

Analysis of Multipurpose Container-Passenger Vessel (MCPV) with Detachable Superstructure to Improve Inter-Island Access in Talaud Island

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Abstract

In 2012, Indonesia developed a National Logistic System (SISLOGAS) framework perceived in Peraturan Presiden (Perpres) No. 26 of 2012, in accordance with the Master Plan of Acceleration and Expansion of Indonesia's Economic Development (MP3EI). One of the plans consisted in SISLOGAS was the improvement of inter-island transportation networks through Short Sea Shipping (SSS) by providing appropriate vessel which had been applied on Kontainer Masuk Desa program and was previously tested in the Talaud Island as the outermost area of Indonesia. Aside from being located in the outermost Indonesia's territory, Talaud Island is one of the marine tourism destinations in North Sulawesi, hence this island needs an inter-island crossing vessel when high demand comes (holiday season). However, due to geographical conditions of Talaud Island which only has an average maximum depth of 6m and the underwater volcano Kawio Barat-Mahangetang which emerges from 5.4-8 m above sea level, could be a problematic for larger ships to sail thus small ships for transportation are required. Seeing the needs equally the existing potential, the making of a Multipurpose Container - Passenger Vessel (MCPV) with Detachable Superstructure could be a solution. Alongside specification of length: 20,85 m, breadth: 7 m, draft: 1,4 m, height 2 m and displacement: 181,32 tons, MCPV could carry containers reaching a weight of 77,28 tons and sail in shallow water by using an engine made by YANMAR which could produce 10 knots speed, besides, MCPV is also equipped with detachable container that could be replaced as requested both for transportation of goods and people. By the existence of MCPV, it is expected to be able to improve inter-island transportation networks.

Keywords : *Container, Multipurpose, Shallow Water, Small Vessel*

Introduction

In the past few years, Indonesian government has been intensively conducting economic equality, especially in disadvantaged, remote and inland (T3P) areas. One of the programs contained in Presidential Regulation (Perpres) No. 26 of 2012 concerning the Development of the *Sistem Logistik Nasional* (SISLOGAS). SISLOGAS has a mission to "*Creating a locally integrated Logistics System, connected globally to increase national competitiveness and nation's welfare*" with a target of completion until 2025. One of the programs listed in SISLOGAS is to increase inter-island transportation networks through Short Sea Shipping (SSS) with the provision of a commercial ship fleet that has a technical character in terms of the needs of the type of the ship, the capacity of the commercial vessel, the speed of the commercial vessel, the range of vessels and the analysis of commodities suitable for carrying out by SSS shipping. Aside from SISLOGAS, development plans and logistics distribution throughout the country are also stipulated in Presidential Regulation (Perpres) No. 48 of 2014 concerning the Master Plan for the Acceleration and Expansion of Indonesia's Economic Development, which was made with the aim of fulfilling Indonesia's development pillars of Pro Growth, Pro Poor, Pro Jobs and Pro Environment

The successful implementation of the SISLOGAS program along with MP3EI is proven by the *Badan Pusat Statistik* (BPS) data which

displays the Human Growth Index (IPM) increases at 71.39 until 2018 after previously being at 67.70 in 2012 with an average active growth of 0.89 per year. Besides

IPM, the Gini Index also has proven to be volatile with an average degression of 0.400 at 0.382 as of March 2019 from the previous figure of 0.410 as of March 2012, the SISLOGAS and MP3EI implementation programs have begun to mature because they have been running for 8 years.

The application of SISLOGAS program along with MP3EI is fairly massive starting from the construction of Trans Papua, Trans Kalimantan, Trans Java toll roads and the expansion in logistics shipping fleets by sea. One of the programs initiated to reduce the Gini Index while enhancing the IPM is "*Kontainer Masuk Desa*" program which is recently initiated by the Directorate General of Sea Transportation of the Ministry of Transportation (Kemenhub) through the Directorate of Sea Traffic and Transportation and the Maritime Research Institute of the Archipelago (Marine Nusantara). The program begins with the initial shipment of three tons of rice transported by the sea toll boat, KM Logistik Nusantara II, to the villages in Essang sub-district, Talaud Regency, North Sulawesi.

Looking at the growth of inter-island trade of agricultural and marine products in the Talaud Island, it could be claimed as a positive trend, as seen on 2015 period which recorded the number of merchandises reaches 9,653 tons and increases in the 2016 period to reach 12,197 tons. Those trends cause the need for logistical and trading vessels from big island to Talaud Island in order to whether in meeting basic needs or the sale of fish (as a trading commodity) of Talaud Island. The increase of logistical needs in Talaud Island is also motivated by the increasing intensity of natural disasters which have hit the Talaud Island throughout 2018-2019.

To support trade routes and better logistics transportation, the government and the private sector have begun improving sea transportation facilities by increasing ship procurement by buying, leasing or renting as well as working to improve port facility support. The escalation is done due to the shortage of fleet of ships which only 37 units as of 2017 for inboard motorboats and 2201 for outboard boats. However, the use of these vessels is not possible to transport containers consequently the inter-island sea trade process in/from the Talaud Island is less accommodated.

Besides, the problem of logistics supply and the potential for the sale of marine products, the Talaud Island also has another potential that is being developed, namely tourism. In 2017, Talaud Island is appointed as a border tourist destination by Indonesian Ministry of Tourism (Kemenpar), it is proven by the increasing number of domestic and foreign tourists as of 2017, which can be seen in **Table 1**.

The arising number of domestic and foreign tourists could make the demand for inter-island crossing vessels increasing. However, due to the demand for passenger vessel is only on certain season, it is causing the use of ships continuously and as a result, it could cause losses due to passenger vacancies.

In addition, with the geographical conditions that are less friendly for voyages in terms of the depth of the water above sea level an average of only 6 m plus the Kawio Barat-Mahangetang volcano that appears from 5.4 - 8 m above sea level of the Talaud Island, then the use of large vessels will be difficult considering the draft (ship) can hit the seabed.

By reviewing the need to support the Short Sea Shipping (SSS) program in SISLOGAS along with limitations (constraints) consisting of a maximum draft of 6 m and optimizing the use (cost), Multipurpose

Container - Passenger Vessel (MCPV) with Detachable Superstructure could be used as multifunctional vessels with payloads worth 77.28 Tons adjust to container ships and safety which adjust to passenger ships.

