ECONOMIC FEASIBILITY AND IMPACT ANALYSIS OF AN IMPROVED FERRY SERVICE BETWEEN JAVA AND SUMATRA

by

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ABSTRACT

The objective of this thesis is to analyze the feasibility of implementing high speed surface craft (hovercraft and hydrofoil) for the purpose of transporting passengers and cargo between Java and Sumatra.

In this thesis, a methodology is developed to deal with the demand analysis, the preliminary cost analysis and the economic impact analysis.

The trip generation and modal split analysis are used as two approaches in the demand analysis. This demand analysis estimates the number of passengers for the alternate ferry service. Based on this analysis, the number of craft and the level of fares are predicted for further study.

The preliminary cost analysis incudes the financial evaluation for a hovercraft operation. The annual operating cost statement and the sensitivity analysis, using six iterations, are preformed on the results of the finacial analysis.

The impact analysis is divided into direct and indirect impacts, and includes an explanation of the causal relationship among several variables. The direct impact was explained in the demand analysis and the feasibility study. The indirect impact was divided into traffic and economic impacts.

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A.P.S.

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Chapter 1 INTRODUCTION

1.1. LOCATION AND BACKGROUND:

At present, the ferry service between Merak (in Western Java) and Bakahuni (in Lampung, Southern Sumatra) provides the only means of transportation between Java and Sumatra (a distance of approximately 37.5 km). This service began operation shortly after the opening of the Bakahuni Port in 1981. Before its completion, ferry boats transported passengers and freight from Merak to Panjang (also in Lampung). This original route is much longer (107 km) than that between Merak and Bakahuni.

Since the opening of the Bakahuni Port, ferry service has experienced a steady increase in both the number of passengers and tonnage of freight transported between Java and Sumatra. The demand for transport service has grown rapidly due to the recent completion of the Trans-Sumatra Highway.

The Trans-Sumatra Highway connects Jakarta (in Java) and Jambi (in Sumatra). This construction was financed by the Overseas Economic Cooperation Fund of Japan (OECF) and completed in the summer of 1984. The total length of this highway is 1,204.3 km. The highway is divided into the following six sections (shown in Figure 1.1) :

Sections:	Length:
1) Jakarta-Merak Toll Road	43.4 km
2) Ferry Service Merak-Bakahuni	37.5 km
3) Lampung Road	108.8 km
4) Kotabumi-Lubuklinggau	467.4 km
5) Lubuklinggau-Muarabungo	306.0 km
6) Muarabungo-Jambi	241.4 km

Source : Impact Study of Trans-Sumatra Highway, LPEM-FEUI, 1985.

This highway is located along 4 provinces in Southern Sumatra (Bengkulu, Jambi, Lampung and South Sumatra) and 2 provinces in Java (West Java and DKI Jakarta). It is separated by the Sunda Straits into two areas: the first is the Jakarta-Merak toll road in Java, and the second is the remainder of the highway in Southern Sumatra (shown in the map of

Southern Sumatra and Western Java in Figure 1.2.). As cited above, the transportation facility across the Sunda Straits is operated by ferry boats. There are eight ferry boats which operate between Merak (in West Java) and Bakahuni (in Lampung, Southern Sumatra).

Ferry boat service is currently the only means of transportation connecting the two sections of highway. The quickest time for each of the eight boats requires 5 hours to complete a round trip, averaging a speed of 25 km/hour. The total time required for a round trip is as follows:

1 hour at each terminal (for loading and unloading) x 2	=	2 hours
1.5 hours cruise time each way x 2	=	3 hours
Total round trip	=	5 hours

According to the Annual Transport Performance data from 1985, the eight existing ferry boats are capable of transporting 25,800 passengers and 2,030 vehicles per day from both directions.[1] However, the demand for traffic has increased very rapidly after the opening of the Trans-Sumatra Highway in 1984. The annual volume of traffic using ferry boats has increased by 13.6 percent for passengers, 56.8 percent for vehicles and 53.5 percent for cargo during period 1981-1985 (Table 1.2.1.).

The current capacity at the two ports is not enough to satisfy the actual demand for traffic. The congestion at Merak-Bakahuni started to increase dramatically one year after the Trans-Sumatra Highway began operation. Passengers and cars have a priority to be transported by the existing ferry. As a result, trucks have to wait on line in order to use the ferry. Sometimes the waiting time occurs for over night, the distance of the waiting line was approximately about 1 kilometer long. This waiting line is also caused a congestion at the port area as it is shown by the traffic jam at the entrance of the port.

This bottleneck at the two sea ports are not caused by the limited capacity of the existing ferry only, but also caused by loading and unloading time of the ferry, docks capacity, time scheduling for ferry operation.

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[1] *OECF Japan, "The Impact Study of Trans-Sumatra Trunk Road", June, 1985.*

Table 1.2.1.

TRAFFIC VOLUME BY THE EXISTING FERRY BOATS

MERAK -BAKAHUNI

1985

	Traffic Volume	Annual Growth (1981-1985)
Passenger	3,890,221 passengers/year (10,410 passengers/day)	13.6 %
Vehicle	486,000 vehicles/year (1,330 vehicles/day)	56.8 %
Cargo	1,529,000 tons/year (4,200 tons/day)	53.5 %

Source: OCS, Lampung Transportation Statistics, 1985.

The construction of a bridge linking Merak and Bakahuni would undoubtedly be the most effective means of remedying this bottleneck. Unfortunately, factors such as: cost, span (37.5 km), depth (200 m), as well as the necessity of maintaining an open navigation channel, along with the present state of bridge engineering technology make this idea prohibitive. Another possibility is to use high speed surface craft, such as hydrofoils and hovercraft, as an alternative means of reducing the transportation bottleneck between Merak and Bakahuni. This possibility is examined further in this thesis.

1.2. HYPOTHESIS:

Based on the data from the OECF, MRI and LPEM study (completed in March 1987), this thesis will analyze the feasibility of implementing high speed surface craft for the transportation of passengers and cargo between Merak and Bakahuni.

The objective of this study is to examine the following hypothesis:

1. The implementation of high speed surface craft will reduce the travel time.
2. This service is financially feasible.
3. The resulting impact on the economy and society will be positive.

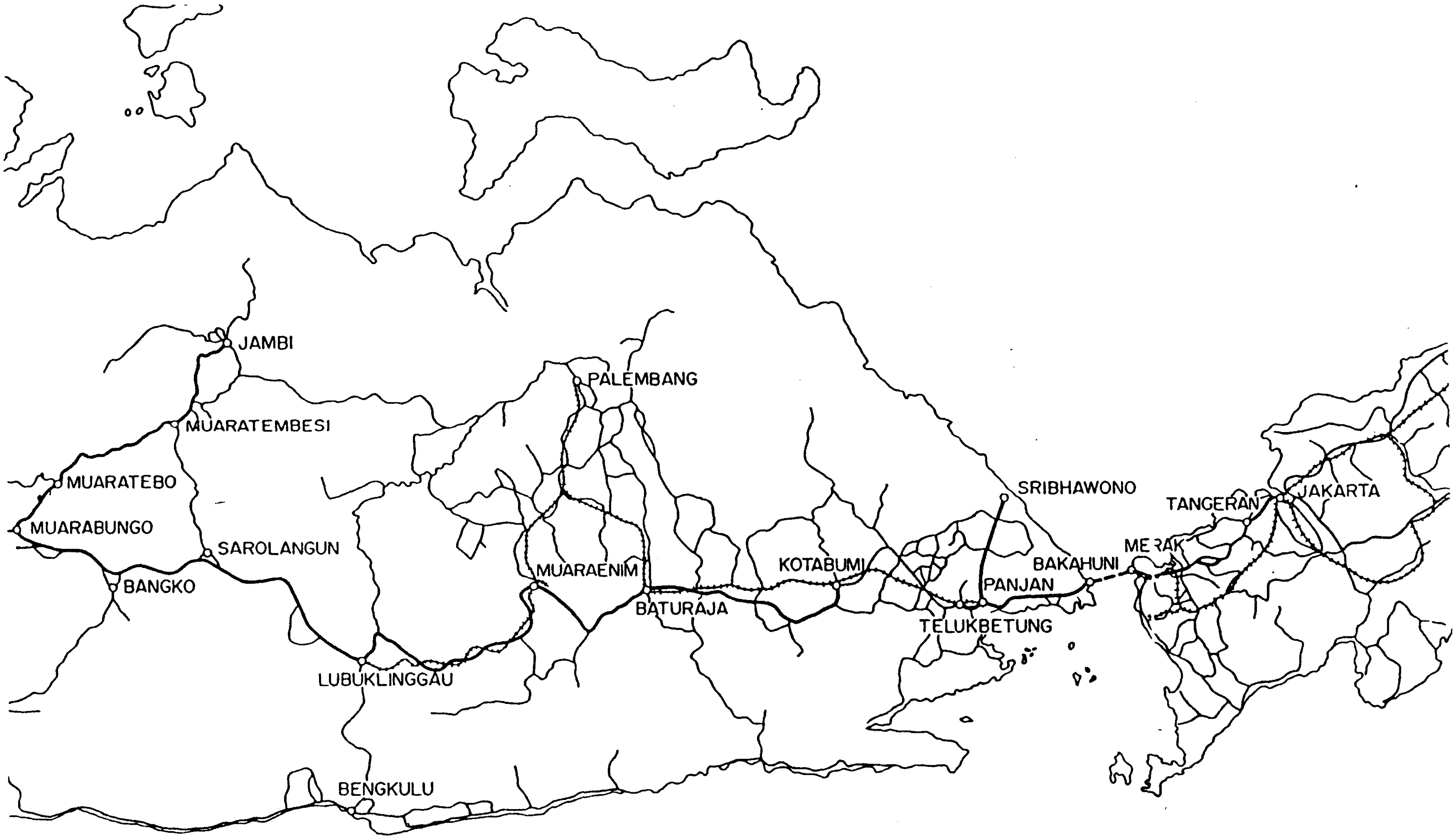

Figure 1.1. Map of Trans-Sumatra Highway
Source: OECF Study, Japan 1984.

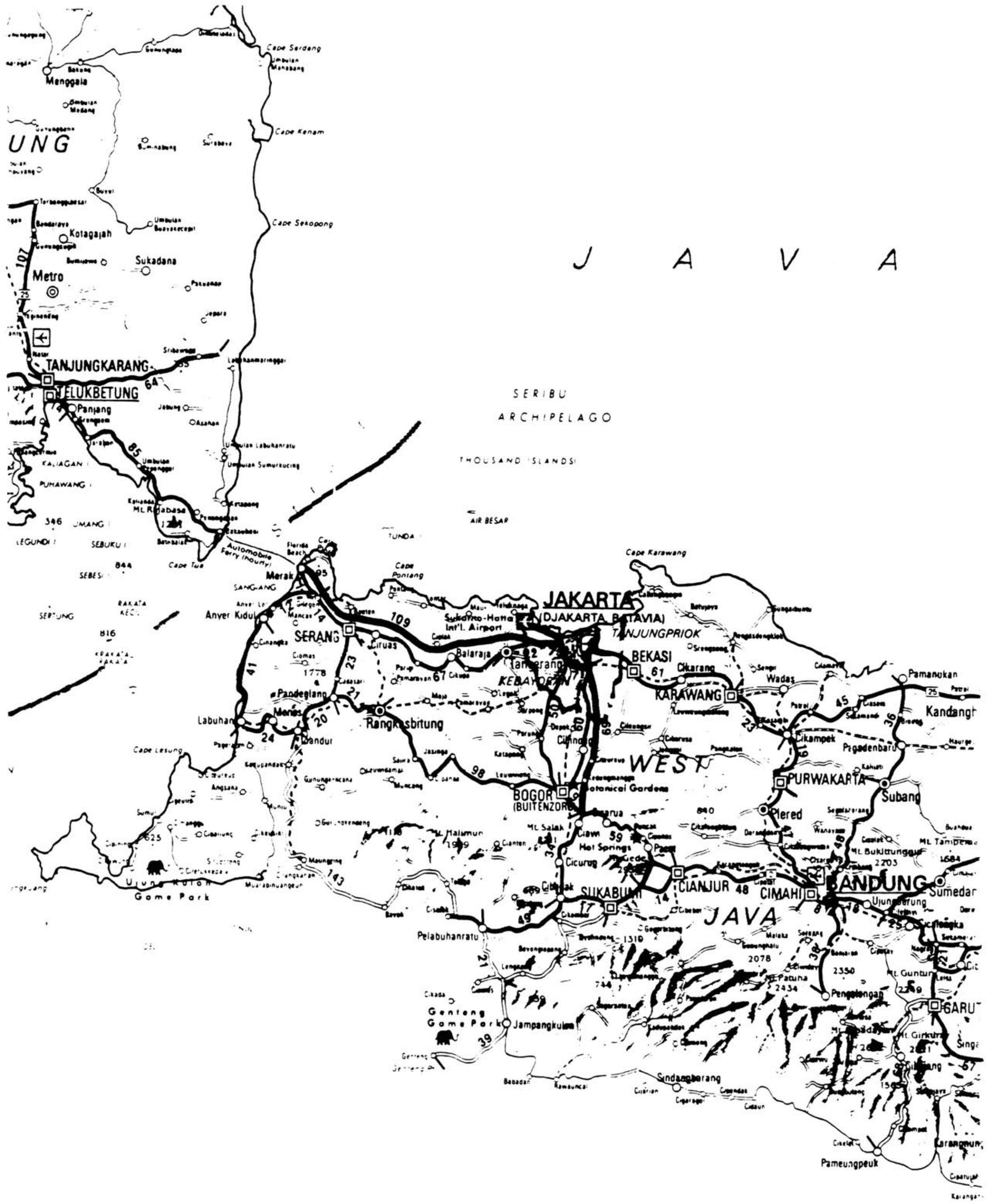

Figure 1.2. Map of Southern Sumatra and Western Java
Source: A.P.A. Map, 1986.

