

THE UTILIZATION OF HIGH SPEED PASSENGER VESSEL JETFOIL ROUTE OF MEDAN – PENANG

Triyono Widi SASONGKO
 Directorate of Transportation Technology
 Agency for the Assessment and Application of Technology
 BPPT 2nd Bldg 10th Floor
 Jl. M.H. Thamrin No. 8
 Jakarta 10340 Indonesia
 Fax: +62-21-316-9345
 E-mail: triyonow@netscape.net

Abstract: In recent years, the utilization of high-speed passenger vessel for inter island transport increases significantly in Indonesia. One of the potential route is between Medan (Indonesia) and Penang Island (Malaysia) about 135 miles. The existing high-speed passenger vessel has the advantage of relatively low cost, especially compared with air transportation. However, it has a limitation in conveniences. Under the circumstances, a high-speed passenger vessel Jetfoil has some advantages over the existing high-speed passenger vessels. She has a higher sailing speed of about 48 knots and more convenience. Indonesian Government has two Jetfoils of troop transport type that can be modified for commercial of passenger vessel type. This paper studies the feasibility of modified Jetfoil for the potential route of Medan – Penang. Based on the technical and financial analysis, it concludes that the route of Medan - Penang is feasible for the implementation of Jetfoil.

Key Words: inter-island transport, jetfoil, feasibility analysis, sensitivity analysis

1. INTRODUCTION

The Province of North Sumatra is a part of Indonesia that is geographically close to Malaysia. Because of this, the Province of North Sumatra as main gate has an importance role for Indonesia – Malaysia relation. Large numbers of Indonesian people work in Malaysia's industries and plantations. Sea and air transportation grows significantly to support mobilization of people and export-import activities.

Nowadays, sea transportation is more interesting, because monetary crisis in Indonesia affects airline ticket fare much more expensive. One of the potential route is between Medan (Indonesia) and Penang (Malaysia) about 135 miles. The embarkation and debarkation of passengers for this route in 1999 were about 185,000 passengers. Based on the data series, the passengers are expected to increase 6.4% annually. The potential passengers are Indonesian workers in Malaysia and businessman who traditionally have business relationship between two countries. Everyday two fleets with capacity of about 200 seats depart and arrive on this route on the average load factor of 61.03%.

The existing high-speed passenger vessel has the advantage of relatively low cost, especially compared with air transportation. With an interval sailing speed of 20 to 23 knots and a travel time of 6 – 7 hours a trip, the ticket fare is about one third of the ticket fare of airline. However, it has limitation on stability and conveniences, so these weaknesses lead to seasickness since they have been easily shaking up in sea wave. Under the circumstances, a

high-speed passenger vessel with a comfortable ride has been required by the user of inter island transport.

A high-speed passenger vessel Jetfoil with capacity of 225 seats has a characteristic that satisfies the requirement. She has a higher sailing speed of about 48 knots and her hull movement can be kept on a certain distance from sea surface like airplane within sea condition up to 3 m of wave high. So that the problem of the silences and conveniences can be met easily. The Jetfoil, however, is high oil consumption and high cost of spare parts, so a comprehensive feasibility study should be done to operate her.

Indonesian Government has five Jetfoils, which were developed by The Boeing Company, USA. The first Jetfoil that was completed in 1981 is a type of passenger vessel, named "Bima Samudra I". Now, she is operated as a commercial passenger vessel for the route of Gresik (East Java) – Bawean island about 80 miles with good performance. The second and third Jetfoils that were completed in 1984 are type of troop transport. The fourth and fifth Jetfoils that were completed in 1986 are type of patrol boat. The latest four Jetfoils are not utilized by military, caused by a very expensive operation cost, especially fuel oil, spare part and maintenance costs. Because The Boeing Marine System as the marine division of The Boeing Company was not a product Jetfoil anymore, so the spare parts of the Boeing Jetfoil are supplied by Kawasaki Heavy Industries Japan under license from The Boeing Company.

To optimize government assets and to support water transportation, Indonesian Government offers private operator to modify the Jetfoil from type of troop transport to type of passenger vessel and operate her in a potential route within five years. In this case, the private operator has to pay modification cost, operation cost and monthly charter fee.