At the processing time, it is done a research which consisted of several analyzes, such as SWOT analysis, PESTEL analysis, technical analysis consisting of ship hull calculations (determination of hull type), parametric design for the final technical design and economic analysis to determine capital returns and profitability MCPV ship. In conducting the research, the design process is adjusted to shipbuilding in the book of Basic Ship Theory, which defines the design as: "Design is a creative iterative process serving a bounded objective" (Rawson et al., 2001). Shipbuilding design could be interpreted to have 4 main processes of circular design engineering including concept design, preliminary design, contract design and village design. The design then is made in advance according to the comparator ship, corrected in accordance with the data constraints (constraints) and repeated until the ship is made in

accordance with the wishes to form a detailed design. The activity hereinafter is referred as iterative design in engineering ship's design.

In the making of ship design, there are several dimensions used to make the hull include; Length Between Perpendicular (LPP) is the distance measured from the vertical line Aft (After Perpendicular) to the vertical line from Bow (Fore Perpendicular), Length Overall (LOA) which is the outermost distance of the ship measured to the outer point (Transom), Molded Breadth (Transfers) Bm) which is the width of the ship, Height (H) and Draft (T) which is laden with ships. The dimension is then used as a variable in determining Dead Weight Tonnage (DWT), which is the weight of the ship's contents and Light Wight Tonnage (LWT) which is the weight of the empty ship. In addition, some important components are needed in calculating the feasibility of ships are Freeboards which according to the International Convention on Load Lines (ICLL) 1966 can be calculated from LBP or 96% of the length of the waterline and the largest area is freeboard.

One other important component is stability, consisting of "GZ, KG and GM stability" (Charisma, 2017). The stability calculation involves the dynamic price of the arm (GZ). So that the static stability of a ship could be divided into 3 types namely stable ships (when point G is below point M), unstable stability (when point G is above point M) and indifference stability (when point G and point M are in the same position). After the technical calculation is done then the economic calculation consisting of development costs, feasibility and others can be calculated.

Table 1. Domestic and Foreign Tourist Visits in Talaud Island Regency, 2012-2017

Years	2012	2013	2014	2015	2016	2017
Domestic	1000	2100	2500	3000	2700	3000
Foreign (Persons)						
Europe	15	10	12	12	17	20
America	7	6	9	9	13	10
Australia	10	4	8	8	12	12
ASEAN	6	15	25	25	25	27
Japan	2	2	5	5	3	6
Others	10	6	10	10	25	30
Total	1050	2143	2569	3069	2795	3105

source: (Badan Pusat Statistika (BPS), 2018: 220)

The results show that optimum ship design is used multifunctionally both as a cargo carrier and passenger-loaded vessel. The design of the ship will be adjusted to the regulations stated in Safety of Life at Sea (SOLAS) and the International Maritime Organization (IMO). The existence of this ship is expected to produce the most optimum costs in the operation of the ship, could be applied according to the demand for shipping in real time and continuously, also is able to support the application of Short Sea Shipping (SSS) to improve inter-island transportation networks.

Methods

The approach in this study uses several analytical methods, divided into qualitative analysis (SWOT and PESTEL) and quantitative analysis (Technical and Economic). The data used in this study could be in the form of variables. Whereas, both quantitative and qualitative analysis begins with the search for data then processed into information that is used as a unit or core of quantitative and qualitative analysis. The broad research flow can be seen in Figure 1.

The flow of this research begins by identifying the problems obtained from primary data collection and literature studies, which subsequently obtain the objective of analyzing and designing multifunctional vessels that can facilitate access to goods and people in the Talaud Island. To achieve this goal, several research variables are chosen regarding the type of ship and detail of the hull, geographical limitations and regional profitability. The information (variables) then shall be used as a reference in technical and economic analysis and produce a final decision.

Research Location and Time

The research is going to be conducted starting on August 1, 2019 and completed on October 20, 2019, which consists of trial and error calculation of ship design, research consulting, study literature, economic analysis and 2D and 3D design. The research is conducted at the ITS Sukolilo campus ITS Shipping Engineering Design Lab. The research plan with a total of 2 months work could be seen in **Table 2**.

Type and Nature of Research

Table 2. Detailed Work Time Plan

Type of Activity	Start	End
Problem Identification	1/8/2019	7/8/2019
Data collection and literature study	8/1/2019	14/8/2019
Data processing (operational requirements and pay-load)	15/8/2019	26/8/2019
Quantitative Analysis	27/8/2019	15/9/2019
Qualitative Analysis	27/8/2019	15/9/2019
Ship Design	16/9/2019	10/10/2019
Evaluation and Improvement	11/10/2019	20/10/2019

There are several parts of research that need to be done in developing a Multipurpose Container - Passenger Vessel (MCPV) ship includes:

Determine the Ship's Dimension

Determining the ship's dimension is started by knowing the shipping lane traversed by the ship. After the lane details is obtained, things that could be done include:

Specifying the type of the hull, Deciding the deck area needed to hold the container, Finding the parent ship's model to do the regression calculation and determining the ship's main dimensions, And Checking the ratio of the main size of the ship with IMO provisions.

Vessel Feasibility Research

The feasibility research is being done to determine the cost that could be maximized by adding the *detachable superstructure* (multifunctions) to the vessels. The steps that could be taken include:

Determining the final main dimensions of the ship, Choosing the appropriate coefficient of ships based on the Principal of Naval Architecture Chapter II guidelines, Calculating the area of the ship's hull according to the coefficients specified, Calculating ship resistance using the Holtrop and Mennen method including calculating viscosity resistance, resistance includes bulge (another appendage) and resistance resulting wave, Calculating the horse power needed based on the resistance produced, Determining the crew capacities, Determining the cost needed, Determining the amount of material needed to build a ship, And Comparing construction costs with comparative ships in accordance with market prices and operational costs.

Regulatory and Licensing Research

Regulatory and licensing research is adjusted to the analysis section of PESTEL, especially on legal aspects. The several factors reviewed include: Regulations according to Safety of Life at Sea (SOLAS), Regulations according to the International Convention of Load Lines (ICLL), And Regulations according to applicable laws.

SWOT Analysis

In developing a product, a SWOT analysis is carried out aimed at weighing the strategic planning of a product to achieve expectations. This consideration is carried out by evaluating 4 main variables namely Strength, Weakness, Opportunities and Threats. The considerations are harmonized with quantitative analysis that has been done. This process involves several considerations including determining the specific objectives of shipbuilding (business) speculation and identifying internal and external factors that support and do not achieve the objectives.

PESTEL Analysis

PESTEL analysis is carried out to review some external factors that may directly or indirectly influence ship building and development. PESTEL analysis involves 6 main factors namely; Politics, Economy, Social, Technology, Ecology and Legal. PESTEL analysis can be done by considering both national and international policies and reviewing social aspects (community life patterns) specifically in the Talaud Island.