Chapter 2 METHODOLOGY

2.1. INTRODUCTION TO METHODOLOGY:

The objective of this chapter is to present all the definitions and methods which will be used in the calculations. The explanation of definitions and methods will be divided into three parts:

a) Explanation of the terms and definitions which will be used in the following chapters.
b) Explanation of the data sources.
c) Explanation of the methods and assumptions which will be used in the demand analysis (Chapter IV) and in the feasibility study (Chapter V).
d) Explanation of the economic impact analysis (Chapter VI).

2.2. DEFINITIONS:

Project Area:

The proposed project area for this study includes all four of the provinces in the southern part of Sumatra (Jambi, Bengkulu, Lampung, and South Sumatra) and the two provinces in the western part of Java (West Java and Jakarta). Jakarta is characterized as a "special province" because of its function as the capital city of Indonesia. The selection of these 6 provinces as a project area coinsides with the Origin-Destination Surveys of 1979 and 1984. The O-D surveys found that the majority of passengers and freight transported in Sumatra and Java originates from, or is directed towards these six provinces. [1/] These provinces would feel the strongest economic impact if the improved ferry service were implemented.

The information needed for further evaluation is divided into two categories:

A) Demand Data
B) Supply Data

[1/] *Department of Communication and Department of Public Works, " Origin and Destination Survey", 1974,1982.*

A) DEMAND DATA:

The information from the demand side includes all of the variables used to estimate the market size. These variables will be presented as:

1) Definition of terms.
2) Data Sources.

1) Definition of Demand Data Terms

Population and Income Groups:

Population is defined as the total number of people who live in a specific area. In this study, the specific area is a province. The total population in each province is divided into three sub-categories: high income group, middle income group, and low income group. The definition for each of these categories is based on 1985 data as follows:

High Income Group:	people who earned income in the range between Rp.2,400,000 Rp.20,000,000 per year (includes professional workers such as: accountants, executive managers, medical doctors, law yers, etc.), .
Middle Income Group:	people who earned income in the range between Rp. 720,000-Rp. 2,400,000 per year.
Low Income Group :	people who earned income less then Rp. 720,000/year.

Income Group Shift:

Income group shift is defined as a shift in the total number of people from a given income group to a higher or a lower income group because their income increased or decreased outside the income levels that represent the limits of their income group.

Total Passenger Trips:

The total number of trips that were taken by passengers from point of origin to destination. The information for total passenger-trips is divided among the modes of travel, as follows:

Car-trip, existing ferry:	the total passenger-trip using car and existing ferry.
Bus-trip, existing ferry :	the total passenger-trip using bus and existing ferry.
Car-trip, improved ferry:	the estimated total passenger-trip for car and improved ferry.
Bus-trip, improved ferry:	the estimated total passenger-trip for bus and improved ferry.
Airplane trip:	the total number of passengers using air-transport from Jakarta to Tanjungkarang.

Generalized Gravity Model:

The choice of probability of an alternative defines the number of times the alternatives is chosen by the individual relative to the total number of times a choice is made. In this study, the generalized gravity model is formulated as follows:

$$T_{ij}' = \frac{k\,(P_i' P_j')^a (I_i' I_j')^b}{(C_{ij}')^g}$$

T_{ij}' = percentage change in the total number of trips.
P_i' = percentage change in the total number of people in Java.
P_j' = percentage change in the total number of people in Sumatra.
I_i' = percentage change in per capita income of people in Java.
I_j' = percentage change in per capita income of people in Sumatra.
C_{ij}' = transportation cost from Java to Sumatra.
k, a,b and g = constants

Income Elasticity of Trips:

The elasticity of trips with respect to income is defined as the percentage change in the total trips as a result of the percentage change in income. The general form of this elasticity is as follows:

$$e_{trips} = \frac{\Delta T / T}{\Delta I / I}$$

e_{trips} = Elasticity of trips with respect to income.
T = Total trips.
ΔT = Percentage change in total trips.
I = Per capita income.
ΔI = Percentage change in per capita income.

The income elasticity of trips was calculated in this thesis using the generalized gravity model.

Trip Generation Growth Rate:

The trip generation growth rate is an annual increase in the number of trips with respect to the annual growth of income. It is calculated by multiplying the elasticty of trips taken by the average income growth rate. Trip generation growth rate is formulated as follows:

$$r_{trips} = e_{trips} \times g_{inc}$$

r_{trips} = trip generation growth rate, as a percentage.
e_{trips} = elasticity of trips to income.
g_{inc} = average income growth rate, as a percentage.

Trip Rate:

The trip rate is defined as the number of total trips per capita. The trip rate in 1985 is used as the base rate. The estimated trip rate in 1988 and 1998 is based on the trip generation growth rate from 1985. The trip rate is formulated as follows:

$$T_{gn} = [1 + r_{trips}]^{\Delta t} \times T_{gn-1}$$

T_{gn} = expected trip rate per thousand population at year n.
T_{gn-1} = total trip rate per thousand population at base year.
Δt = time difference between forecasted year and based year, for example:
i.e. for 2 different base year: 1988, Δt = 1988 - 1985 = 3;
1998, Δt = 1998 - 1988 = 10

Normal Traffic:

Normal traffic is the total number of trips under normal conditions (without any effect from the improvement of: transportation infrastructure, transportation network and other transportation facilities) .

Diverted Traffic:

Diverted traffic is the total number of trips which is diverted to the new improved facility due to the lowering transport cost. In this study, the traffic is diverted due to the lowering of the generalized cost.

Induced Traffic:

Induced traffic is the total number of trips in addition to normal traffic, created after the opening of a new transport facility. In this study, no induced traffic is assumed for the improved Merak-Bakahuni ferry service, only diverted traffic from both air and existing ferry. This is a conservation assumption from the view point of financial feasibility.

Total Trips:

Total trips is defined as the expected total number of trips by all modes between Java and Sumatra for 1988 and 1998, including normal traffic and diverted traffic. This traffic, however, includes traffic from earlier improvements to the Trans-Sumatra Highway and the ferry system. It is formulated as:

$$\text{Total } T_{gn} = T_{gn} \times P_{gn}$$

Total T_{gn}	=	Total number of trips for population from income group g at year n
T_{gn}	=	Expected trip rate per thousand population from group g at year n.
P_{gn}	=	Estimated number of population from group g at year n, in thousand.

Modal Split Analysis:

Modal split analysis is a method to forecast the proportion of the total number of predicted trips to be allocated to the various transportation modes. This analysis usually uses modal split models to determine the number of person trips made on each mode of travel.

Modal Choice:

Modal choice is defined as a choice of people from different income groups to use a particular transport mode from a certain origin to destination.

Transport Mode:

Transport mode is defined as any kind of transportation means to move passengers and cargo.

Logit Model:

A binary choice model using a logistic function to determine the proportion of choice between two transportation alternatives.

Probability of Choice:

This probability is defined in a logit model as the proportion of total trips that are made on one mode of transportation when the travel characteristics of two modes are compared.

Model Calibration:

A method of using a specified model structure and a particular data base to estimate the model parameters.

Perceived Cost:

Perceived cost is defined here as out-of pocket expenditure (i.e., money spent for the trip). In this study, the out-of pocket expenditure includes: toll fare, ferry-fare, gasoline cost, taxi-cab cost, driver cost, parking cost, and other cash payments for the round trip.

Time Value Cost:

This is an indirect transportation cost which is defined as the value of time spent in travelling. In this study, the time value cost is defined as the opportunity cost of time (per hour) for the traveller in order to make a round trip.

Generalized Cost:

Generalized cost is defined as the sum of the perceived cost and the time value cost.

2) Demand Data Sources:

Population:

The source of this information is the Indonesian Census Data for 1980, and the Intra-Census Survey (Supas) taken in 1985.[2] The census and survey data include the total number of people in each province, the estimated rate of population growth, and the population projections for 1988 and 1998.

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[2] *Central Bureau of Statistics, " Social and Economic National Survey 1985"*

Distribution of Population by Income Group:

The source of this information is based on the Supas of 1985 and the Indonesian Year Book of 1986.

Total Number of Passengers:

This information is based on the Indonesian Origin and Destination Survey of 1977 and 1982, and the OECF Impact Study for Trans-Sumatra Highway, 1986. These surveys contain the total number of passengers by ground modes for each province. For the air mode data on trips for South Sumatra and Lampung were taken from the Office of Center Statistics (OCS) Lampung.

Total Passenger Trips:

The source of this information is the LPEM Final Report for Trans-Sumatera Highway Impact Analysis.

B) Supply Data:

The information from the supply side includes all of the variables used to estimate the capacity and the cost of the proposed craft. These variables will be presented as :

1) Definition of Terms.
2) Data Sources.

1) Definition of Supply Data Terms:

Exchange Rate:

The price of a currency in terms of another currency. In this study, the base currency is Rupiah in terms of US Dollar and Pounds Sterling.

Capital Investment Cost:

Capital invesment cost or capital cost is defined as the cost of capital required to finance initial and replacement investment. Capital Costs include : (1) the procurement cost, (2) the capital investment cost (for construction of the facilities for hovercraft operation) and (3) the engine overhaul cost per year. The items included in the capital costs are listed below:

- Terminal Cost
- Landing Pads Facility
- Parking Facility
- Procurement Costs of the Hovercraft
- Maintenance Equipment
- Engine Overhaul Cost

Operating Cost:

The cost required for a craft operation in a particular operation hour per year. The list of costs included in the operating costs are as follows:

i) *Variable Costs:*
- Fuel and Oil
- Rotables: Engines, Propellers, etc.
- Spares and Skirt Maintenance

ii) *Fixed Costs:*
- Annual Personnel Costs
- Insurance
- Port Charges
- Administration Costs
- Interest Costs

iii) *Estimated Profit* (assumed: 15% of total costs).

Variable Costs:

The costs which vary with the level of output (i.e. number of passenger trips) .

Fixed Costs:

The costs which do not vary with the output.

Operating Characteristics:

The specific information on craft operation, including the expected fuel usage, craft capacity, craft size, loading and unloading time and crew members required.

Route Characteristics:

Information about craft operation and the expected costs for a specific route, include route layout, terminal data, the number of trips per day, vehicle life, salvage value, administration costs, local conditions, estimated fares.

Capacity:

The maximum ability of a craft to carry passengers and freight.

Payload:

The maximum weight capacity that a craft can carry in its operation.

Down Time:

The time that craft is not in service due to overhaul, maintenance or repairs. The definition of additional variables from supply side will be explained at Chapter V.

2) Supply Data Sources:

The supply data were obtained from:

- the Boeing Marine System for hydrofoil (type: Jetfoil 929-119)
- the British Hovercraft Company, and the Hoverspeed Ltd. for hovercraft (type SR.N4.MK.II and SR.N4.Mk.III (SUPER-4)).

This information contains the characteristics of craft, capital investment, and operating cost.[3/]

2.3. DEMAND MODELS.

This section explains each step involved in the use of the trip generation and modal choice models. Some assumptions were used in the estimation of trip generation, trip rate and total number of trips, because the real data from the improved ferry service have not been established. As stated previously, the calculation is divided into two approaches, they are:

A) Trip Generation.

B) Modal Split Analysis.

[3/] The base year for this research is 1988. The base currency is the Indonesian Rupiah. The rate of exchange for the US dollar to Rupiah is approximately: 1 US $ = Rp. 1,650; that for Pounds Sterling to Rupiah is approximately: 1 Pounds Sterling = Rp. 3,135.

A) TRIP GENERATION:

The steps used to calculate the estimated trip generation are explained below:

First: Estimate the total passenger-trips between Java and Sumatra for each income group for the base year.

Second: Forecast the population growth, including the shift of population from one group to another group due to the rise in real income.

Third: Estimate the trip generation rate using the elasticity of trips with respect to income.

First : **Estimation of Passenger Trips**

In order to estimate trip generation, information is needed on the total number of passengers using each mode of transportation and the generalized costs for an average trip (in this study, Jakarta-Tanjungkarang is chosen as the average trip).

The choice of transport mode is different for each income group. For example, high income people can afford to choose the fastest and most convenient mode of transport, while the choices of middle and low income people are more constrained by their income. Therefore, the percentage of people who will choose a transport mode from a certain income group were estimated as follows: [4]

Modal Choice	High Income	Mid.Income	Low Income	Total
Ferry and Car	40%	55%	5%	100%
Ferry and Bus	10%	65%	25%	100%
Ferry and Rail	0% *	55%	45%	100%
On-foot	0% *	30%	70%	100%
Airways	75%	24%	1%	100%

note: *) All the high income people will be using either a car or bus or air.

[4] *These assumptions are made based on the local knowledge, and should be verified when additional field data is available.*

***Second:* Population Forecast**

Population forecasts by income group are made using 1985 base data, population growth by province and growth in income per capita by province. In order to simplify calculations, the travellers are divided into 3 income groups. Each income group has a different time value. It is assumed that: the higher the income, the greater the time value. The estimates for each income group are formulated below:

Income Group	Avg. Income/year	Hours/year*	Income/hour (Rp./hour)
High Income (HI)	11,200,000	2,000	5,600
Middle Income (MI)	1,560,000	2,000	750
Low Income (LI)**	600,000	2,000	240

Notes: *) The standard of working hours per year in Indonesia.
**) The minimum standard for per capita income is 480,000 (Rp.)