This paper analyzes one of the modified Jetfoil for the potential route of Medan – Penang, both technically and financially, and determines the feasibility of the Jetfoil implementation for this route.

Figure 1 shows a location of Medan (North Sumatra, Indonesia) and Penang Island (Malaysia), beside the existing Jetfoil route in Gresik (East Java) and Bawean Island.

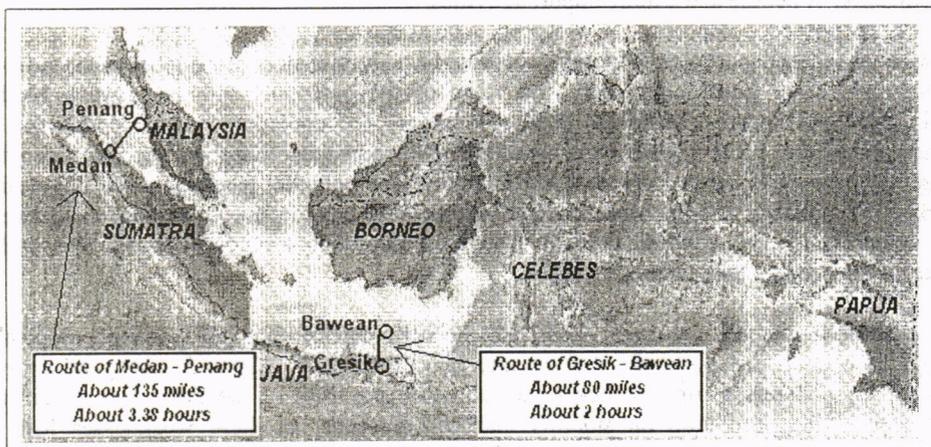


Figure 1. Proposed Jetfoil Route of Medan – Penang and Existing Route of Gresik - Bawean

2. METHODOLOGY

The methodology to finish the study is described systematically as below.

▪ Data Collection

All kinds of data are the specification and technical aspect of the high-speed vessel Jetfoil, port condition and facilities, environment of the route (wind, current, climate, debris, etc), the passengers flow, and social economic condition of hinterland.

▪ Technical Analysis

The technical analysis is performed to analyze on the feasibility of port conditions and facilities, sea environment, nearest shipyard for docking possibility, supporting spare parts and technicians.

▪ Financial Analysis

The financial analysis is performed to carry out on passenger demand analysis, estimation of investment or modification cost, operation cost (both variable cost and fix cost), benefits (from passengers ticket and luggage's overweight) and calculation of *Net Present Value* (NPV) and *Internal Rate of Return* (IRR).

▪ Sensitivity Analysis

The analysis is performed to identify the sensitivity of the items of cost and benefit against the differences between projection and reality, represented into *switching value*. *Switching value* shows how many percent some item can be allowed to increase or decrease from the projection rates, so that the project is still feasible to be done.

3. TECHNICAL ASPECT OF JETFOIL

The high-speed vessel of Jetfoil, type of troop transport, is planned to be modified as a type of passenger vessel with general specifications as below:

- Length overall
 - Foils up : 27.43 m
 - Foils down : 30.78 m
- Length between perpendiculars : 23.77 m
- Maximum breadth : 9.14 m
- Maximum draft
 - Foils up : 1.829 m
 - Foils down : 5.18 m
- Displacement : 115 long ton
- GRT : 100 ton
- Foilborne speed : max 48 knot
- Number of passengers : 225 - 250

The general arrangement is shown in Figure 2.

The Jetfoil is equipped with fully submerged foils at the fore and aft of the hull. The dynamic lift of these foils keeps the hull away from the surface of the water when foilborne. Each foil has a trailing edge flap driven by an electro-hydraulic servo actuator. The flap on the forward foil controls the ship's height from the surface of the water. The flaps on the aft foil control

the ship's pitching and rolling. The single swivelling forward strut functions as a rudder rotating to port and starboard.