Technical Analysis

At this stage, data processing is carried out in accordance with technical requirements in the construction of the Multipurpose Container - Passenger Vessel (MCPV). Technical analysis must be based on the owner requirements to determine payload, main dimensions and calculation of general engineering aspects. After all the initial data has been obtained, several technical analyses include:

Calculation of ship weight is calculating DWT which is the weight of the ship and consumables and LWT which is the weight of steel when the ship is empty, Load capacity calculation, Trim calculation, Freeboard calculation, Stability calculation.

Economical Analysis

At this stage, data processing is carried out in accordance with economic needs both in / after ship building. The economic analysis phase is intended to determine the feasibility of the ship to make a direct decision without the need to re-design it to be feasible. Analysis is carried out to determine the cost of development, feasibility of development and product price comparison. The calculation involves the following formula:

$$Tc = (Cc + Oc + Vc + CHc) / GRT \dots \dots \dots (1)$$

Other costs included during ship operation, which consist of capital costs, operational costs and travel costs, are then used as a component cost of the ship at 1 time and calculated from the ship's GRT. Alignment and cost can be formulated with the formula Tc.

Result and Discussion

Research Result

After conducting research by analyzing both qualitatively and quantitatively the following results were obtained:

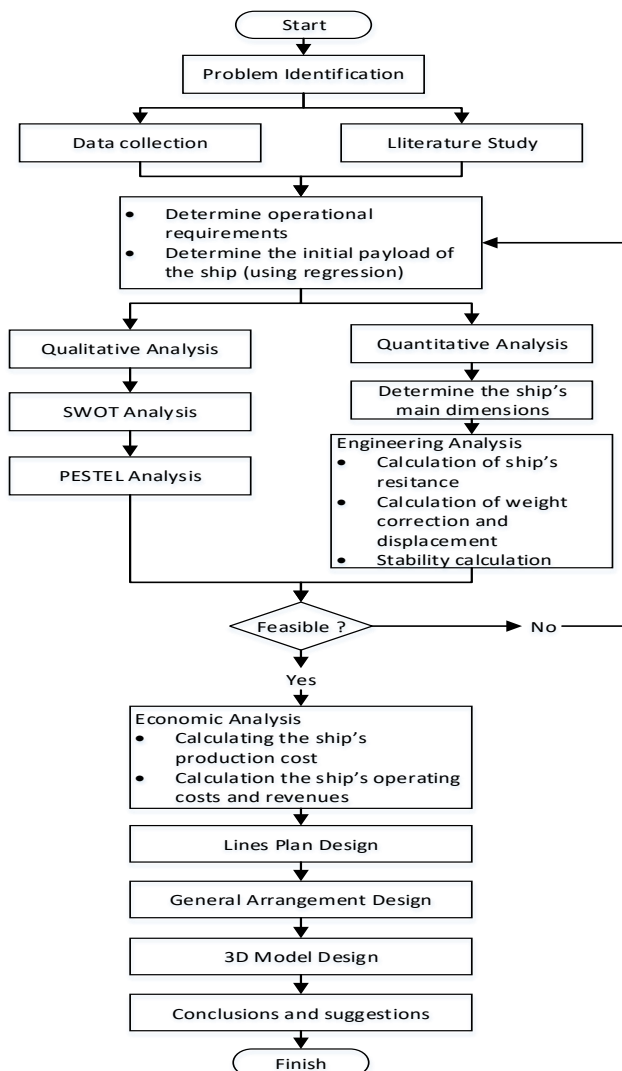


Figure 1. Methodology flow

SWOT Analysis Result

In developing a product, a SWOT analysis is carried out aimed at weighing the possibility of a product reaching expectations. This consideration is carried out by looking at 4 main variables namely Strength, Weakness, Opportunities and Threats. The considerations are harmonized with quantitative analysis that has been done.

Main Objective

Before starting the analysis, it is important to know the main purpose of making a Multipurpose Container - Passenger Vessel (MCPV) ship which includes: Creating a pioneer ship concept that is able to provide logistical coverage in underdeveloped, remote and inland (T3P)

areas, Make the concept of a multifunctional ship that can function according to the season (container-passenger), Generating the concept of a ship that is able to reach shallow water areas, and Designing the concept of a ship that is able to optimize operational costs and increase trading activities in the T3P region.

Implementation strategy

After the main objectives have been determined, it is necessary to know the strategy to achieve the planned goals. The implementation strategy includes: Making a small boat with a length (L) ≤ 20 m with the type of hull Mono Hull, Creating detachable superstructure that can be assembled according to the function and business season, Making small vessels with draught (T) less than 6 m, and Creating ships with Short Sea Shipping (SSS) criteria.

SWOT analysis diagram

After the main objectives are determined and the implementation strategy is obtained, a SWOT analysis is then performed according to the quantitative analysis and PESTEL analysis. The diagram of the results of the SWOT analysis could be seen in **Table 3**. In the diagram it is found that the Multipurpose Container - Passenger Vessel (MCPV) ship is included in the helpful category in achieving the specified destination.

PESTEL Analysis Results

After conducting a literature study of conditions and policies that occur in the project, a strategic planning is obtained in the form of strategic analysis which is then used as an evaluation material for the impact of Political, Economic, Social, Technological, Ecological and Legal factors. The PESTEL analysis obtained includes:

Political factors

Political factors would review government regulations and legal factors that influence the process. The political factors that are going to affect the process of implementing Multipurpose Container - Passenger Vessel (MCPV) include: Value Added Tax (PPN) covering water transportation has the potential to increase the competitiveness of multimodal fleets in Indonesia. Government Regulation (PP) Number 50 Article 1 of 2019 concerning Import and Delivery of Certain Transport Equipment as well as the Delivery and Utilization of Taxable Services Related to Certain Transport Equipment that are not subject to Value Added Tax, Tax Holiday policy or 7-20 years of tax exemption for new investment providers would reach USD 50 million could increase financing potential, Application of series ship design has the potential to increase mass production time if it is taken over by the government, The national logistics distribution smoothing program contained in the framework of the National Logistics System (SISLOGAS) which must be in line with the Master Plan for the Acceleration and

Expansion of Indonesian Economic Development (MP3EI) has the potential to spawn innovative and new marine fleets and Sea transportation subsidy policy.

Economical factors

Political factors would review the economy of the country concerned. The economic factors that is going to influence the MCPV implementation process include: The BI Rate is fluctuating in 2019 but is stable below 5% in the last 5 months until September 2019, Indonesia's economic growth is stable at 5.07% year on year slightly down by 0.20% from 2018 which posted a growth of 5.27%, The rupiah exchange rate fluctuates during the tense US-China relations, The prediction of the SKHA Institute for Global Competitiveness (SIGC), Indonesia will experience two expansions in one cycle so that it has the potential to drive the economy.