The estimation of population including the income shift in each group for 1988, is formulated below :

High Income Population :

$$P_{1n} = [P_{1n-1}(1+r_p)^{\Delta t} + \{(i/2) \text{ x } \Delta t\} P_{2n-1}]$$

n - 1 = base year in 1985

n = 1988

n+1 = 1998

P_{1n} = Total number of high income population in 1988.

P_{1n-1} = Total number of high income population in base year1985.

P_{2n-1} = Total number of middle income population in base year1985.

r_p = Average growth rate for population, 6 provinces.

Δt = Time differences (in this example t = 1988-1985)

i / 2 = Incremental shift to the next highest income group; it is assumed as half of the average rate of increase in income per capita.

Middle Income Population:

$$P_{2n} = [\ P_{2n-1}(1+r_p)^{\Delta t} + \{(i/2)\ \Delta t\ \}\ P_{3n-1}] - [\ \{(i/2)\Delta t\ \}\ P_{2n-1}\ ]$$

P_{2n} = Estimated total number of population in middle income group at year n.
P_{2n-1} = Total number of middle income population in base year 1985.
P_{3n-1} = Total number of low income population in base year 1985.

Low Income Population:

$$P_{3n} = [P_{3n-1}\ (1+r_p)^{\Delta t} - \{(i/2)\ x\ \ \Delta t\ \}\ P_{2n-1}]$$

P_{2n-1} = Total number of middle income population in base year 1985.
P_{3n} = Estimated total number of population from low income group in 1988.
P_{3n-1} = Total number of population from low income group in base year 1985.

***Third:* Estimation of the Trip Generation Rate**

The estimate for trip generation for 1988 and 1998 is based on the results from the first and second calculations cited above. At this stage, the estimated trip generation is computed for each group using the average elasticity of trips to income, and the expected trip rate.

B) MODAL SPLIT ANALYSIS :

To forecast the traffic distribution between Java and Sumatra by the various modal choices, a logit model was developed. The logit model used in this study will calculate the following: (1) the probability choice between existing and improved ferry, and (2) the probability choice between air transport and ferry transport.

The first model was adapted from a study by the Centre for Transportation Studies, at the University of British Columbia.[5/] This study used a logit model based on time difference. This model was extended in this thesis to incorporate generalized cost, since it was hypothesized that these costs were more important than time by itself.

[5/] *Doll, C.L., " A Model for Predicting Traffic on New Ferry Routes", Center for Transportation Studies University of British Columbia, 1975.*

In this thesis, the decision rule for each passenger is hypothezed that:

1) People choose the transport mode which results in the least expected time value and least generalized cost for the multiple trips from origin to destination.
2) There is a difference between the individual perception of time value cost and generalized cost.

Specifically this logit model represents the probability of choice between the existing ferry and improved ferry as a function of time value and the generalized cost difference between these two services. Mathematically this model is expressed as follows:

$$P_{improved} = \frac{1}{1 + \exp(a + b\,V_g + c\,\Delta GC_g)}$$

$P_{improved}$ = probability ratio of people who choose to travel by the improved ferry service to those who use the existing ferry service.

V_g = time value for each income group.

ΔGC_g = the difference for generalized cost using the improved ferry compare to the existing ferry.

The calibration of the logit function for the first model is shown in Chapter IV, Appendix B. The general shape of this model is shown at Figure 2.1.

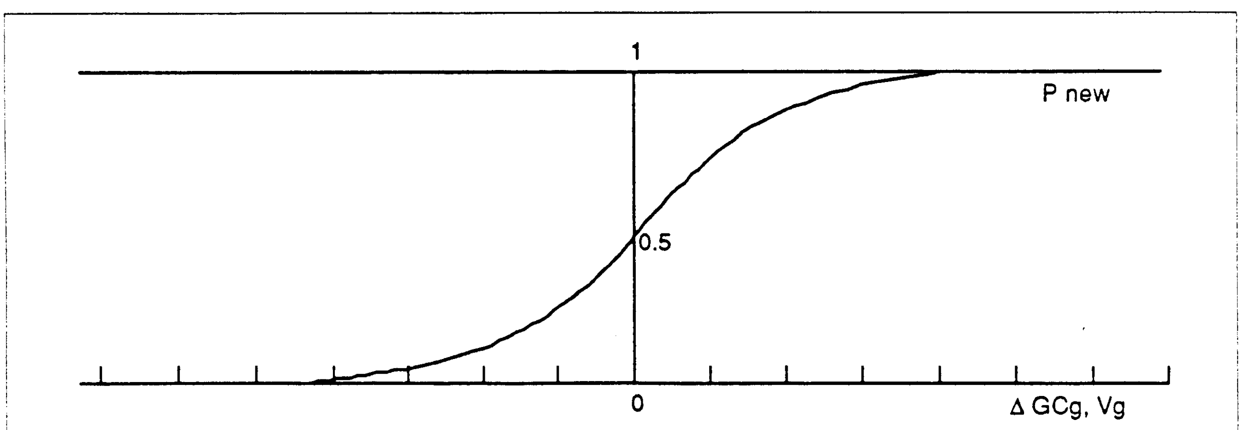


Figure2.1. General Shape of Logit Function

The second model was developed from the hypothesis that some of the high income people would shift from using air transport to the improved ferry, because the expected generalized cost for the improved ferry would be significantly less than the generalized cost for the air transport.

This second logit model represents the probability of choice between the improved ferry and the air transport. The structure of the model is slightly different from the first model in order to account for the larger difference in the range of generalized cost between the two modes. Also the mode uses a basic assumption that there is a proportion of high income people that travel by air in any case, and this is $(P_0) = 0.30$. Mathematically this model is expressed as:

$$P_{air} = \frac{1 - P_0}{1 + \exp(a + b\,V_g + c\,\Delta GC_g)} + P_0$$

P_0 = proportion of people from high income group who will travel by airway in any case.

P_{air} = proportion of people from high income travelling by air transport.

Both models are applied in Chapter IV and the calibration is shown in Appendix B.

2.4. Cost Analysis:

The demand analysis discussed above gives an estimated number of passengers for the improved ferry service in 1988 and 1998. This information provides the numbers for predicting how many craft are needed and what fare is required per passengerto cover costs plus profit.

The capital and operating cost information was adapted for hovercraft operation in Indonesia, taking into consideration the differences in labor cost, exchange rate, level of technology, and other economic and social conditions in Indonesia. The basic assumptions for such a cost analysis are:

1) Base currency for this calculation is the Indonesian Rupiah, with the rate of exchange being 1US$ = 1650 (Rp.), and 1 Pounds Sterling = 3,135 (Rp.)
2) Capital investment is funded with a private loan based on supplier credit; the interest rate is approximately 12 % per year.

A number of terms are used in this study to describe the different types of cost. The basic classifications of costs are: Capital Costs and Operating Costs (these two classifications are discussed in more detailed in Chapter V).

2.5. Impact Analysis:

The Trans-Sumatra highway has had a great impact on the social, economic and environmental development of Southern Sumatra and Java. A previous study conducted jointly by the OECF, the Mitsubishi Research Institute (MRI) and the Institute of Economic and Social Research Department of Economics of the University of Indonesia (LPEM) evaluated the potential impact of the Trans-Sumatra Highway on Southern Sumatra.

An improved link between the ports of Merak and Bakahuni is likely to have far reaching impact. This impact will be both direct and indirect in nature and will appreciably alter the economic, social and environmental status quo of Sumatra and Java. The direct impact will be examined in detail in Chapter IV and Chapter V. The indirect impact will constitute a secondary topic for this study, as it has been the subject of a previously detailed study conducted jointly by the OECF, MRI and LPEM [6/]. The relationship between the direct and indirect impacts as hypothesized in this thesis is shown in Figure 2.2. This chart is synthesized from two sources: (1) the OECF study of Trans-Sumatra Highway and (2) the Southeast Asian Agency for Regional Transport and Communication Development (SEATAC) final report [7/].

[6/] *LPEM-FEUI*, "Impact Study of Trans-Sumatera Highway", *Final Draft, 1985.*

[7/] *Louis Berger International Inc.*," Study of Transport Investment and Impact on Distribution of ncome in Remote Areas", *SEATAC Final Report, 1979.*

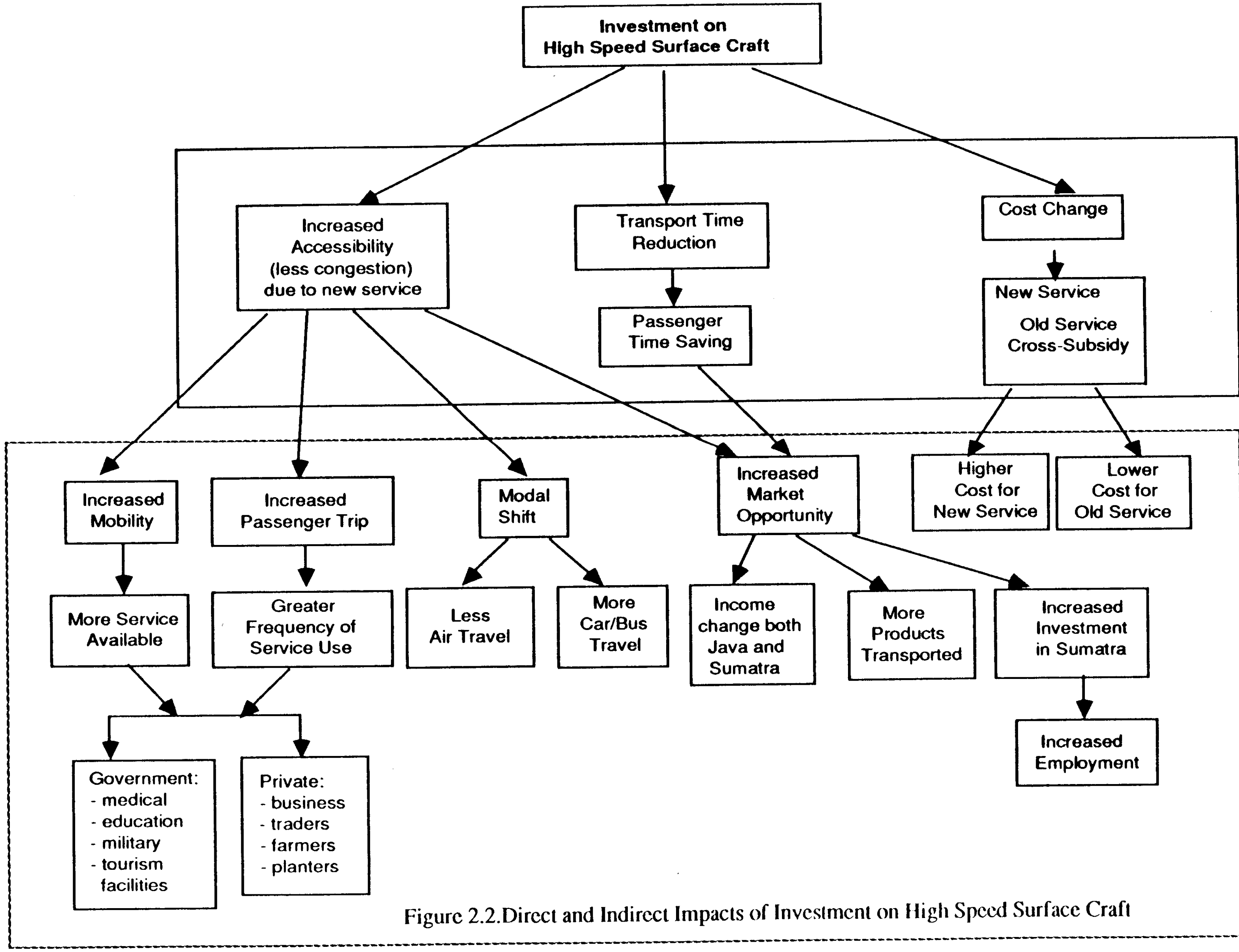


Figure 2.2.Direct and Indirect Impacts of Investment on High Speed Surface Craft

Chapter 3 CHARACTERISTICS AND COSTS OF HYDROFOIL AND HOVERCRAFT

3.1. Introduction to the Proposed Vehicles:

The objectives of this chapter are:

1) Introduction to the proposed high speed surface craft.
2) Presentation of data for:

A) operating characteristics
B) capital and operating costs
C) route characteristics of proposed hydrofoil and hovercraft (presented in sections 3.2. and 3.3.).

The scope of this research is restricted to those craft likely to be used in the Sunda Straits, assuming that these craft have a maximum speed of approximately 60 knots in calm waves (2 foot waves and 5 knots wind), a gross weight of less than 300 tons, and a maximum payload capacity of 60 cars and 400 passengers. This chapter will distinguish the characteristics of the two craft (hydrofoil and hovercraft) separately. The characteristics of each vehicle are described in three tables:

(Table 1) Craft Operating Characteristics.
(Table 2) Operating Costs.
(Table 3) Special Requirements (e.g., route characteristics, market characteristics, number of trips per day, number of operating days/year, fare per passenger).

Definition of Hydrofoil:

A hydrofoil is defined as a high speed surface craft that operates with its hull suspended above the surface of the water. In order to lift the hull out of the water, the hydrofoil utilizes small hydraulic lifting foils similar to an aircraft wing. The operation of a hydrofoil is shown in Figure 3.1.1.