The Jetfoil is high oil consumption and high cost of spare parts. Jetfoil with 225 passengers consumes 2 tons fuel oil (solar HSD) in one-hour operation

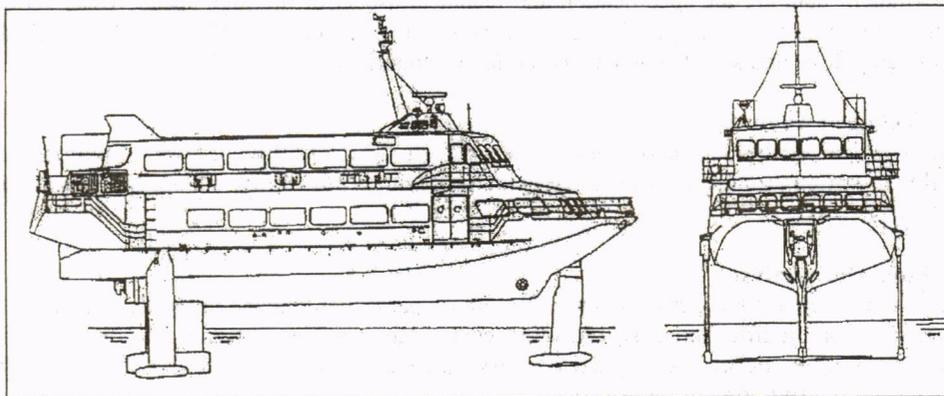


Figure 2. General Arrangement of Jetfoil

To operate Jetfoil, there is some important requirement related to a port, a route condition and other facilities as bellow:

- A minimum depth of basin is 3 m LWS.
- A minimum depth of channel is 2.5 m LWS.
- A minimum wide of channel is 30 m.
- A maximum high of wave along the route is 3 m.
- There isn't a floating debris along the route.
- There are docking facilities near the route, which are equipped with 150 ton's crane.

4. TECHNICAL ANALYSIS

The technical analysis is objected to identify the feasibility of Jetfoil operation in the route of Medan – Penang. Base on the requirement of port and route condition, Port of Belawan (Medan) and Port of Georgetown (Penang), it is feasible for operating Jetfoil. The depth of basin, the depth and wide of channel, and the height of wave along the route satisfy the requirement. The feasibility is proved in Table 1.

Table 1. The Technical Analysis of Jetfoil Operation Route of Medan - Penang.

Items	Requirement of Jetfoil Operation	Port of Belawan (Medan)	Port of Georgetown (Penang)
The depth of basin	Min 3 m LWS	6 – 10 m LWS	5 – 9 m LWS
The depth of channel	Min 2.5 m LWS	9.5 m LWS	5.5 m LWS
The wide of channel	Min 30 m	60 m	50 m
The height of wave along the route	Max 3 m	Max 1.5 m in June, July and August	
The floating debris along the route	None	None	
The docking facility (150 ton's crane)	Available	In Singapore and Malaysia	

Table 1 also informs there is not significantly floating debris along the route. This condition minimize the trip cancellation due to debris on water inlet to water jet propulsors. The docking facility near the route that equipped with 150 ton's crane is available in Malaysia and Singapore. The crane is needed to lift the vessel from water and put on a cradle at the docking space. Using the crane is a standard procedure in docking work of Jetfoil to ensure safety of the submerged part, such as struts, foils and flaps.

5. FINANCIAL ANALYSIS

The financial analysis of the Jetfoil operation, having route of Medan – Penang, consists of the passenger demand analysis, the estimation of modification cost, the estimation of operation cost, the NPV and IRR calculation and the sensitivity analysis.

5.1. Passengers Demand

Table 2 shows the number of a high-speed vessel's passengers from 1992 to 1999 and the projection of Medan – Penang route up to 2004. The passengers trend increase significantly annually, except in 1997, that was the first-year of monetary crisis which causes a decline in passenger number.

The passengers demand is projected using a regression analysis. The regression equation is:

$$\text{Number of passengers} = (26,174,726.94) + 13,174.56 \text{ Year}$$

$$R \text{ square} = 0.62$$

Among other advantages over the existing high-speed passenger vessels, Jetfoil is expected to compete and able to get good market share. Supposing there is strict competition among the high-speed passenger vessels, so the Jetfoil market share is assumed about 25% of the projection of potential passengers demand.