Social factors

Social factors would review the socio-economic environment through several elements to understand consumer needs. The social factors that shall influence the MCPV implementation process include: the needs of workers could be fulfilled with the population of the Talaud Island in 2017 amounting to 90,678 people and the percentage of the workforce is 68.32%, The number of workers who usually work as fishermen is around 14,536 people per 2017, Cheap labor with a minimum wage per 2019 of Rp. 3,051,076, The majority of the population works as fishermen and provides tourism facilities.

Table 3. SWOT Analysis Diagram

	Helpful To Achieving the objective		Hamful to achieving the objective	
	STRENGTH	No.	WEAKNESS	
Internal origins (Attributes of the organizations)	Have a module (container) that can be changed according to the needs	1	There are additional cost when changing the modules (container)	
	Can be used in shallow water level	2	The container can't be used 100% considering the shallow water depth	
	Have a strongengine for fast sailing	3	There are additional cost when changing the modules (container)	
	Cost saving because the module can be changed as needed (season)	4		
	Can be used as a rescue boat during emergencies	5		
	It,s safer because it follows the same safety standars as passenger vessels	6		
External Origins (Attributes od the environment)	OPPORTUNITIES		THREAT	
	There are No. pioneer vessel that have a multifunction purpose (modules)	1	The entry of another multifunctional small ship	
	Large and increasing tourism potential	2	The module unloading facility in the form of a crane is still not available	
	Abundant sell and buy commodities between island	3	Becase it is classified as new, govemment support and developoment facilities (ship yards) are still classied as passive	
	Sea transportation is being promoted by the local government	4	Natural disaster	
	Transferring functions to rescue boat can increase the likelihood of rescuing people during a disaster	5		

Technological factors

Technological factors review technological progress and technological developments that are applied. The economic factors that would affect the process of implementing Multipurpose Container - Passenger Vessel (MCPV) include:

There is a lack of crane capacity at the port so that the container capacity is limited to 20 teus, Utilization of modified containers including passenger containers has not been implemented in Indonesia, Great distances from the nearest island (372.3 km from Manado), requires ships with high mobility.

Ecological factors

Ecological factors review the condition of the environment around the island. The ecological factors that will affect the process of implementing a Multipurpose Container - Passenger Vessel (MCPV) ship include: the talaud island are famous for their maritime potential in both the tourism and fisheries sectors, the talaud island are vulnerable to earthquake disasters which have occurred several times in 2018-2019, and

the average coastal area of the talaud island is classified as shallow water.

Legality factors

The legality factor reviews the regulations that are applied in shipbuilding and operations. The legality factor that would affect the process of implementing a Multipurpose Container - Passenger Vessel (MCPV) ship includes:

The government is a regulator that makes, implements and enforces regulations related to the management of screen permits, tariffs and ownership as attached in PM 39 of 2017 concerning Ship Registration and Nationality, Some voyages require ship owners to pay for the right to operate a cross-sea service as attached to PP No. 51 of 2002 concerning Shipping, There are rights that need to be paid to the government when the ship before it is finished is made as stated in PP No. 20 of 2010 concerning Transportation on Water.

Technical Analysis Results

Technical analysis is done using the iteration method. The results of the technical analysis calculations include:

Determine the operational scheme

Before determining the operational distance of the Multipurpose Container - Passenger Vessel (MCPV), it is necessary to know the shipping area first. The shipping area of the MCCI ship starts from Manado and is anchored to 4 different ports in the Talaud Island namely Mangaran Port, KKP, Melonguane and Beo. The operational voyaging scheme of the MCCV Ship can be seen in Figure 2.

Determine the ship's main dimensions

In determining the main size of the ship, there are several things to consider. As for some of the things that subsequently become constraints in determining the main size of the ship include: the number of containers on the deck is 4 units, maximum draft size is 6 m, the shipping area reaches 372.3 km assuming a minimum diesel fuel requirement is 20 tons.

From this limit, the main size of the ship is obtained, which then becomes the operational requirement. The operational requirement of the ship can be seen in Table 5 and checking dimensions in Table 4.

Ship's weight to ratio calculation

Calculation of the weight of a Multipurpose Container - Passenger Vessel (MCPV) is divided into two, namely DWT and LWT where DWT is the weight of the ship and consumables and LWT is the weight of the steel of the empty ship plus machinery and equipment. With the value of LWT = 109.127 tons and DWT value = 9,419 tons. The results of the calculation of weight and correction can be seen in Table 6.

Ship's load capacity calculation

To determine the amount of tonnage, using PM No. 8 of 2013 concerning international measurements of vessels with a length <24 m. The Tonnage calculation results could be seen in Table 7.

Table 4. Vessel Dimensions Checking (Parametric Design)

	Unit	Rules	Status
L / B =	2.82 →	$2.52 \leq L/B \leq 18.26$	ACCEPTED
B / T =	5.00 →	$1.7 \leq B/T \leq 9.8$	ACCEPTED
L / $\nabla^{1/3}$ =	8.38 →	$3.07 \leq L/\nabla^{1/3} \leq 12.4$	ACCEPTED
$A_p/\nabla^{2/3}$ =	4.70 →	$4.0 \leq A_p/\nabla^{2/3} \leq 8.5$	ACCEPTED
LP / BPX =	4.96 →	$2.0 \leq LP/BPX \leq 7.0$	ACCEPTED
LP / BPA =	5.82 →	$2.36 \leq LP/BPA \leq 8.5$	ACCEPTED

Table 5. Operational Requirement MCPV

Summary		
Main Dimension	Unit	Dimension
LPP		19.73 m
LWL		20.85 m
B		7.00 m
H		2.00 m
T		1.40 m
CB		0.88
CM		0.988
CWP		0.989
CP		0.886
LCB		9.643 m dari AP
Δ (Displacement)		121.300 ton
Volume Displacement		118.3415 m ³
Speed		12 knot
Fn (Froude Number)		0.360
ME	2 x 1200	HP
AE	2 x 150	HP

Table 6. Ship's Weight and Correction

Total Weight of The Ship (DWT + LWT)			
No	Ship's Weight Component	Value	Unit
1	Ship's Dead Weight (DWT)	9.419	ton
2	Ship's Light Weight (LWT)	109.127	ton
Total		118.546	ton
Ship's Capacity Limits in Accordance with Archimedes Law			
No	Ship's Weight Component	Value	Unit
1	Displacement = Pemodelan Maxsurf	121.3	ton
2	DWT	9.419	ton
3	LWT	109.127	ton
4	Displacement = DWT + LWT	118.546	ton
Deviation		2.754	ton
		2.32%	(2% ~ 10%)