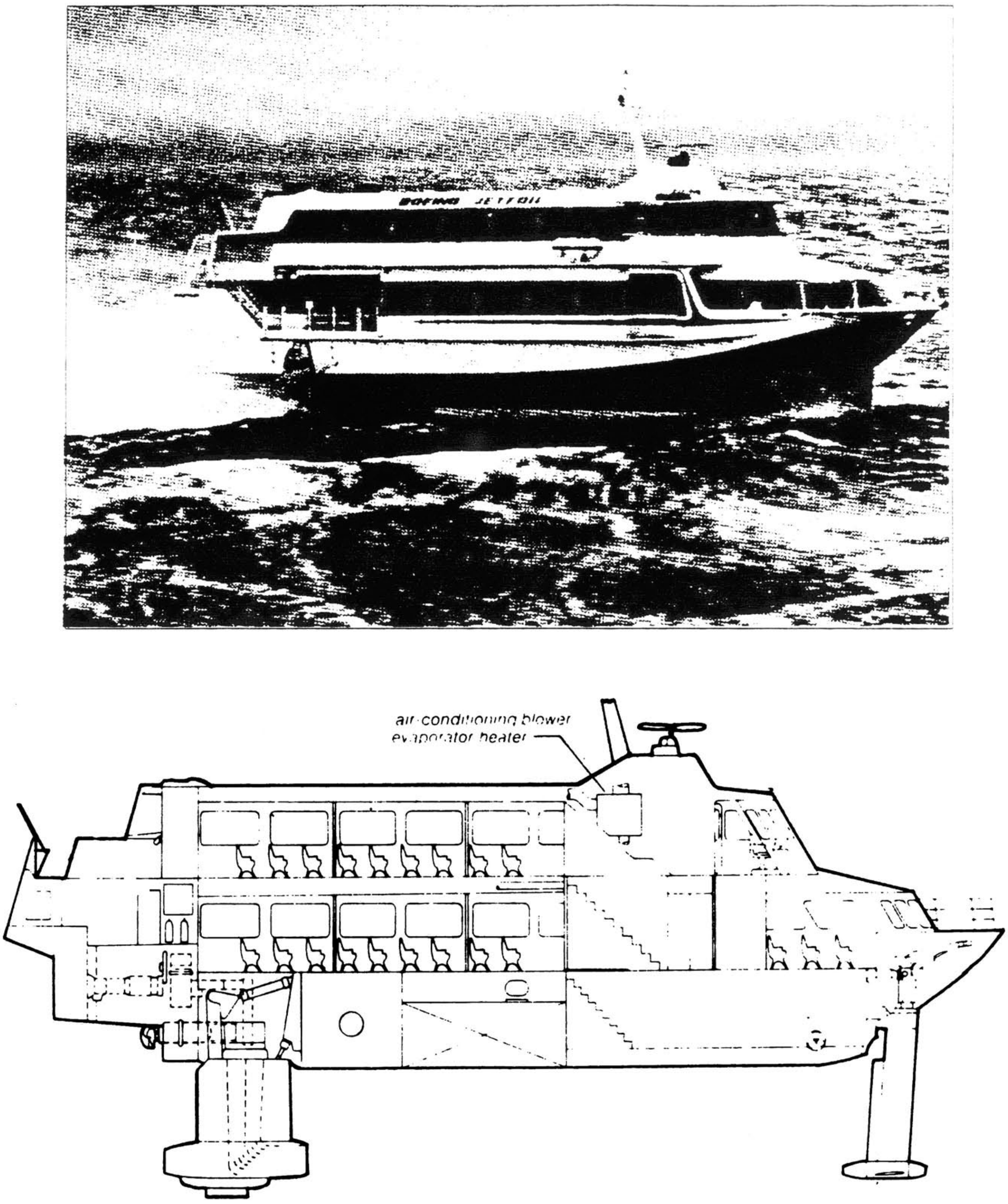
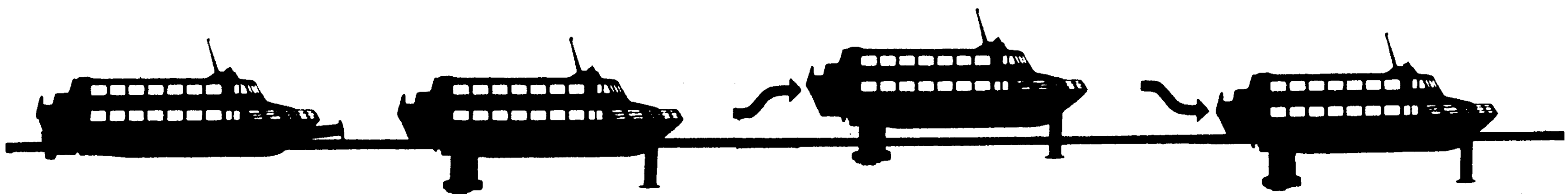


Figure 3.1.1. Boeing JETFOIL
Source: Boeing Marine Systems



Hullborne speeds of up to 10 knots (18.5 km/hr) can be achieved with the foils retracted.

With the foils extended in a hullborne mode, normal speed is 10 knots (18.5 km/hr), with up to 16 knots (30 km/hr) possible at higher power settings. The foils may be extended underway at normal hullborne speeds in 1 minute.

Once the foils are extended, the JETFOIL will accelerate to foilborne speed in less than 2 minutes. The bottom of the hull clears the water at approximately 25 knots (46 km/hr). Normal foilborne cruise speed is 43 knots (80 km/hr).

When foilborne, the JETFOIL banks into all turns so that there are no lateral forces on the passengers. Normal foilborne turn rates of up to 5 degrees per second are attainable, which provides a turn radius of less than 830 feet (254m) at 43 knots (80 km/hr).

Stops may be made in less than 500 feet (152m).

Figure 3.1.2. Outstanding Maneuverability of Hydrofoil in Congested Waters
Source : Boeing Marine Systems

Definition of Hovercraft:

A hovercraft is defined as a high speed surface craft capable of amphibious operation. The hovercraft "hovers" above the surface it is traversing, supported by a cushion of air. The operation of a hovercraft is shown in Figures 3.1.3. and 3.1.4.

A summary of the differences between the hovercraft and hydrofoil follows (shown in Figure 3.1.5.) :

1/ The hydrofoil achieves high speeds by utilizing small hydraulic foils to lift the hull out of the water, thus reducing hydraulic drag. While the hovercraft uses low pressure air to form an air cushion thus reducing hydraulic drag.

2/ The hydrofoil needs forward speed to develop lift, while the hovercraft can develop lift while stationary.

3/ The hydrofoil always operates in the water while the hovercraft has the ability to become an amphibious craft.

3.2. Characteristics and Operating Costs of Hydrofoil:

The information concerning the hydrofoil was compiled by using the example of the Boeing Jetfoil 929-119, operated by the Indonesian Shipping Company (PT Pelni) at Sunda Straits on the route from Jakarta (in Western Jawa) to Panjang (in Lampung, Southern Sumatera). Future construction of this type of hydrofoil has been planned as a joint venture between the Boeing Marine System (Division of the Boeing Company), the Indonesian Craft Assembling Industry (PT.PAL) and the Ministry of Research and Technology of Indonesia; but the implementation of this contract is still in process due to funding difficulties. The proposed Boeing Jetfoil 929-119 has an approximate speed of 45 knots/hour (83.4 km/hour), weighs 115 tons, and has the capacity to transport 255 passengers (without cargo).

There are advantages in using hydrofoils over the existing Merak-Bakahuni ferry service. First, the hydrofoil offers higher operating speed compare to the existing diesel ferry. Second, it has improved riding comfort for passengers. However, it should be noted that, the hydrofoil has two inherent disadvantages:

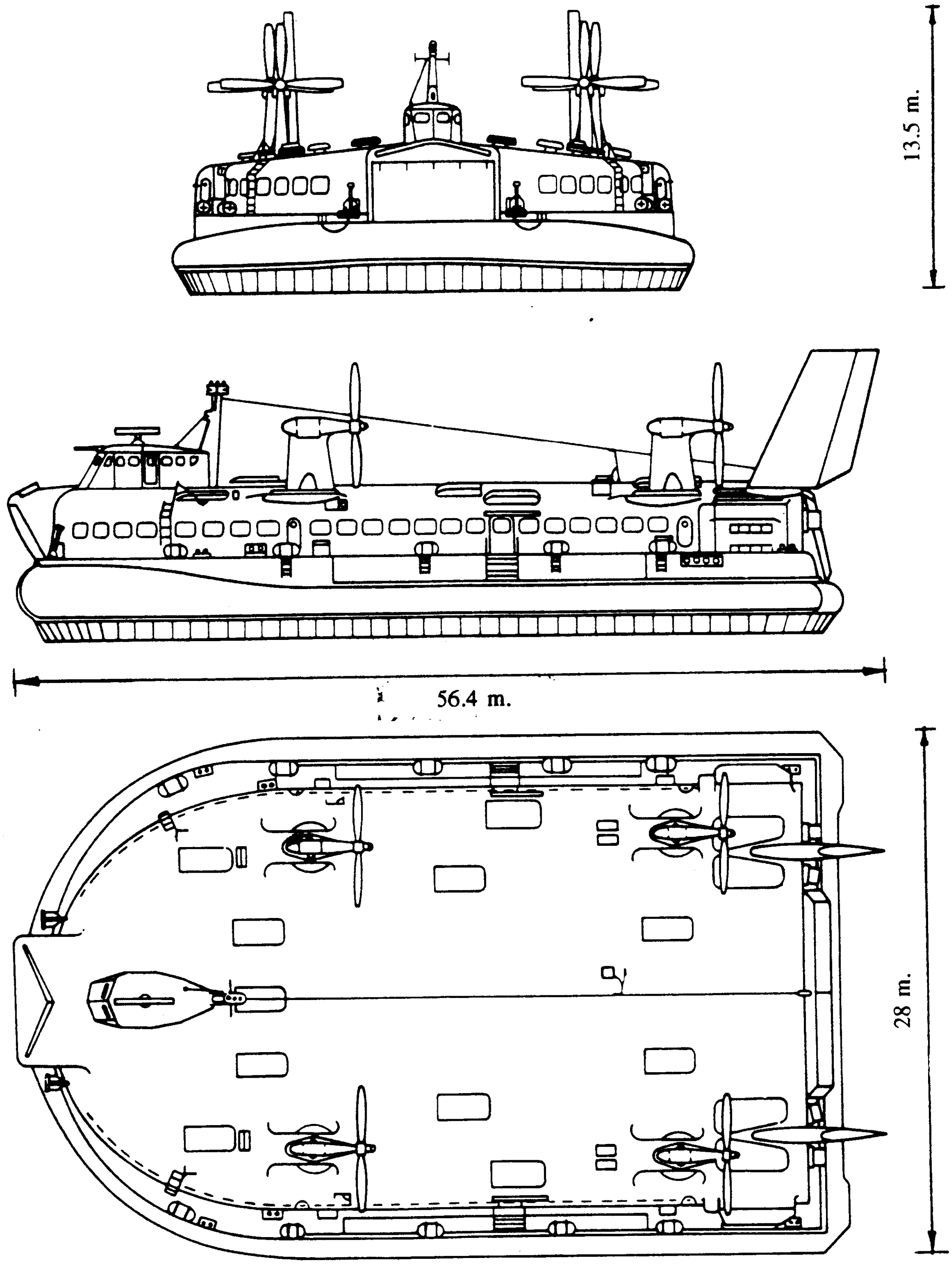


Figure 3.1.3. Amphybious Hovercraft Type SR.N4.
Source: *Air Cushion Vehicles for Use in Developing Countries,* United Nations 1979.

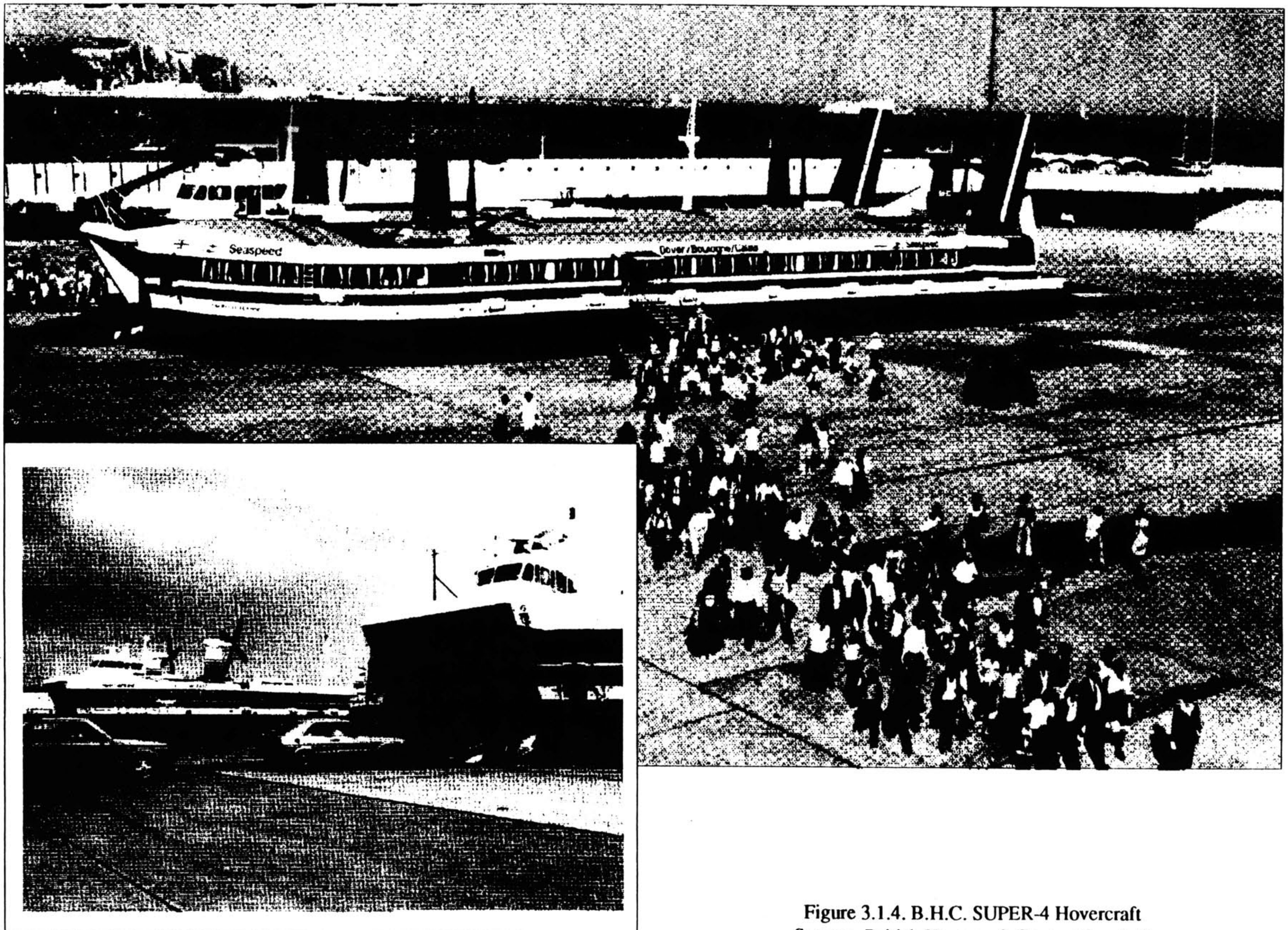


Figure 3.1.4. B.H.C. SUPER-4 Hovercraft
Source: British Hovercraft Corporation, Ltd.