Table 2. The Passengers Demand of the High-Speed Vessel Route of Medan - Penang

Year	Existing (All)	Projection	
		All	Jetfoil
1992	70,543		
1993	99,868		
1994	89,553		
1995	113,942		
1996	117,118		
1997	78,548		
1998	164,460		
1999	186,764		
2000		175,970	43,993
2001		189,265	47,316
2002		202,559	50,640
2003		215,853	53,963
2004		229,148	57,287

The passenger's backgrounds are worker in Malaysia's industries and plantations, merchant and tourist. The passengers from the Province of North Sumatra who go to Malaysia via Medan have advantage, because of a free fiscal policy.

5.2. Operation Plan

The projection of passenger demand above is used to calculate Jetfoil operation cost and revenue based on the estimation of the number of operation days in one week and the estimation of load factor per trip.

The Jetfoil has an average of sailing speed about 40 knots, so the route of Medan – Penang has a travel time about 3.38 hours. Assumed that the Jetfoil's home base is in Medan, so if the vessel start from Medan at 8 a.m., she will arrive again in Medan at 4 p.m.

Base on the projection of passenger's number and estimation of load factor per trip, so she will be planned to be operated three times a week. Table 3 describes the operation plan within five-years in details.

Table 3. Jetfoil Operation Plan of Medan – Penang Route

Items	0	1	2	3	4
Projection of passenger demand	21,996	47,316	50,640	53,963	57,287
Number of roundtrips a week	3	3	3	3	3
Number of operation weeks a year	25	50	50	50	50
Number of roundtrips a year	75	150	150	150	150
Average of load factor	65.53	69.86	74.47	79.39	84.63

5.3. Estimation of Costs

Costs of Jetfoil operation consist of the investment cost (the modification cost) and the operation cost. The operation cost consists of the variable cost and the fix cost.

➤ The investment cost (the modification cost)

The modification and preparation of Jetfoil from troops transport to passengers vessel type costs about Rp. 5 billion. Table 4 shows the items of the modification in detail. The modification work is predicted to be six months.

➤ The Variable Costs

The estimation of Jetfoil operation costs for Medan – Penang route by using the Jetfoil operation data of Gresik – Bawean route (East Java) as a reference, the average of one trip variable cost for the first one-year operation of Jetfoil route of Medan – Penang can be seen in Table 5.

The meaning of one trip is that the Jetfoil operates in one way, from one port to another port. For example, from Medan to Penang is one trip, and from Penang to Medan is one trip. Meanwhile, one roundtrip (voyage) is that the Jetfoil operates from port A to port B and back to port A again, so one roundtrip is equal to two trips.

Table 4. The Cost of Jetfoil Modification

No	Items of the Modification	Billion Rupiah	%
1	Retrofit	0.95	19.0
2	Overhaul of engine	0.15	3.0
3	Renovation of interior (main deck and upper deck)	0.65	13.0
4	Radio/radar	0.34	6.8
5	Safety equipment	0.58	11.6
6	Spare parts	1.09	21.8
7	Running test	0.15	3.0
8	Sea trial	0.21	4.2
9	Document	0.42	8.4
10	Insurance	0.25	5.0
11	Crew training	0.21	4.2
Total		5.00	100.00

Note: US\$ 1,- = Rp. 9,000,-

Table 5. The Variable Costs of Route of Medan – Penang in One Trip

No	Items of the Variable Costs in One Trip	Rupiah	%
1	Fuel oil (solar HSD)	7,105,050	56.03
2	Lubricating oil	850,500	6.71
3	Sales fee	766,667	6.05
4	Passengers snacks	737,267	5.81
5	Passengers insurance and port tax	737,267	5.81
6	Passengers bus	1,000,000	7.89
7	Fresh water	100,000	0.79
8	Berthing and port clearance	700,000	5.52
9	Crew meals	300,000	2.37
10	Crew sailing intensive	383,334	3.02
Total		12,680,084	100.00

Note: US\$ 1,- = Rp. 9,000,-

Table 5 above shows that in one trip, the fuel oil (solar HSD) cost is more than a half of the total of the variable cost, 56.03%.