Table 7. Tonnage Calculation Results

Gross Tonnage (GT)	
V1	= $p \times l \times d \times f$
	= 202.86 m3
V2	= $p \times l (r) \times t (r)$
	= 55.2 m3
V	= V1 + V2
	= 258.1 m3
GT	= 0.25 x V
GT	= 64.5 m3
Nett Tonnage (NT)	
NT	= 0.30 c GT
	= 19.3545 m3

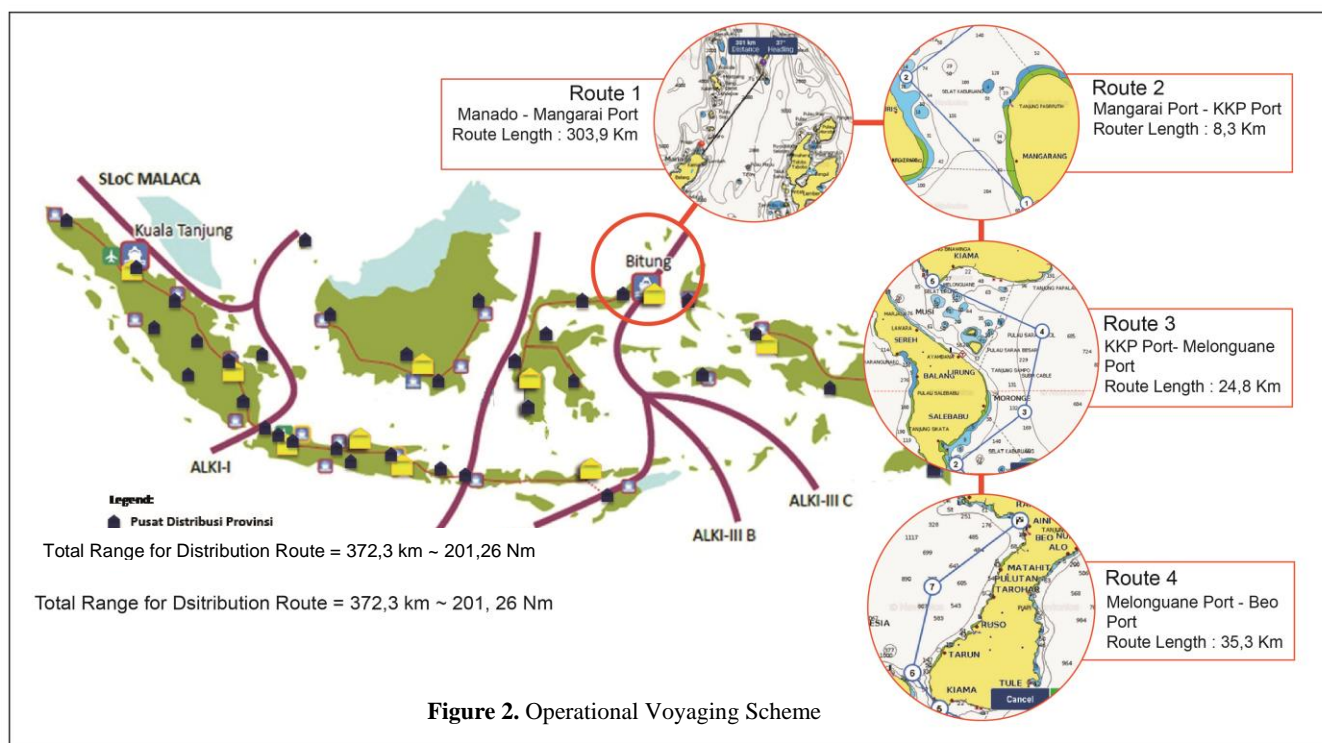


Figure 2. Operational Voyaging Scheme

Table 8. Freeboard Calculation Results

Fb >	16.56 cm
Correction CB (Fb 1)	
Fb 1 =	37.9906 cm
Correction D (Fb 2)	
Fb 2 =	50.3906 cm
The value of Fb + Acceptebale	
Fb	= H – T
	= 0.6 m
	= 60.0 cm

Ship' s freeboard calculation

Determining the amount of freeboard using the provisions stated in PM No. 39 of 2016 with the following formula:

$$fb = 0,8 L \text{ cm} \dots \dots \dots (2)$$

So, the results of the calculation of the freeboard with corrections that can be seen in Table 8.

Ship' s Trim calculation

To determine that a Multipurpose Container - Passenger Vessel (MCPV) could operate in a number of conditions, a calculation is made of the trim that is adjusted to the condition of the load case. Whereas the trim limit is obtained from the maxsurf stability enterprise for each loadcase and based on SOLAS Reg. III / 7, the trim value must not exceed the limit of 0.5% of Lwl [14]. The load case for the analysis could be seen in Table 9 and the calculation results could be seen in Table 10.

Table 9. Ship' s Load Case

No	Name	Condition		
		Container	Passenger	Fuel
1	Load Case 1	50 %	50 %	100 %
2	Load Case 2	50 %	50 %	75 %
3	Load Case 3	50 %	50 %	50 %
4	Load Case 4	50 %	50 %	25 %
5	Load Case 5	100 %	0 %	100 %
6	Load Case 6	100 %	0 %	25 %
7	Load Case 7	0 %	100 %	100 %
8	Load Case 8	0 %	100 %	25 %

Table 10. Trim Analysis Result

No	Name	TrimResult (m)	Trim Status	
			Trim Type	Status
1	Load Case 1	0.296	Trim by Stem	Pass
2	Load Case 2	0.175	Trim by bow	Pass
3	Load Case 3	0.056	Trim by bow	Pass
4	Load Case 4	-0.069	Trim by bow	Pass
5	Load Case 5	0.287	Trim by bow	Pass
6	Load Case 6	-0.017	Trim by Stem	Pass
7	Load Case 7	0.192	Trim by bow	Pass
8	Load Case 8	-0.323	Trim by Stem	Pass

Ship' s stability calculation

Stability analysis is used to determine the ship's balance transversely in several loading conditions. The stability criterion used is the general ship stability criterion which refers to the Intact Stability (IS) Code Ch. III / 3.5 [13]. The recapitulation of the stability and trim values can be seen in Table 11.

Tabel 11. Intact Stability Calculation Depend on Condition

No	Condition	Status	Additional Information
1	Load Case1	Pass	
2	Load Case 2	Pass	
3	Load Case 3	Pass	
4	Load Case 4	Pass	
5	Load case 5	Pass	
6	Load Case 6	Pass	
7	Load Case 7	Fail	Lack displacement/Passenger crowded of
8	Load Case 8	Fail	Lack displacement/Passenger crowded of

Economic Analysis Results

After obtaining operational requirements from a Multipurpose Container - Passenger Vessel (MCPV) vessel, an economic analysis then would be carried out consisting of capital adequacy, cash flow, and payments to calculation of the economic viability of the ship.

