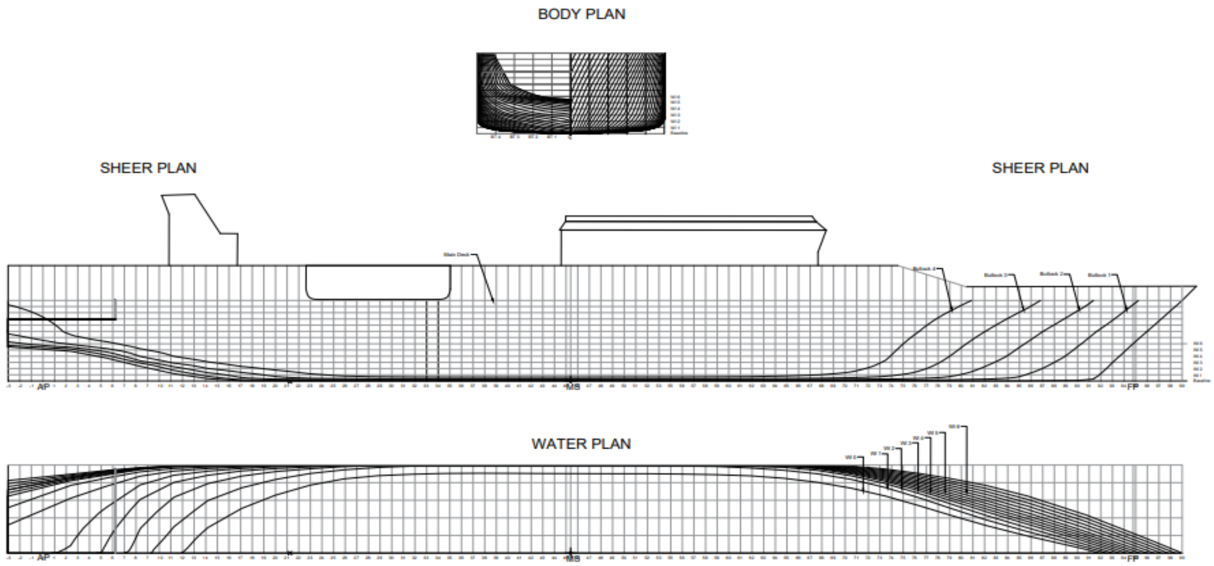

Figure 2. Lines plan of the training vessel design.

3.5. Weight Estimation

The weight of the training vessel design was estimated and it consists of several components of lightweight ton (Lwt) and deadweight ton (Dwt) as shown in Table 1. Then, the weights of Lwt and Dwt is 1471.15 tons.

Table 1. The weight of Lwt and Dwt estimation.

Item component	Weight (ton)
Lwt	
1. Hull steel (Wst)	484.61
2. Outfitting (Woa)	332.30
3. Machinery and installation (Weng)	89.25
Dwt	
Supply and consumable	
1. Fuel oil	62.84
2. Lubrication oil	0.32
3. Fresh water	50.67
4. Crew	1.68
5. Provision	1.58
6. Diesel oil	13.82
Payload	
1. Cargo (Container) 12 TEUs	265.2
2. Passenger including luggage	18.4
Total	**1471.15**

3.6. Gross Tonnage

The value of gross tonnage (GT) was calculated by using the formula that is based on the International Convention on Tonnage Measurement of Ships [15]. Based on Figures 1 and 2, the volume of each space in the training vessel design was measured and the calculation results are shown in Table 2. Furthermore, the GT value was obtained approximately 1711.0 tonnage.

Table 6. Volume of rooms and container hold each deck.

Room	Length (m)	Width (m)	Height (m)	Coefficient	Volume (m^3)
Accommodation deck	69.23	12.0	5.50	0.65	2969.97
Main deck	63.72	12.0	2.40	1	1835.22
Lower deck	40.0	10.0	2.40	1	960.00
Navigation deck	6.0	12.0	2.40	1	172.80
Total					**5795.42**

3.7. Total resistance and power requirements

The prediction of the total resistance for the training vessel design was calculated by using the Holtrop method through the Maxsurf Resistance application [9]. The total resistance in increasing speed was obtained as shown in Figure 3. The total resistance under the speed requirement of 12.75 knots for the training vessel design is 70.20 kN.

The power under the speed was obtained 950.35 horse power (HP). This power is the effective power and it was also calculated by using the Maxsurf Resistance application [9]. Therefore, the power requirement for main engine with the assumed propulsion efficiency of 0.65 is 1462.08 horse power HP or 1090.70 kilowatt (kW).