- hydrofoil can carry passengers only
- hydrofoil cannot carry freight, in particular cars.

It should also be noted that most of the high income people who travel from Java to Sumatra use cars. Because of the hydrofoil inability to carry automobiles, travellers would need parking facilities for them. As a result, congestion would still occur in the ports if parking facilities at the port were not expanded.

The input information for hydrofoils is divided into three categories, and all of the calculations appear in Chapter V. There are basic assumptions made in these calculations, as follows:

- *Operating hours per year :*	1,752 hours (12 hours/day, 365 days/year, 40% capacity).
- *Operating days per year :*	365 days for hydrofoil and hovercraft.
- *Number of proposed craft for operation :*	2 craft.

All information concerning the proposed hydrofoil is presented in the following Tables.

Table 3.2.1
HYDROFOIL OPERATING CHARACTERISTICS

1) Expected annual fuel usage/craft	*1.5 million gallons*
2) Capacity/craft:	
a) Passengers (seats)	*255 seats*
b) Cargo (cars)	*0 cars*
3) Craft Size:	
a) Length	*27.4 m*
b) Width	*9.5 m*
c) Gross weight	*115 tons*
4) Loading and Unloading time per trip:	
a) Loading time	*15 min.*
b) Unloading time	*15 min.*
5) Crew members required per trip:	
a) captains	*1*
b) first officers	*1*
c) chief engineers	*1*
d) steward/stewardess	*5*

Source: Boeing Marine Systems.

Table 3.2.2.
HYDROFOIL CAPITAL AND OPERATING COSTS

1) Capital Cost per craft	*16,000 million (Rp)*
2) Annual Spare parts cost per craft	*800 million (Rp)*
3) Annual Maintenance cost	*4,160 million (Rp)*
4) Annual Insurance cost	*800 million (Rp)*

Source: Boeing Marine Systems.

Table3.2.3.
HYDROFOIL ROUTE CHARACTERISTICS

1) Route layout:	
- Distance	*37.5 km*
- Speed limit	*80 km/hour*
2) Terminal data:	
- Car parking areas	*300 spaces*
- Port charges / year	*400 million (Rp)*
3) Objective/Costs:	
- Number of trips per day	*12 trips*
- Vehicle life	*10 years*
- Salvage value	*8,000 million (Rp)*
4) Annual Administration costs	*320 million (Rp)*
5) Local conditions:	
- Fuel and oil per year	*3,000 million (Rp)*
- Crew cost per year	*960 million (Rp)*
6) Estimated Fares and Subsidies per person:	
- With government subsidy	*15,000 (Rp)*
- Without government subsidy	*25,000 (Rp)*

Source: Boeing Marine Systems.

3.3. Characteristics and Operating Costs of Hovercraft:

The information for hovercraft was compiled by using the example of SR.N4.Mk.II hovercraft which is owned by British Hovercraft Corporation Limited. The Cross-Channel commercial service for passengers and cars between Dover (England) and Boulogne (France) has operated since August 1968. In 1969, the service was expanded to include the ports of Dover (England) and Calais (France). The largest commercial hovercraft is the British Hovercraft Corporation's SR.N4.Mk.III (SUPER-4), which began service in July 1978 and is operated by Seaspeed Corporation and Hoverspeed Ltd. Its route runs between Dover, Boulogne and Calais.

The SR.N4.Mk.III (SUPER-4) craft are some 16 m longer than the SR.N4.Mk.II, and have 60% more car capacity and 50% more seats. However, these increases in payload also caused a 15% increase in craft operating costs. The information about thesetwo types of hovercraft is described in the three categories that follows.

Table 3.3.1.
<u>HOVERCRAFT OPERATING CHARACTERISTICS</u>

	SR.N4.Mk.II	SR.N4.MK.III.
1) Expected fuel usage per year	*1.5 ml.gallon*	*1.7 ml.gallon*
2) Capacity:		
a) Seats (passengers)	*280 seats*	*416 seats*
b) Cargo (cars)	*40 cars*	*60 cars*
3) Craft size:		
a) Length	*40 meter*	*56 meter*
b) Width	*24 meter*	*28 meter*
c) Gross Weight	*200 tons*	*300 tons*
4) Miscellaneous characteristics:		
a) Loading time	*15 min.*	*15 min.*
b) Unloading time	*15 min.*	*15 min.*
5) Crew members required per trip:		
a) Captain	*1*	*1*
b) Officers	*1*	*2*
c) Chief Engineer	*1*	*1*
d) Steward/Stewardess	*5*	*8*
e) Car-deck Crews	*3*	*5*

Source: British Hovercraft Corporation, Ltd.

Table3.3.2.
HOVERCRAFT CAPITAL AND OPERATING COSTS

	SR.N4.Mk.II	SR.N4.MK.III.
1) Cost per craft	*108,000 million (Rp)*	*141,000 million (Rp)*
2) Annual Spares Cost	*2,000 million (Rp)*	*2,636 million (Rp)*
3) Annual Maintenance Cost	*1,000 million (Rp)*	*1,500 million (Rp)*
4) Annual Insurance Costs	*100,000 (Rp)*	*152,000 (Rp)*

Source: Hoverspeed Limited

Table 3.3.3.
HOVERCRAFT ROUTE CHARACTERISTICS

	SR.N4.Mk.II	SR.N4.MK.III.
1) Route layout:		
a) Distance	*37.5 km*	*37.5 km*
b) Speed Limit	*120 km/hour*	*120 km/hour*
2) Terminal Data:		
a) Car Parking Area	*200 spaces*	*200 spaces*
b) Port Charges per year	*135 million (Rp)*	*135 million (Rp)*
3) Objective / Costs		
a) Number of Trips	*12 trips*	*12 trips*
b) Vehicle life years	*10 years*	*10 years*
c) Salvage Value	*26,000 million (Rp)*	*34,000 million (Rp)*
4) Administration Cost	*6,500million (Rp)*	*7,000 million (Rp)*
5) Local Conditions:		
a) Fuel and Oil Costs/year	*5,000 million (Rp)*	*6,000 million (Rp)*
b) Crew Cost/year	*200 million (Rp)*	*288 million (Rp)*
6) Fares and Subsidies:		
a) Fares with Subsidy	*15,000 (Rp)*	*15,000 (Rp)*
b) Fares without Subsidy	*25,000 (Rp)*	*30,000 (Rp)*
c) Fare per car	*45,000 (Rp)*	*90,000 (Rp)*
d) Fare per tonnage cargo	*50,000 (Rp)*	*50,000 (Rp)*

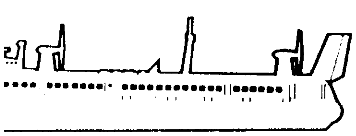
Source: Hoverspeed Limited

C SRN4 Mk.3 SUPER 4

4 is the largest commercial hover- n the world. Designed and built by at Cowes, the first Super 4 came rvice in July 1978 and is operated speed on its route between Dover, gne and Calais. The second Super red service y 1979. The craft are some 16 m) longer than the SRN4 Mk.2 de- and have 60% more car capacity)% more seats. These increases in ad are achieved with only a 15% ses in the craft operating costs and only an extra 1600 shp. Large ter propellers and a skirt system of rgest design has brought to Super ater seakeeping ability and im- d levels of passenger comfort.

h Overall 56m (185 ft)
Overall (skirt inflated) 28 m
)
weight 305.5 tonnes (300

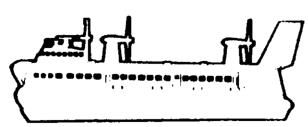
e speed (over calm water)
ots
led Power 15,200 shp.
city 418 passengers, 56 cars



BHC SRN4 Mk.2

Manufactured by British Hovercraft Corporation at East Cowes, there are presently four craft of this type in operation. They are all used by Hoverlloyd Limited on its Ramsgate/Calais services. Modified from the earlier SRN4 design, the Mk.2 craft features wider passenger cabins, greater car capacity and more passenger seats than the Mk.1. Loading of cars is achieved through bow and stern doors that give access to the central car deck which runs the length of the craft. Passengers enter and leave via doors on each side of the craft.

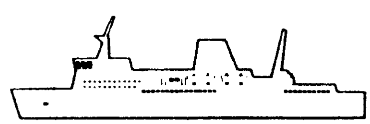
Length Overall 40 m (130 ft)
Beam Overall (skirt inflated) 25 m (82 ft)
All-up weight 203 tonnes (200 tons)
Service speed (over calm water) 65 knots
Installed Power 13,600 shp.
Capacity
280 passengers, 37 cars



Cross-Channel Car Ferry Ships

The latest designs of cross-Channel car ferry ships are capable of carrying large numbers of passengers and their cars, together with heavy commercial lorries and trailers. Vehicles are accommodated in car decks which often feature mezzanine or "wing" levels for cars requiring low headroom. All cars and lorries are usually loaded or unloaded via a single or multi-level linkspan bridge, with some ships having additional side loading ramps.

Length Overall 130-145 m (430-475 ft)
Beam Overall (skirt inflated) 21-23 m (70-75 ft)
Draught, normal 4.5-5 m (15-17 ft)
Gross Tonnage 5000-6000 tons
Service speed 19-21 knots
Installed Power 14,000-18,000 shp.
Capacity 1000-1300 passengers, 300-350 cars



Hydrofoils

The Boeing Jetfoil is a U.S.-de and built hydrofoil boat which i with a fully submerged canard fo tem. This system incorporates v sophisticated control and motio ing equipment and is designed vide the hydrofoil with a smoot None of the Jetfoil designs cu available can carry cars. The tw which has been produced - the 9 and 929-115 - are both intend commercial ferry operation al they owe certain of their featu Boeing's earlier work on military foils for the U.S. Navy.

Length Overall (foils extended) m (90 ft)
Beam Overall (maximum) 9.5 ft 2 ins)
Draught:
- foils retracted 1.7 m (5 ft 7 ins
- foils extended 5.2 m (17 ft 10
Displacement 116 tonnes (115
Cruise/Normal Service Speed 4 knot.
Installed Power 6,600 hp
Passenger Capacity 190-300 de ing upon seating arrangement a onboard facilities.

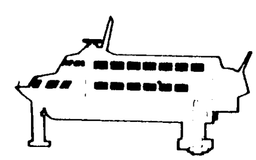


Figure 3.1.5. The Differences between Hydrofoil and Hovercraft.
Source : British Hovercraft Corporation, Ltd.

Chapter 4 THE DEMAND ANALYSIS

4.1. HISTORICAL BACKGROUND IN TRAFFIC:

The ferry boats connecting Merak and Bakahuni were put into service in 1980, started transporting people after the opening of Bakahuni Port in 1981. The opening of this ferry service created an increase in traffic, especially for passenger and cargo using this service. This increase shows that the improvement of the transportation facility connecting Java and Sumatra plays an essential role in the mobility of people and freight.

According to the OECF study, the total number of passenger trips by ferry boat increased by an average of 17.4 % per annum from 1981 to 1984 (Table 4.1.1). In contrast, the total number of air passenger trips decreased by 7.8 % per annum during that period of time.

Table 4.1.1
TOTAL NUMBER OF PASSENGERS AND
ANNUAL GROWTH (1981-1984/85)

Year	Air Pass.	Ferry Pass.	Total Pass.	Annual Growth (%)		
				Air Pass	Ferry Pass.	Total Pass.
1981	686,220	2,338,420	3,024,640			
				-12.0%	12.9%	7.3%
1982	603,715	2,640,393	3,244,103			
				-13.8%	31.2%	22.8%
1983	520,582	3,463,713	3,984,295			
				3.5%	9.3%	8.5%
1984	538,582	3,785,043	4,323,599			
				n.a.	2.8%	n.a.
1985	n.a.	3,890,221	n.a.			
Avg. Annual Growth Rate (1981-1984)	*-7.8%*	*17.4%*	*12.6%*			

Source: OECF Japan, The Impact Study of Trans-Sumatra Highway, 1985.