➤ Fix Costs

Fix costs for the first one-year operation of Jetfoil route of Medan – Penang can be seen in Table 6. The fix costs will be used after modification work completed (about 6 months), so in the first year, the fix costs is a half of the estimation above. The fix costs is assumed to increase 5% annually, except fuel oil and ship charter fee that increase 8% and 10% annually.

Table 6 shows that the ship charter fee is the highest (26.02%) among other items of the fix costs, and the item of promotion follows with 15.49%.

Table 6. Fix Costs of Medan – Penang Route in First One-Year Operation

No.	Items of the Fix Costs in One-Year	Million Rupiah	%
1	Crew salary	225	6.97
2	Crew accommodation and local transport	120	3.72
3	Crew working equipment (cloths, shoes, etc.)	7.5	0.23
4	Management and staffs salary	200	6.19
5	Office stationary	10	0.31
6	Rent office	200	6.19
7	Floating repair	40	1.24
8	Store	60	1.86
9	Spare part	180	5.58
10	Docking	125	3.87
11	Ship insurance	180	5.56
12	Crew insurance	6	0.19
13	Ship document	15	0.46
14	Promotions	500	15.49
15	Berthing (in home base)	20	0.62
16	Ship charter fee	840	26.02
Total		3,228.5	100.00

Note: US\$ 1,- = Rp. 9,000,-

5.4. Estimation of Benefits

The benefit of Jetfoil operation between Medan and Penang comes from sale of passenger tickets and charge of luggage's overweight.

➤ Passenger Ticket Fare

In the first year, the passenger ticket fare is about Rp. 189,000,- one way. The fare is slightly more expensive than the other fast passenger vessel fare; however, it is only a half of the airline fare. Especially, the fare for child and infant are 50% and 10% of adult fare. Following the survey of the passenger pattern for the route of Gresik – Bawean, the passenger composition of adult, child and infant are 86%: 13%: 2%. The fare is projected to increase about 5% annually.

➤ Charge of Luggage's Overweight

Every passenger is allowed to carry 20 kilogram's luggage. If they have luggage more than 20 kilogram, they must pay Rp. 2,500,- a kilogram as luggage's overweight charge and this charge will be increased 5% annually. The average of luggage's overweight in one trip is estimated to be 1,000 kg.

5.5. NPV and IRR

To assess the feasibility of the Jetfoil operation route of Medan – Penang, it may use two investment criterias; there are *Net Present Value* (NPV) and *Internal Rate of Return* (IRR). The route will be concluded as feasible (GO), if it has NPV positive and IRR > OCC (*Opportunity Cost of Capital*). *Discount rates*, and will be assumed as OCC, is 20%. The long of time horizon is 5 years.

The result of financial analysis route of Medan – Penang including calculation of costs, benefits and profits within five years-time horizons can be seen in Table 7.

Table 7 shows the financial analysis result NPV is Rp. 3.18 billion and IRR is 60%. Since $NPV > 0$ and $IRR > OCC$, so it can be concluded that the Jetfoil operation between Medan and Penang is feasible (GO) financially.

Table 7. Financial Analysis of Jetfoil Operation Route of Medan – Penang (billion rupiah)

Items	0	1	2	3	4
• Cost					
Investment (modification)	5.00				
Operation	3.52	6.58	7.07	7.60	8.16
Total of cost	8.52	6.58	7.07	7.60	8.16
• Benefit					
Passengers ticket	3.83	8.58	9.61	10.75	12.03
Luggage's overweight	0.38	0.79	0.83	0.87	0.91
Total of benefit	4.21	9.37	10.44	11.62	12.94
• Profit					
Gross profit	(4.31)	2.79	3.37	4.03	4.79
Profit before tax	(4.31)	(1.52)	1.85	4.03	4.79
Tax rate 15%	-	-	0.37	0.81	0.96
Net profit	(4.31)	2.79	3.00	3.22	3.83
NPV 20%	3.18				
IRR	60%				

Note: US\$ 1,- = Rp. 9,000,-

5.6 Sensitivity Analysis

To know the sensitivity of the items of cost and benefit against the differences of projection and reality, it is important to performed sensitivity analysis. The principal of sensitivity analysis is *ceterus paribus*. In this case, one item of cost or benefit is changed and other items are assumed to be constant, where in the financial calculation leads to condition $NPV = 0$ (the minimal condition that the project is feasible). Base on this condition, the *switching value* can be calculated and it may show how many percent some item can be allowed to increase or decrease the projection rates, and the project is still feasible to be done.