3.8. Ship Stability

The ship stability was calculated by using the Maxsurf Stability application [9]. The stability arm in the full loaded condition was obtained as shown in Figure 4. The maximum stability arm is about 0.33 meters in 40 degrees. The stability range is about 56.50 degrees. The stability in this condition was assessed in order to fulfil the IMO criteria [16]. Then, the assessment results is as follows:

1. The area of the stability arm curve from the angle of inclination of 0^o-30^o > 0.055 m.rad. The area of stability of the training vessel design was obtained 0.311 m.rad. This criterion is met.
2. The area of the stability arm curve from a slope angle of 30^o-40^o > 0.03 m.rad. For the training vessel, it was obtained 0.249 m.rad and this criterion is met.
3. The area of the stability arm curve from the angle of inclination of 0^o-40^o > 0.09 m.rad. For the training vessel, it was obtained 0.559 m.rad and this criterion is fulfilled.
4. Value of stability arm (h) or GZ on a slope of 30^o > 0.2 m. For the training vessel, it was obtained 0.31 m and this criterion is fulfilled.
5. The maximum stability arm (h_{max}) occurs on slopes > 25^o. For the training vessel, it was obtained 40^o and this criterion is fulfilled.
6. The metacentric height (MG) value > 0.15 m. For the training vessel, it was obtained 0.68 m in the stability angle of 57.34^o and this criterion is fulfilled.

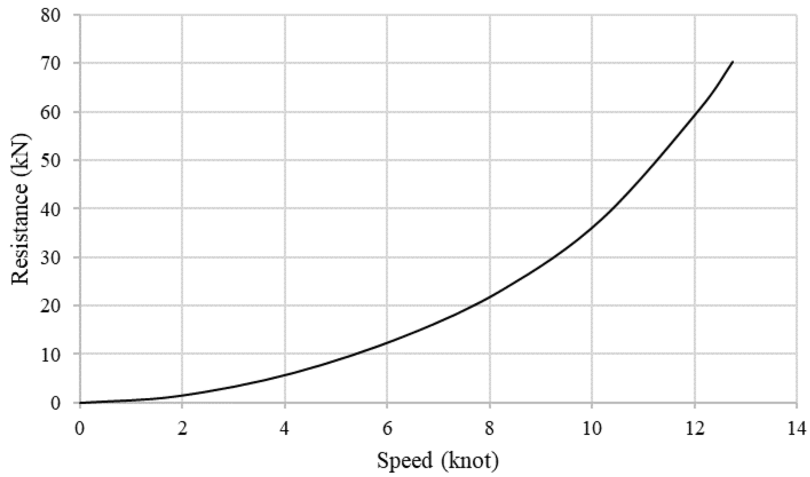

Figure 3. Total resistance in increasing speed.

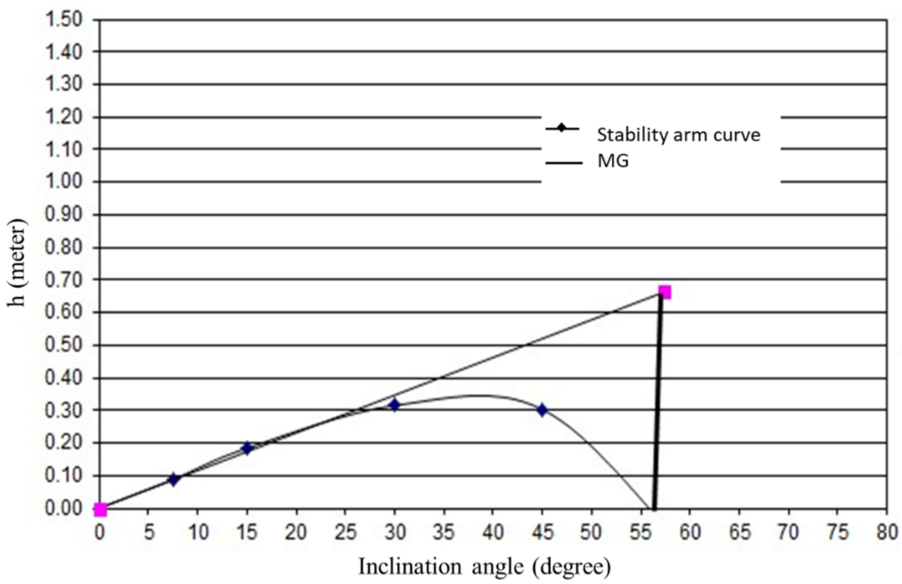

Figure 4. Stability arm curve of the training vessel design in full loaded condition.

4. Conclusions

The training vessel design with the type of passenger-container was carry out by developing the previous study of the passenger-cargo type and following several stages of preliminary ship design. This study was addressed to AMI Makassar Maritime Polytechnic in order to implement and increase the competence of cadets as a real practice for students. The training vessel design fulfils the Standards of Training Certification and Watchkeeping (STCW) wherein the fulfilment of STCW is explained as follows.

The capacity of the training vessel design includes 150 student and 12 containers (TUEs). This capacity was arranged in the vessel design in order to obtain the main dimensions. From the arrangement of capacity, the main dimensions are the breadth (B) of 12 meters, draft (T) of 2.54 meters, length of waterline (Lwl) of 72.95 meters, length between perpendiculars (Lbp) of 69.23, and height (H) of 5.50 meters.

The weight of the training vessel design was estimated wherein the lightweight ton (Lwt) and deadweight ton (Dwt) is 1471.15 tons. Then, the gross tonnage (GT) was calculated and obtained approximately 1711.0 tonnage. The prediction of the total resistance under the speed requirement of 12.75 knots for the training vessel design is 70.20 kN. Then, the power requirement for main engine with the assumed propulsion efficiency of 0.65 is 146.08 HP or 1090.70 kW.

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