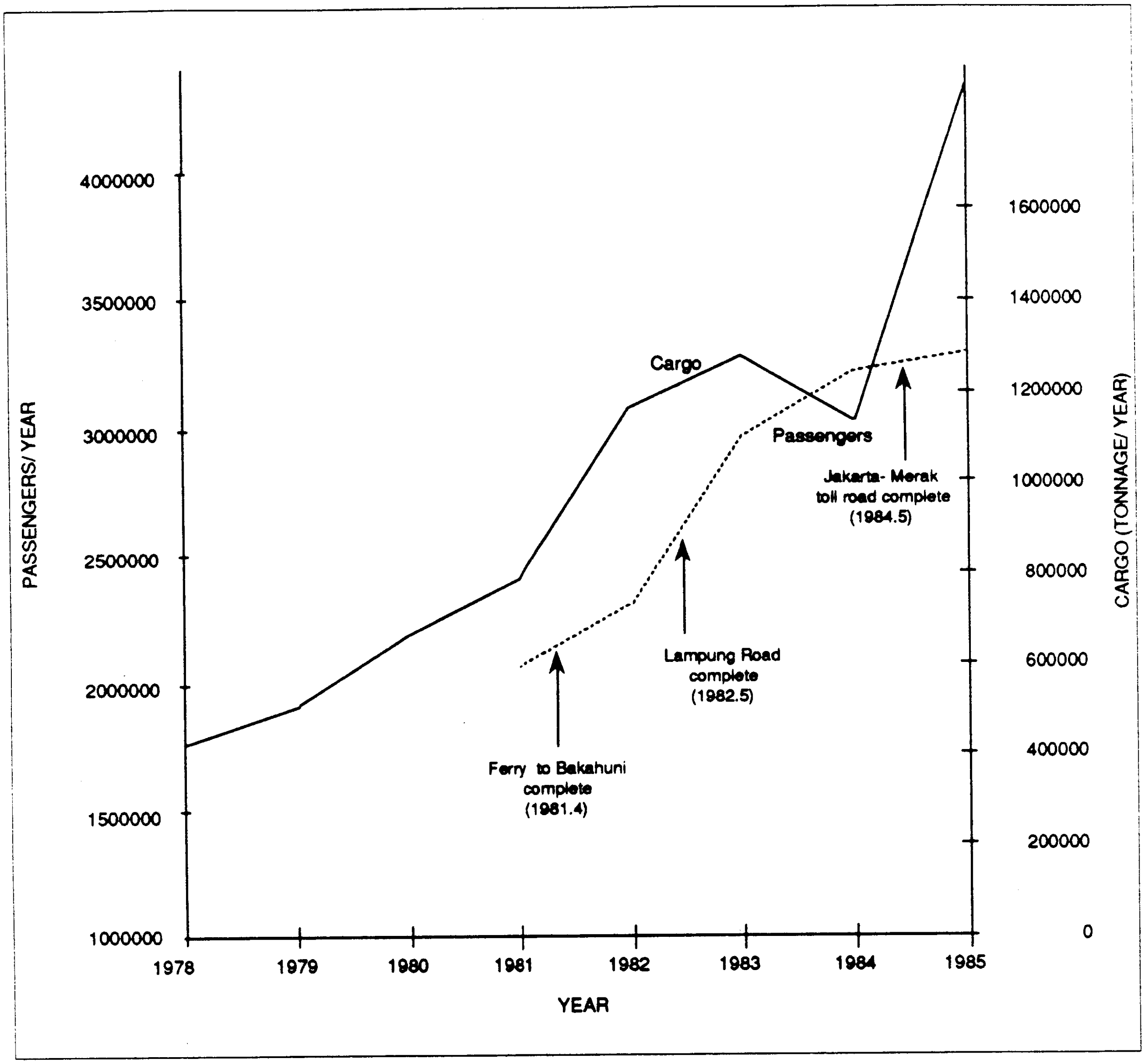


Figure 4. 1.1. Flow of Passengers and Cargo between Java and Sumatra.
Source: Table 4.1.1.

The decreasing number of air passengers and the increasing number of ferry passengers from 1981 to 1983 is significantly related because the air passengers probably diverted to the ferry after the opening of Merak-Bakahuni service.

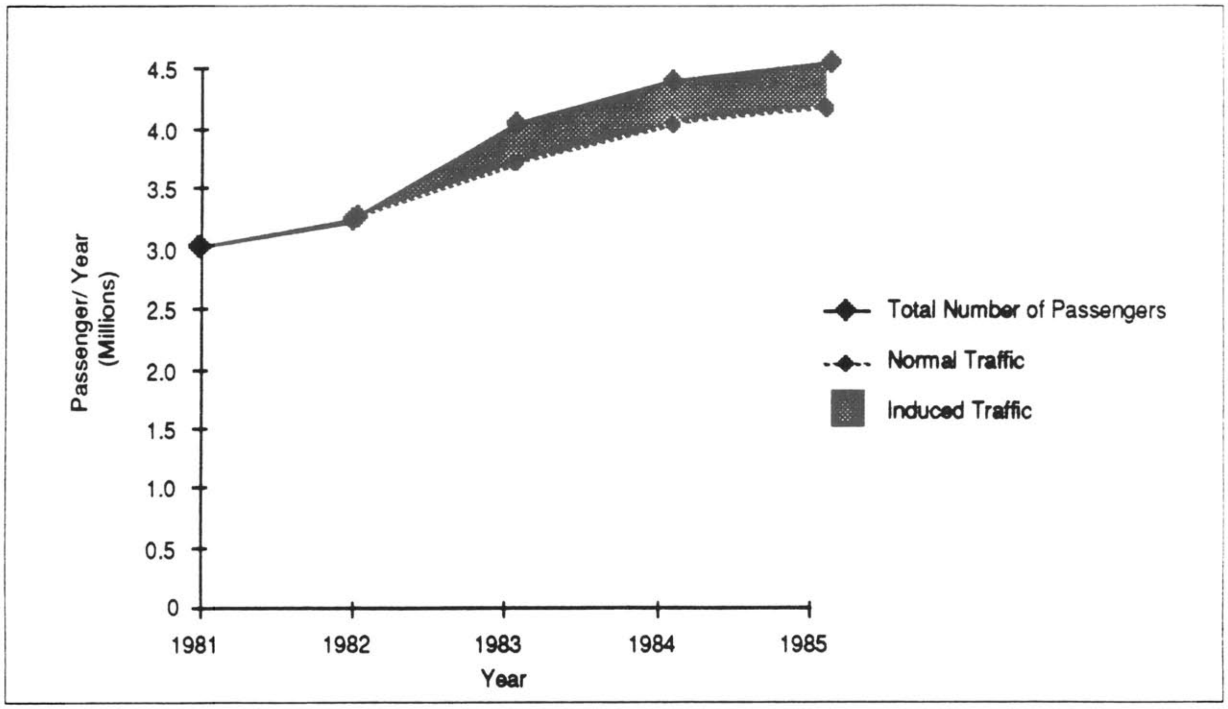


Figure 4.1.2. Total Number of Passengers 1981-1985
Source: Table 4.1.1.

There was also a significant increase in the total number of passengers, especially during the period 1982 - 1983. This represents traffic induced by both the completion of Trans-Sumatra highway and the opening of ferry service to Bakahuni. As shown in Figure 4.1.1., the big jump in this period was caused by the completion of Lampung road in Southern Sumatra. As a result, the total traffic between Java and Sumatra has had two different rates of growth from 1981-1984, which is shown in Figure 4.1.2. above.

Normal traffic growth appears in 1981-1982 and 1983-1985, while the big increase during the years 1982-1983 was caused by the special events explained above. Therefore, in this period, the growth is assumed normal growth plus induced traffic growth. The normal trip growth between Java and Sumatra would be the average of annual growth rate in 1981-1982 and 1983-1985 (approximately 8%). The induced traffic shown in Figure 4.1.2. represents 14.8% of normal traffic.

4.2. ESTIMATING FERRY TRAFFIC BY GROUND TRANSPORTATION MODES:

The information for ground transportation is divided into four categories :

1) ferry and car
2) ferry and bus
3) ferry and rail
4) ferry and truck

The study conducted by the OECF shows that the traffic volume between Jawa and Sumatera increased at an annual rate of 13.6 percent for passengers and 56.8 percent for vehicles from 1981 to 1985 (Table 4.2.1.).

Detailed information concerning the types of vehicles transported by the existing ferry was not available for the OECF study. An estimation based on the Annual Average Daily Traffic (AADT) was used as an approach to break down the total number of vehicles using the ferry by type (Table 4.2.2 and Table 4.2.3).

Table 4.2.1.
TRAFFIC VOLUME OF THE EXISTING FERRY

Year	Passengers	Vehicles
1981	2,338,420	80,472
1982	2,640,393	210,333
1983	3,463,713	336,912
1984	3,785,043	410,605
1985	3,890,221	485,910

Source: OCS, Lampung Transportation Studies, 1985.
Note: Passengers are all persons who purchase a ticket.

Table 4.2.2.
ANNUAL AVERAGE DAILY TRAFFIC (AADT)
TRAFFIC VOLUME BY TYPE OF VEHICLE
1985

Section	Car	Bus	Truck	Total
Jakarta-Merak	6,945	1,475	3,705	12,125
Bakahuni-Telukbetung	2,594	335	1,614	4,543
Total	9,539	1,810	5,319	16,668
Percentage of Total Vehicles	*57.2 %*	*10.9 %*	*31.9 %*	*100 %*

Source: OECF Japan, The Impact Study of Southern Sumatra Trunk Road, 1985.

The information for railway passengers is shown in Table 4.2.3. below. All of these passengers used the existing ferry service to travel between Java and Sumatra because it is the only transportation means that crosses the Sunda Straits at this point.

Table 4.2.3.
RAILWAY PASSENGERS
JAKARTA-TANJUNGKARANG

Year	Railway Passengers
1981	1,645,677
1982	1,498,228
1983	1,334,090
1984	1,329,648
1985	1,330,000*

Source: OCS, Lampung Transportation Studies, 1985.
* Estimated number for railway passengers in 1985 (no growth from 1984)

The total passenger-trips on the existing ferry by vehicle type for 1985 are estimated as shown in Table 4.2.4.

Table 4.2.4.
PASSENGER TRIPS BY TYPE OF VEHICLE
1985

(1) Types of passenger trips	(2) Number of vehicles on ferry	(3) Percentage number of vehicles	(4) Number of persons in a vehicle	(5) Total number of passengers
Ferry and car	278,083	57.2 %	3	834,249
Ferry and bus	52,766	10.9 %	16	844,256
Ferry and truck	155,061	31.9 %	2	310,122
Ferry (on-foot pass.)				571,594
Ferry and rail				1,330,000
Total ferry traffic	485,910	100 %		3,890,221

Source: (2) Total vehicles multiplied by proportion from Table 4.2.2.
(3) Average from the OECF Impact Study of Southern Sumatra Trunk Road, 1985.
(4) Assumptions that used at the OECF study.
(5) Column (2) multiplied by column (4), except that on-foot passengers are total ferry traffic less 'ferry and car', less 'ferry and bus', less 'ferry and truck' and less 'ferry and rail' passengers.

4.3. TRIP GENERATION:

The operation of improved ferry service will influence passengers' choice concerning the transport mode they use. The trip generation estimate is calculated into three stages:

i) Estimate Passenger-Trips by mode and income group in 1985.
ii) Forecast Population by Income Group.
iii) Forecast of Trip Rate and Total Trips.

i) Estimate Passenger Trips by Mode and Income Group in 1985:

The expected total number of passenger trips between Java and Sumatra is broken down into three income groups (the assumption of percentage trip made by the population in a certain income group is explained in Chapter II). The total number of passenger trips by income group is a basic way of estimating the trip rate and the total trip explained in next section. The results of estimating the passenger trips between Java and Sumatra is shown at Table 4.3.1.

Table 4.3.1.
PASSENGER TRIPS BETWEEN JAVA AND SUMATRA
AVERAGE ANNUAL PERCENTAGE BY INCOME GROUP

	1985	Trips by High Incon	(%)	Trips by Mid. Incom	(%)	Trips by Low Income	(%)
Ferry and car	834,249	333,700 39%	40%	458,837 21%	55%	41,172 3%	5%
Ferry and bus	844,256	84,426 10%	10%	548,766 26%	65%	211,064 14%	25%
Ferry and rail	1,330,000 *	0 0%	0%	731,500 34%	55%	598,500 41%	45%
On-foot passenge	881,716 **	0 0%	0%	264,515 12%	30%	617,201 42%	70%
Air passenger	582,000 ***	436,500 51%	75%	139,680 7%	24%	5,820 0%	1%
Total	4,472,221	854,625 100%	19%	2,143,298 100%	48%	1,474,298 100%	33%

Assumptions:
* Estimated to be the same as in 1984.
** Derived from the total ferry passengers.
*** Estimated from 1984 or 1985 with 8 % growth rate.

Source: Derived from Appendix C

ii) **Forecast of Population by Income Group:**

In order to forecast the population in 1988 and 1998 based on population data available in 1985, certain assumptions must be made concerning the shift in the population between income groups. The shift in population between income groups comes as a result of an increase in per capita income, as described in Chapter II.

The estimated population by income group in 1988 and 1998 is shown at Table 4.3.2. below :

Table 4.3.2.
ESTIMATED POPULATION BY INCOME GROUP
1985, 1988,1998 (in thousands)

Year	High Income Population	Middle Income Population	Low Income Population
1985	7,455	23,987	20,682
1988	9,446	26,417	21,695
1998	17,310	32,743	26,348

Source: Derived from Appendix C.