Table 12. Capital Investment Plan (Bank-Investor)

Year	Bank	Invesor	Bank	Investor
	Initial Loan		Loan Interest	
0	Rp.1,015,322,622	Rp.4,061,290,497	Rp.0	Rp.0
1	Rp.1,015,322,622	Rp.4,061,290,497	Rp.101,532,262	Rp.304,596,787
2	Rp.812,258,099	Rp.3,249,032,397	Rp.81,225,810	Rp.243,677,430
3	Rp.609,193,575	Rp.2,436,774,298	Rp.60,919,357	Rp.182,758,072
4	Rp.406,129,050	Rp.1,624,516,199	Rp.40,612,905	Rp.121,838,715
5	Rp.203,064,525	Rp.812,258,099	Rp.20,306,452	Rp.60,919,357
Year	Total Payment		Remaining Loan	
0	Rp.0	Rp.0	Rp.1,015,322,624	Rp.4,061,290,497
1	Rp.304,596,787	Rp.1,116,854,887	Rp.812,258,099	Rp.3,249,032,397
2	Rp.284,290,335	Rp.1,005,935,829	Rp.609,193,575	Rp.2,436,774,298
3	Rp.263,983,882	Rp.995,016,172	Rp.406,129,050	Rp.1,624,516,199
4	Rp.243,677,430	Rp.934,096,814	Rp.203,064,525	Rp.812,258,099
5	Rp.223,370,977	Rp.873,177,457	Rp.0	Rp.0

Capital investment plan

In producing a ship, there are 2 types of financing carried out, namely financing through

Tabel 13. Detail of *Total Capital Investment* (TCI) and *General Expenses* (Yearly)

No	Cost Subject	Cost Value
1	Manufacturing Cost	Rp 1.327.766.693.72
2	Equipment Cost	Rp 2.670.846.427.35
3	Contains Cost	Rp 668.000.000.00
4	Other Utilities Cost	Rp 410.000.000.00
5	Variable (factor X) Cost	Rp 470.068.971.21

Total Capital Investment (TCI)		Rp 5.076.613.121.06
No	Cost Subject	Cost Value

banks and financing through investors/government. The difference between the two types of financing are the waiting time and interest payments. As for the construction of a Multipurpose Container - Passenger Vessel (MCPV) ship, it is assumed that 20% of financing is bank loans while 80% is the government. Calculation results can be seen in **Table 12.**

Cash flow calculation

Cash flow could be interpreted as a calculation of the flow of money obtained, issued or stored during operations and ship construction. The cash flow

calculation results that are reviewed in the 10 years of operational period can be seen in Table 15 with the annual Capital Cost and General Expense components in **Table 13** and the Depreciation and Salvage calculations in **Table 14.**

Tabel 14. Detail of Depreciation and Salvage Value as Fixed Cost Component

Year	Depreciation	Salvage	Deviation
1	Rp 14.600.548.20	131.404.933.80	116.804.385.60
2	Rp 13.140.493.38	118.264.440.42	105.123.947.04
3	Rp 11.826.444.04	106.437.996.74	94.611.552.34

4	Rp 10.643.799.64	95.794.196.74	85.150.397.10
5	Rp 9.579.419.67	86.214.777.07	76.636.357.39
6	Rp 8.621.477.71	77.593.299.42	68.971.821.65
7	Rp 7.759.392.94	69.833.969.42	62.074.639.49
8	Rp 6.621.477.71	62.850.572.48	55.867.175.54
9	Rp 6.285.057.25	56.850.572.48	60.820.457.98
10	Rp 5.656.551.52	50.908.963.71	45.252.421.19

Tabel 15. Cash Flow Calculation Summary

Year	Cash Flow	PW	Total PW
0	(3.440.915.398.56)	(120.926.5019.289.16)	120.926.509.219.16
1	(231.704.012.16)	(3.427.267.130.07)	124.353.786.419.23
2	100.981.242.16	3.583.078.502.08	120.770.707.917.20
3	433.663.558.19	9.0966.093.083.08	111.671.614.834.12
4	766.336.218.96	13.361.892.289.29	98.309.859.600.47
5	1.098.992.828.42	609.852.944.36	96.779.835.187.60
6	1.865.153.099.06	920.024.412.87	95.956.672.228.65
7	1.862.215.895.23	817.167.958.95	95.952.672.228.05
8	1.823.485.095.00	725.788.110.85	95.236.672.228.65
9	1.860.691.014.12	644.616.617.85	94.592.267.399.95
10	1.862.701.391.50	561.535.210.32	94.303.732.189.63
		IRR	NPV
		19 %	1.494.899.139.09

(ticket sold)	(person)	Income	
25 %	Rp. 150.000.00	42	1.575.000 1.575.000
50 %	Rp. 150.000.00	42	3.150.000 3.150.000
75 %	Rp. 150.000.00	42	4.725.000 4.725.000
100 %	Rp. 150.000.00	42	6.300.000 6.300.000
Ticket Income			Rp.322.957.500 Rp.0
Total Income			Rp.338.707.500 Rp.15.700.000
Total	Income		Rp322.957.000
Condition	Rent Tariff	Capacity	MCPV Normal
Cargo Rented	Income		
25 %	8.500.00	75990	161.478.750 161.478.750.000
50 %	8.500.00	75990	322.957.500 322.957.500.00
75 %	8.500.00	75990	484.436.250 484.436.250.00
100 %	8.500.00	75990	645.915.000 645.915.000.00
Cargo	Income		Rp.3.150.000 Rp.0
Total	Income		1.617.937.500 1.614.787.500