Table 8 describes the result of sensitivity analysis of Jetfoil operation route of Medan – Penang and shows the sensitivity rates of some important items if the projection has lack of value over the real data.

Table 8 shows the investment cost, the number of passenger, the number of roundtrip, the ticket fare, the price of fuel oil, and the ship charter fee has low sensitivity. It indicates the Jetfoil operation between Medan and Penang is relatively stable upon the change of mean items.

Table 8. Sensitivity Analysis of the Jetfoil Operation Route of Medan – Penang

One Changed Item (other items are constant)	First Year Data		Switching Value (%)
	Projection Value	NPV = 0	
Investment (modification) cost	Rp. 5 billion	Rp. 9.35 billion	87.01
Number of passengers	21,996	18,375	(16.92)
Number of roundtrip a week	3	5	56.34
Passenger ticket fare (adult)	Rp. 189,000,-	Rp. 159,241,-	(15.74)
Price of one liter fuel oil (solar HSD)	Rp. 1,000,-	Rp. 1,601,-	60.12
Monthly ship charter fee	Rp. 70 million	Rp. 173 million	147.23

Note: US\$ 1,- = Rp. 9,000,-

If one item is changed and other items are constant, as described in Table 8, the switching value mean:

- The estimated cost for modification work, about Rp. 5 billions, has a possibilities of being increased up to Rp. 9.35 billions or 87.01% increase.
- Every year, the number of passengers has a possibility of being decreased to 16.92% from the projection value.
- The number of maximal roundtrip in a week is 5 times. This point gives the Jetfoil operator flexibility to arrange operation schedule.
- The passenger ticket fare has a possibility of being decreased to 15.74% from the projection value. So the cheapest ticket fare for adult in the first year is Rp. 159,245,-. This advantage gives the Jetfoil operator flexibility to use factor of ticket fare in competition with other vessel or airline.
- The route is still feasible although the price of fuel oil increases up to 60.12% from the projection value.
- The ship charter fee for the Jetfoil owner has a possibility of being increased to approximately Rp. 173 million monthly.

6. CONCLUSION

Since a high passenger demand, the Province of North Sumatra needs a high-passenger vessel to connect this region with Malaysia. A potential route is Medan – Penang.

Jetfoil has a higher sailing speed of about 45 knots than an existing high-speed vessel and her hull movement can be kept on a certain distance from sea surface like airplane within sea condition up to 3 m of wave high, so it is much more satisfied and convenient.

The embarkation and debarkation passengers for the route of Medan – Penang in 1999 were about 185,000 passengers and expected to increase 6.4% annually. If Jetfoil will be operated in this route, a market share of Jetfoil is estimated about 25%.

Based on the technical and financial analysis, it concludes that the route of Medan - Penang is feasible for the implementation of Jetfoil. With a discount rate 20%, the NPV is Rp. 3.175 billions and IRR is 60%. The route has low sensitivity, so financially interesting for a ship's operator.

ACKNOWLEDGEMENTS

The author would like to thank Mr. Soengeng Hardjono, Mr. Yulianta, and Mr. Sucipto for their many discussions and suggestions in writing this paper.

REFERENCES

- Au, T. and Thomas, P.A. (1992) **Engineering Economics for Capital Investment Analysis**. Prentice-Hall, New Jersey.
- Steiner, H.M. (1988) **Engineering Economic Principles**. The McGraw-Hill Companies, Inc., New York.
- Branch, A. E. (1982) **Economics of Shipping Practice and Management**. Chapman and Hall, New York.
- Sasongko, T.W., Yulianta, Sucipto and Hardjono, S. (2000) Pre Feasibility Study of Boeing Jetfoil Operation in Region of Palembang – Bangka – Belitung (in Indonesian), **Pengkajian Industri (Industrial Assessment)**, Vol. 9, No. V, 49-58.