The result of the estimated population by income group was used for the next calculation in forecasting the trip rate and the total trip by income group (as shown in Appendix C.).

iii) **Estimation of Trip Rate and Total Trips:**

The trip rate is computed by using the income elasticity of trips . This elasticity was estimated from the average annual growth of total passenger trips (8 percent) using the generalized gravity model. The resulting elasticity of trips with respect to income is 1.08.

The trip rate for each income group was calculated by multiplying the income elasticity of trips times the growth in income (g_{inc}) as a percent for each group, and using the formula as given in Chapter II to factor up the base year trip generation rate to future years. The results are shown in Table 4.3.3.

Table 4.3.3.
ESTIMATED TRIP RATE BY INCOME GROUP
1985, 1988,1998 (in thousands)

Year	High Income Population	Middle Income Population	Low Income Population
1985	115	89	71
1988	126	98	79
1998	175	136	109

Source: Derived from Appendix C.

The expected total trips for 1988 and 1998 are calculated from the estimated trip rates multiplied by the total number of people. This expected total trips will be used in determining the fare per passenger, shown in table 4.3.4. (it will be discussed later at Chapter V).

Table 4.3.4
ESTIMATED TOTAL TRIPS BY INCOME GROUP
1985, 1988,1998 (in thousands)

Year	High Income Population	Middle Income Population	Low Income Population
1985	855	2,143	1,474
1988	1,193	2,601	1,704
1998	3,023	4,457	2,861

Source: Derived from Appendix C.

4.3. TRIP FORECAST BY MODE.

As explained in the methodology (Chapter II), the demand model that is used in this study is divided into two logit models . These are the logit model as a function of value of time and the difference of generalized cost. The difference in generalized cost is presented at Table 4.3.1. and 4.3.2. The results of this calculation is a probability ratio for the expected number of people using the improved service compared to the expected number of people using the existing ferry service (the result is shown in Table 4.3.3.). The results from callibration demand model are presented as follows:

$$P_{air} = \frac{1 - 0.141}{[1 + \exp(1.177 - 0.000283\, V_g - 0.0000256\, \Delta GC_g)]} + 0.141$$

$$P_{new} = \frac{1}{[1 + \exp(1.177 - 0.000283\, V_g - 0.0000256\, \Delta GC_g)]}$$

Vg = Time value for each income group
ΔGCg = Difference of generalized cost for each income group

The modal split between air service and ground transportation service (using the Merak-Bakahuni ferry service is considered for the high income trips only (as described in Chapter II). The trips for middle income and low income people are split between the existing and the improved ferry service. The probability of choice between these services are shown at the following tree diagrams (Figures 4.3.1., 4.3.2., 4.3.3.).

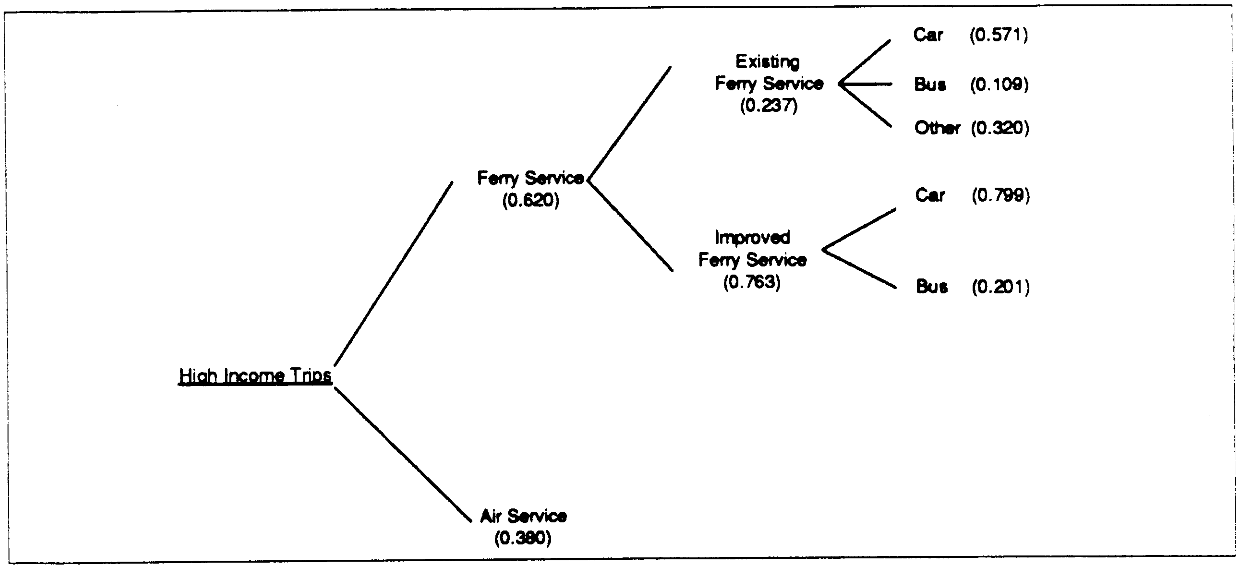


Figure 4.3.1. Tree Diagram for Trips by High Income: Base Case

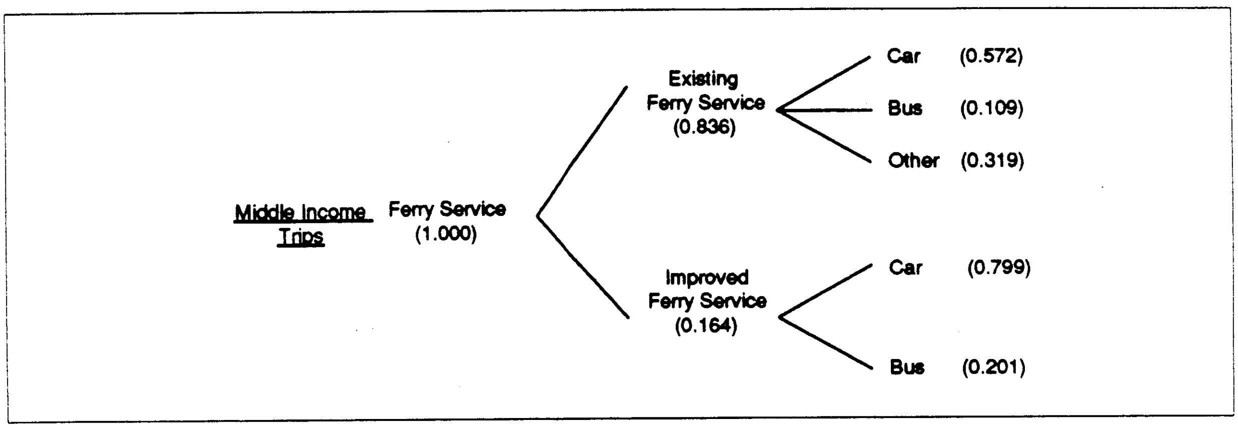


Figure 4.3.2. Tree Diagram for Trips by Middle Income: Base Case.

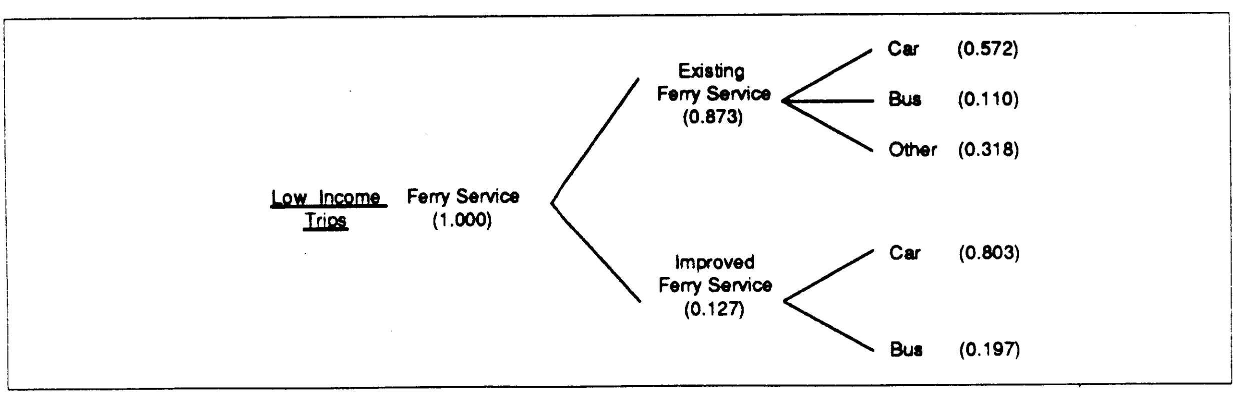


Figure 4.3.3. Tree Diagram for Trips by Low Income : Base Case.

The results of the probability choice above is shown at the following table as a forecast of total number of passenger trips by income group (Table 4.3.5.).

Table 4.3.5.
TRIP FORECAST AS A PERCENTAGE AND NUMBER OF PASSENGERS FROM THE TOTAL TRIPS

PERCENTAGE FROM THE TOTAL TRIPS

Total Trips in 1985	Air Service	Ferry Service	Old Service Car	Old Service Bus	Old Service Other	Total Old Service	New Service Car	New Service Bus	Total New Service
High Income	0.365	0.635	0.086	0.016	0.048	0.151	0.387	0.097	0.484
Middle Income	0	1	0.493	0.094	0.275	0.861	0.111	0.028	0.139
Low Income	0	1	0.512	0.098	0.285	0.895	0.084	0.02	0.105

NUMBER OF PASSENGERS (in thousands)

Total Trips in 1988	Air Service	Ferry Service	Old Service Car	Old Service Bus	Old Service Other	Total Old Service	New Service Car	New Service Bus	Total New Service
High Income	453	788	107	20	60	187	480	120	600
Middle Income	0	2,677	1,319	251	735	2,305	297	74	371
Low Income	0	1,751	896	171	500	1,567	148	35	184
Total Passengers	453	5,216	2,322	443	1,295	4,060	925	229	1,154

NUMBER OF PASSENGERS (in thousands)

Total Trips in 1998	Air Service	Ferry Service	Old Service Car	Old Service Bus	Old Service Other	Total Old Service	New Service Car	New Service Bus	Total New Service
High Income	1,088	1,892	258	49	144	450	1,153	288	1,442
Middle Income	0	4,807	2,368	451	1,321	4,140	534	133	667
Low Income	0	3,080	1,576	300	879	2,755	259	62	324
Total Passengers	1,088	9,779	4,202	801	2,343	7,346	1,946	484	2,433

Source: Derived from Appendix A, Appendix B and Appendix C.

Chapter 5 PRELIMINARY COST ANALYSIS

5.1. GENERAL DESCRIPTION:

This analysis includes two computational sections. The first section is a preliminary calculation for annual capital cost analysis and annual operating cost analysis. The second section is the financial evaluation for hovercraft operation on the Merak to Bakahuni route. The calculation of cost elements which will be described in the first section includes the definition and method of measurement for each of the cost-item. At the end of this section an annual operating costs statements with six iterations will be presented along with financial analysis.

In the financial evaluation the passenger, car and minibus fares will be calculated using the results of the demand analysis found in chapter five and the results from section 5.2. (total operating costs per passenger-seat and total operating costs per passenger-km).

5.2. CALCULATION OF COST ELEMENTS:

The calculation of cost elements is divided into two parts :

i) Capital Costs
ii) Operating Costs

i) Capital Costs:

Capital costs include the capital cost for hovercraft and the capital cost for terminal modification.

The capital cost for hovercraft:

The total capital cost of the craft include the procurement cost of the hovercraft, the maintenance equipment cost, the capital recovery cost and the annualized engine overhaul cost.

The procurement cost of the hovercraft is established by the manufacturer and will depend on the number of craft purchased. In this study, it is assumed that the procurement cost will include all delivery costs. It should be emphasized that these costs are estimated on the basis of "approximate costs of craft designed and manufactured by the British Hovercraft Company, England". Table 5.1.1. presents the estimated procurement costs of the proposed craft designed for this study.

Table 5.1.1.
PROCUREMENT COST OF HOVERCRAFT
TYPE SR.N4.MK.III (SUPER 4)
(includes the equipment)
(in Million Rupiah)

Year	Number of Craft	Operating Hours	Procurement Costs
1988	2	2803	282,150
1998	4	5606	564,300

Source: British Hovercraft Corporation, Ltd.

The capital cost for the terminal modification:

It will be necessary to modify the terminals at both ports for hovercraft operation. The study of terminal facilities for passenger hovercraft need to be more detailed, because when selecting a site and designing the terminal lay-out, consideration should be given to future expansion in fleet size. Each terminal must be unique to its particular site. The addition of a terminal facility should include the following features [1/]:

1/ A ramp of no less than 90 m (300 ft) wide, preferably with an incline not greater than 1:15. Concrete is recommended, and should be sufficiently thick so as to withstand a load of 60 tons imposed by each of the craft's seven 155 lb / in^2 (33 in. diameter) landing pads.

2/ A hard landing area built of concrete at least (90 m) deep, and wide enough to accomo date the maximum number of craft expected to occupy the terminal at the same time, while leaving room for easy manouvering. In the area of the ramp crest, the concrete should be capable of withstanding 3-pad loads of 150 tons each (390 lb/in^2).

3/ Maintenance area for craft, incorporating craft lifting jacks.

4/ Separate parking areas for vehicles awaiting embarkation, and non-travelling vehicles.

5/ Convenient exit facilities.

6/ Ticketing and check-in facilities.