Feasibility investment calculation

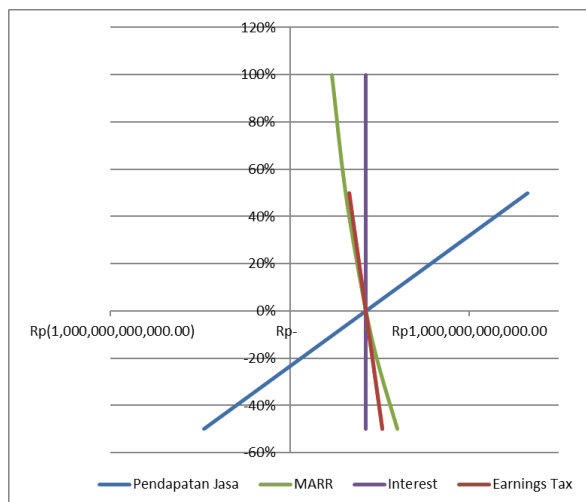
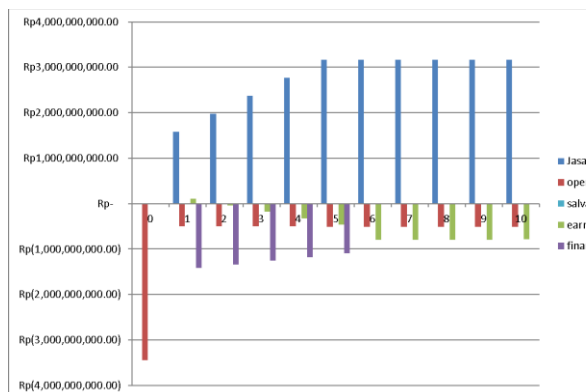
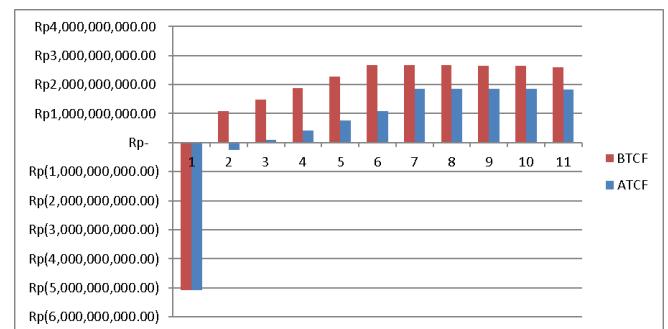
Feasibility Investment can be interpreted as an analysis of the feasibility of a production (business). In feasibility investment, feasibility is evaluated in terms of NPV, IRR and PP of a business that is run until it finds a payback period. In addition, the present value of the planned cash flow is calculated. The results of the calculation of feasibility investment can be seen in Table 16. Assuming income is obtained from ticket prices and container rental. To know the feasibility more clearly, can be seen in the Sensitivity Curve in Figure 3, Turnover Chart in Figure 4 and BTCF / ATCF Graph in Figure 5.

Tabel 16. Business Feasibility Calculation Results

Condition	Ticket tariff	Capacity	MCPV	Normal
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Table 17. Comparative Cost Analysis Calculation Result

Condition (Tickets Sold)	Ticket Tariff	Capacity (Person)	MCPV (Optimun)	Normal
			Income	
25%	Rp.150,000.00	42	Rp1,575,000	Rp1,575,000
50%	Rp.150,000.00	42	Rp3,150,000	Rp 3,150,000
75%	Rp.150,000.00	42	Rp4,725,000	Rp4,725,000
100%	Rp.150,000.00	42	Rp6,300,000	Rp6,300,000
Ticket income			Rp322,957,500	Rp0
Total income			Rp338,707,500	Rp15,750,000
Total income deviation			Rp322,957,500	
Condition (Lot Cargo Rented)	RentTariff	Capacity (Kg)	MCPV (Optimun)	Normal
			Income	
25%	Rp8,500.00	75990	Rp161,478,750	Rp161,478,750
50%	Rp8,500.00	75990	Rp322,957,500	Rp322,957,500
75%	Rp8,500.00	75990	Rp484,436,250	Rp484,436,250
100%	Rp8,500.00	75990	Rp645,915,000	Rp645,915,000
Ticket income			Rp3,150,000	Rp0
Total income			Rp1,617,937,500	Rp1,614,787,500
Total income deviation			Rp3,150,000	

**Figure 3.** Sensitivity Calculation Result Curve**Figure 4.** Turnover Charts**Figure 5.** BTCF / ATCF Graph

Comparative cost analysis

Comparative Cost Analysis is an economic analysis carried out by comparing 2 or more objects that move in the same business. This type of economic analysis would provide a comparison of payback period between 2 ships assuming the same maximum capacity but with different designation. The result from comparative cost analysis can be seen in Table 17.

Lines Plan Design

The lines plan could be interpreted as a projection of the body of the ship that is cut transversely (body plan), lengthwise (sheer plan), and vertical lengthwise (half breadth plan). The process of making the line plan design starts after the main size of the ship is known. The line plan created is adapted to the Maxsurf model that can be seen in figure 6. The design of the MCPV line plan can be seen in Figure 7.

General Arrangement (GA) Design

General Arrangement (GA) of the Multipurpose Container - Passenger Vessel (MCPV) was made after

carrying out the line plan design process. The GA of the MCPV is adjusted to the results of technical calculations and space requirements. The GA of MCPV can be seen in Figure 8.

3D Model Design

After the GA design process is completed, a 3D model design is carried out taking into account the placement of space. The 3D design of a Multipurpose Container - Passenger Vessel (MCPV) can be seen in Figure 9.

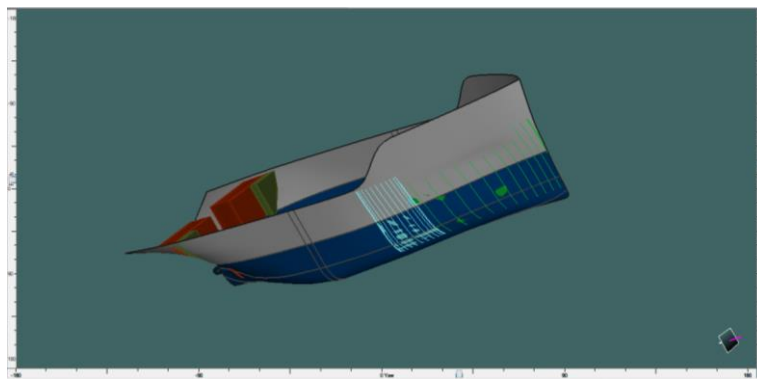


Figure 6. Ship's Hull on Maxsurf Modeller

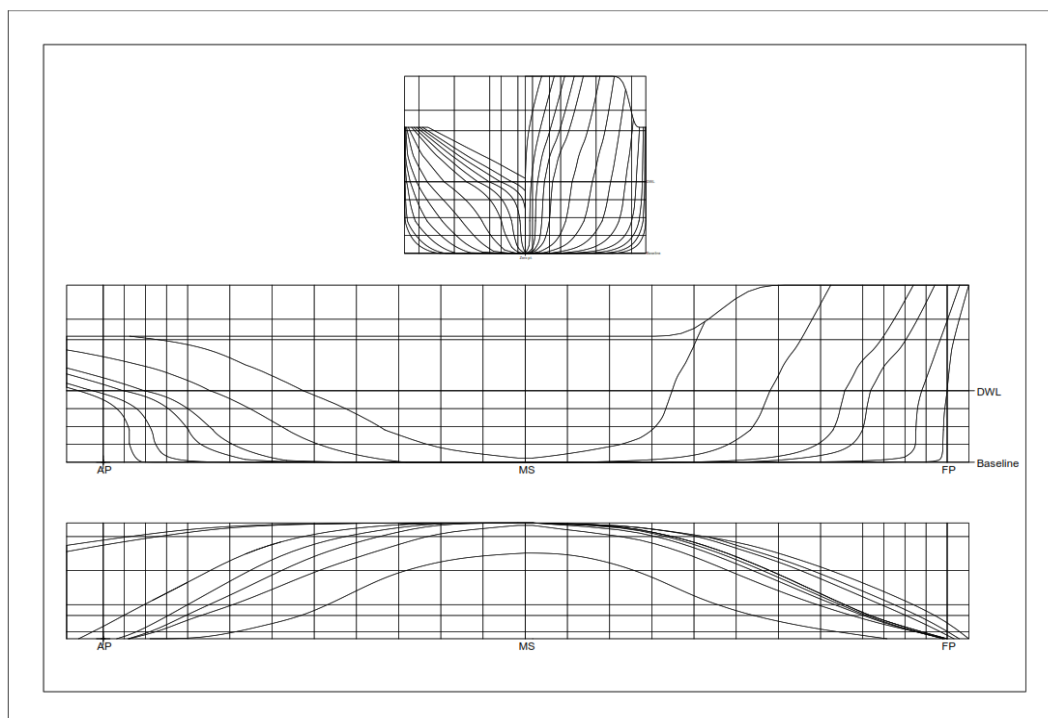


Figure 7. Lines Plan

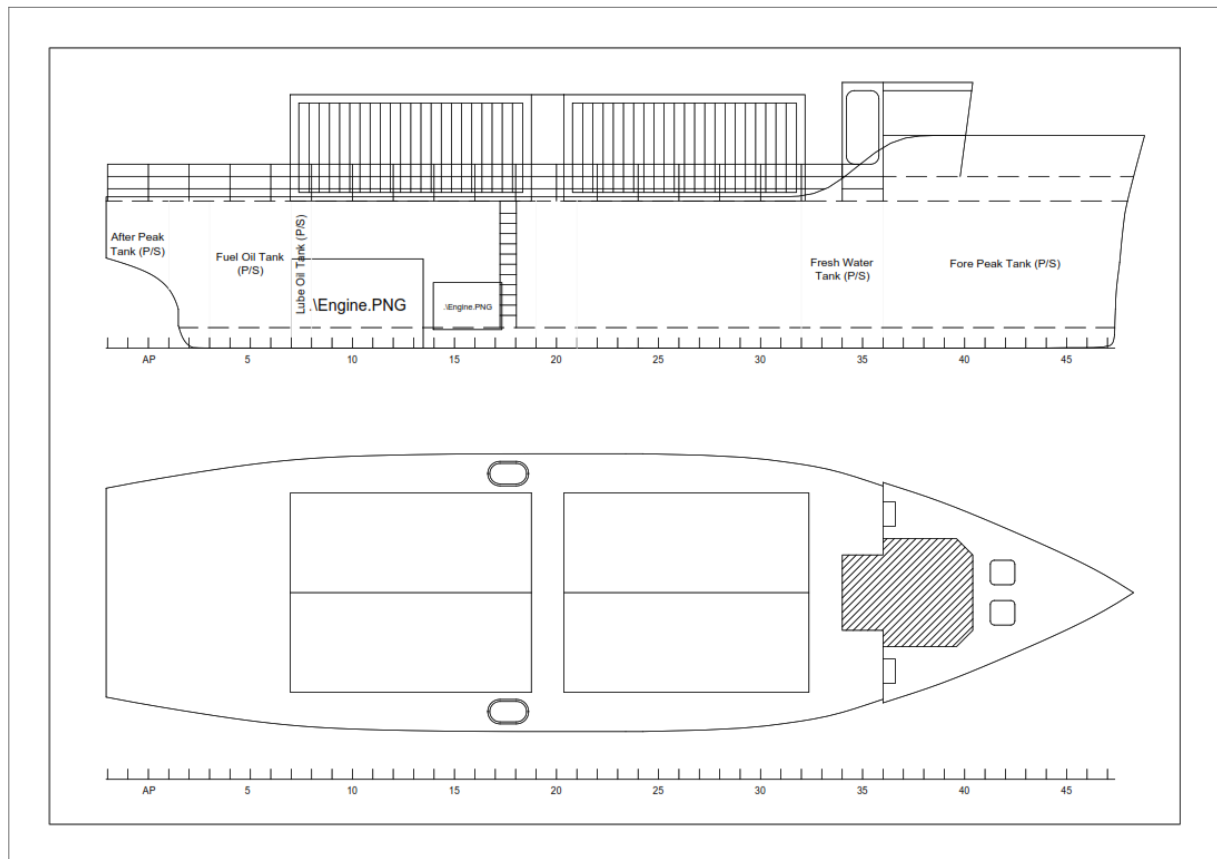


Figure 8. General Arrangement



Figure 9. 3D Models

Conclusion

After conducting research from the ship Multipurpose Container - Passenger Vessel (MCPV), the following conclusions could be obtained:

1. The MCPV payload is worth 77.28 tons
2. The optimum ship's dimension based on calculation:
 - LoA : 20,85 m
 - Breadth : 7m
 - Height : 2m

- Depth : 1,2 m

3. Technical calculations including comparisons of cargo space, trim, freeboard and stability meet regulations.

4. Generated design of Line Plans, General Plans, and 3D Designs of Multipurpose Container - Passenger Vessel (MCPV) vessels.

Based on the economic analysis that has been done, it can be concluded that the construction of a Multipurpose Container - Passenger Vessel (MCPV)

meets the minimum investment feasibility by referring to the Index Rates

5. Ratio (IRR), Net Present Value (NPV), Break Even Point (BEP) and Present Worth (BEP) PW). The investment value is obtained by reviewing several parameters including Total Capital Investment (TCI), General Expenses, depreciation value and salvage value. The economic value of MCPV development includes:

- IRR = 19%
- NPV = Rp. 1.494.899.189,09
- PP = 3,28 Tahun
- BEP = Rp. 124.353.786.419,23
- TCI = Rp. 5.076.613.121,06
- GE = Rp. 633.422.971,29/Tahun

6. This value then is compared to the income comparison with similar sized vessels but only has 1 function. Thus, it is concluded that the construction and operation of Multipurpose Container - Passenger Vessel (MCPV) vessels is far more profitable compared to regular (fixed) vessels.

7. The vessels are met with SISLOGAS vessel requirement for Short Sea Shipping (SSS).

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