7/ Administration offices.

[1/] *British Hovercraft Corporation Ltd., "Pre-operational Guide to the BHC.Super-4 Hovercraft", England, 1978.*

Illustration of the terminal lay-out is shown in Figure 5.2.1.

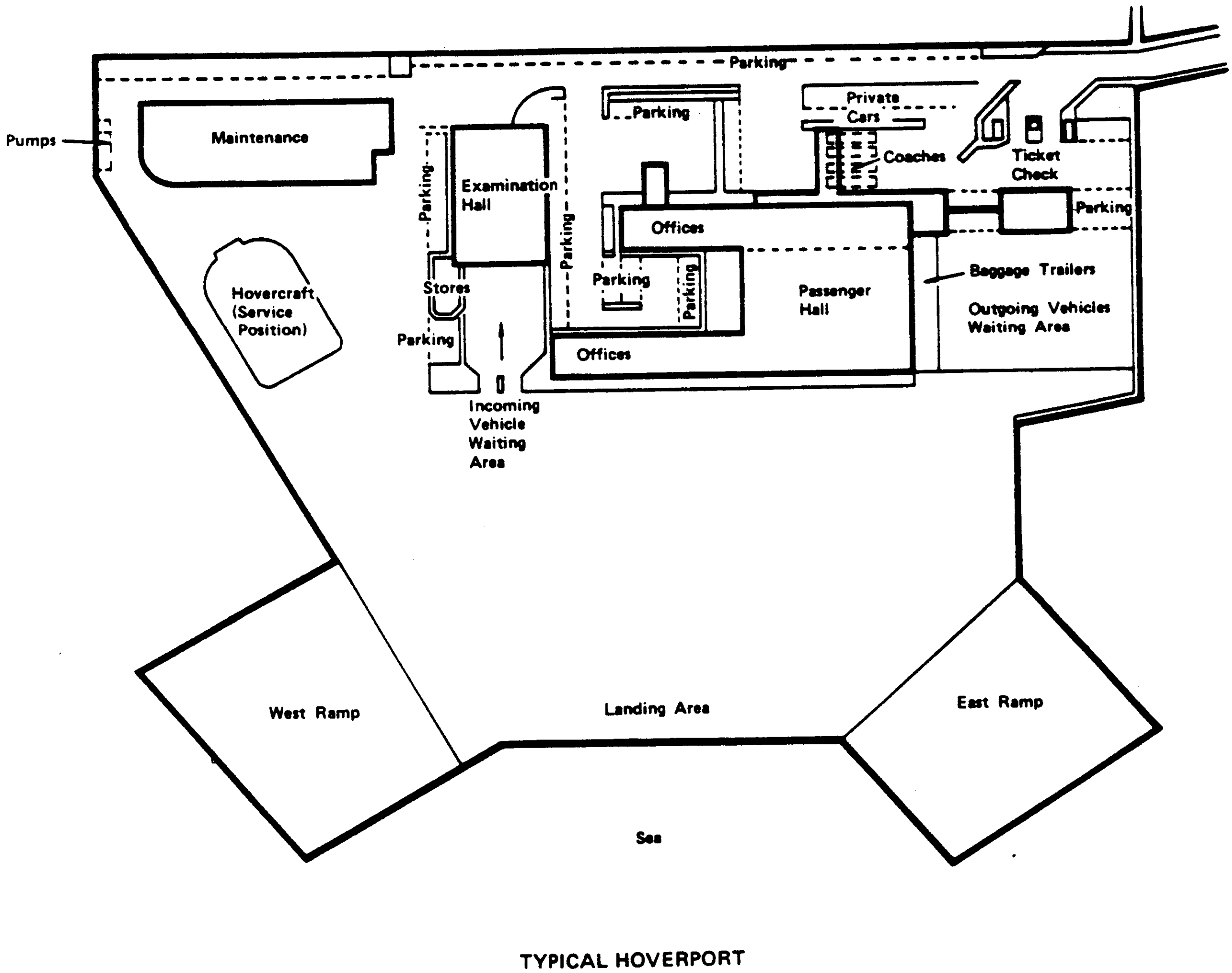


Figure 5.2.1. Hovercraft Terminal Layout
Source: *Air-Cushion Vehicles for Use in Developing Countries*, U.N. 1979.

The proportion of total annual costs devoted to terminals is lower than the hovercraft procurement costs. These terminal facilities are approximated at 18.8% of the total capital costs in 1988. For the operation of the proposed hovercraft (in 1998), the terminal needs expansion, especially in the area of landing pads and passenger waiting rooms. Therefore the estimated terminal costs for base case in 1998 increase approximately 50% compared to the terminal costs in 1988.

The procurement and terminal facilities costs constitute a large proportion of the total cost. The technique chosen to analyze the procurement and terminal facilities costs uses the annual capital recovery cost method with interest of 12%. This method is the most common way of presenting the annual charge of capital expenditure. To obtain an annual charge, the capital expenditure is multiplied by the capital recovery factor. This charge is the same for all the years of study.

The engine maintenance costs were estimated by detailing the tasks required at each overhaul, and by multiplying the overhaul costs by the number of overhauls per year. It is customary for the manufacturer to quote an engine overhaul price for a specified number of equivalent engine hours. The engines for SR.N4.Mk.III BHC hovercraft need to be rebuilt every 6,000 hours of life operation or approximately every 3 years of operation at the Sunda Straits. The estimated engine rebuilding cost after 6,000 hours of operation is approximately Rp.627 million per craft. In order to give an average annual engine overhaul cost, this figure is simply divided by three.

ii) Operating Costs:

Operating Costs are similar to the term "vessel expense" used by the Maritime Administration. Operating costs are discussed as:

a) variable costs

b) fixed costs

The division of operating costs between variable and fixed depends on whether or not cost varies with the number of hours of engine operation. Fixed costs are independent of hours of operation. The division is somewhat arbitrary for the personnel costs and other costs (e.g. insurance, port charges and cargo handling costs, depreciation and engine overhaul, administration and general costs, and interest cost).

a) Variable Costs:

The variable costs include some cost-items which expenditure is measured by the hourly operation (e.g. fuel cost, oil cost, rotables maintenance cost, spare parts and skirt maintenance cost).

Fuel Costs : expenditures for fuel which will be a major part of total variable costs. It is estimated that each craft needs 5,150 litres of fuel per hour.

Oil Costs : expenditures for lubricating oil. The average consumption of lubricating oil is 0.45 litres/hour. The cost is estimated to be Rp.131.8 million per craft.

Maintenance Costs (exclude Engine Overhaul):

The two major items in maintenance cost are those of rotables (engine, propellers), spares and skirts. The maintenance of the transmission engine has no parallel in displacement craft. The transmission of power from the engine to the propeller is complicated by the requirements for speed reduction. This maintenance is estimated at Rp. 627,000 per hour for each craft , or Rp.1,757.6 million for two craft in 1988. The general maintenance for spares and skirts is estimated at Rp. 1.552 million/hour for each craft, or Rp. 4,350. 1 for two craft.

b) Fixed Costs:

Fixed costs are divided between *personnel costs* and *other fixed costs*. *Personnel costs* are the crew charges for craft operation. The SR.N4.Mk.III requires a minimum operating crew of 28, with 18 serving as flight crew and 10 as ground crew for each craft. The breakdown looks like this :

On-board crew per craft :	**Ground crew per craft :**
1 Captain 1 First Officer 1 Second Officer 5 Car Deck Staff 8 Cabin Hostesses	1 Chief Engineer 2 Mechanics 1 Office Manager 2 Shore Staff 4 Administration Personnel

Source: British Hovercraft Corporation, Ltd.

Crew costs are normally taken as fixed costs since it is customary to pay annual salaries and because employment may be considered permanent. For the proposed two craft operation (in 1988), taking into account safety regulations and crew fatique, it is necessary to have up to six complete crew available. The salaries for these operating crews are based on the salaries of aircraft crews in Indonesia.

Other Fixed Costs: include : insurance, port charges and cargo handling costs, general and administation costs, and interest cost.

INSURANCE:

Insurance rate quotes vary depending upon the type of craft and operation involved. The insurance required will cover the craft hull (an allumunium alloy structure) and passenger liability. The insurance cost is approximately Rp.156.8 million for the two proposed hovercraft operating in the Sunda Straits.

PORT CHARGES AND CARGO HANDLING COSTS:

Port charges are those costs that are paid to local authorities for the use of publicly owned piers and terminal areas. Cargo handling costs are the charges for stevedoring labor to load and unload cargo. The total for these items were estimated at 1% of the total personnel and variable costs.

GENERAL AND ADMINISTRATION COSTS:

The anticipated general and administration costs of a hovercraft are estimated as a percentage of the total operating costs. In this study, they are estimated as 20% of the total operating costs.

PROFIT MARGIN:

The calculation of profit is estimated as 15% of the total operating cost. This amount would be the part of the operating cost which goes to the the operator of the hovercraft as business profit.

The calculation of operating costs and capital costs is presented in Table 5.2.1 and 5.2.2. This figure also contains the estimated operating cost per passenger and the estimated operating cost per passenger-km. The operating cost per passenger is calculated by dividing the total operating costs and profit by the estimated number of passenger. The estimated number of passengers and passenger-km are shown in Chapter IV.

Table 5.2.1.
B.H.C. HOVERCRAFT TYPE SR.N4.MK.III: BASE CASE
(in million Rupiahs)

	Life (years)	1988	1998
Capital Costs:			
Terminal Costs	20	40,000.00	60,000.00
Landing Pads	20	20,000.00	30,000.00
Parking Space	20	4,000.00	4,000.00
Vessels	15	282,150.00	564,300.00
Maintenance Equipment	5	1,567.50	2,351.30
Total Capital Costs		347,717.50	660,651.30
Capital Recovery at 12%			
Terminal Costs		5,355.20	8,032.70
Landing Pads		2,677.60	4,016.40
Parking Space		535.50	535.50
Vessels		41,426.50	82,852.90
Maintenance Equipment		434.80	652.30
Total Cost Recovery		50,429.50	96,089.80
Engine Overhaul (annualized)		418.00	836.00
Total Cost recovery and Engine Overhaul		50,847.50	96,925.80

Assumptions:
Expected life = 15 years for vessels, 20 years for other facilities, 5 years for equipment.
Depreciation using 'straight line method'.
Engine Overhaul = 200,000 Pounds Sterling for every 3 years.

Source: Hoverspeed Limited, England.

Table 5.2.2.
ANNUAL OPERATING COSTS FOR THE IMPROVED FERRY SERVICE: BASE CASE
(in million Rupiahs)

		Variable Costs/hour per vessel	Annual Costs 1988	Annual Costs 1998
I)	Variable Costs:			
	1) Fuel	1.615	4,525.80	9,051.70
	2) Oil	0.094	263.60	527.30
	3) Rotable Maintenance: Engines, Propellers. etc.	0.627	1,757.60	3,515.20
	4) Spares and Skirt Maintenance	1.552	4,350.10	8,700.20
	Total Variable Costs		10,897.20	21,794.30
II)	Fixed Costs:			
	1) Annual Personnel Costs:			
	Captain		48.00	96.00
	Officers		48.00	96.00
	Stewardesses		96.00	192.00
	Crews (Deck Staff)		24.00	48.00
	Shorestaff		4.80	4.80
	Chief Engineer		12.00	12.00
	Mechanics		12.00	24.00
	Office Manager		12.00	12.00
	Administratif Officers		16.20	16.20
	Administratif Personnel		15.00	15.00
	Total Personnel Costs		288.00	516.00
	2) Other Fixed Costs:			
	Insurance		156.80	313.50
	Port Charges and Cargo Handling Costs		111.90	223.10
	Total Cost Recovery and Engine Overhaul		50,847.50	96,925.80
	General and Administratif Costs		10,280.80	19,595.70
	Total Other Fixed Costs		61,397.00	117,058.10
	Total Fixed Costs (II.1+II.2)		61,685.00	117,574.10
III)	Total Operating Costs (I + II)		72,582.20	139,368.40
IV)	Profit Margin at 15%		10,887.30	20,905.30
V)	Total Operating Costs and Profit Margin (III + IV)		83,469.50	160,273.70
VI)	Number of Passengers and Passengers Equivalent:			
	Total Passengers (000 passengers)		1,247.00	2,587.00
	Total Cars-Passengers Equivalent (000 passengers)		167.00	345.00
	Total Number of Passengers and Passengers Equivalent		1,414.00	2,932.00
VII)	Operating Costs per Passenger (in Rupiah) {(V / VI) * 1000}		59,030.76	54,663.61

Assumptions:
Down Time = 20% of the Expected Operating Hours (per 12 hours/day operation).
Type of Hovercraft: SR.N4.MK.III (SUPER 4).
1 Pounds Sterling = $ 1.9; $1 = Rp. 1,650; 1 Pounds Sterling = Rp. 3.135
Number of vessels in 1988 = 2; number of vessels in 1998 = 4
Port Charges for 2 vessels = 1% of total variable costs and personnel costs.
Administration and General Costs = 20 % of Total Personnel and Other Fixed Costs.

Source: Hoverspeed Limited, England.

5.3. SENSITIVITY ANALYSIS OF A HOVERCRAFT OPERATION:

The financial analysis in this section was based on the results from the demand model (in Chapter IV) to estimate the fare per passenger. This method is using the total operating cost and the expected number of trips to estimate the passenger-fare, it is presented in Table 5.2.2.. The following information is derived from Table 5.3.1.

- The total operating cost and profit margin in for base case in 1988 is Rp. 83,469.5 million.
- The expected total number of passengers and passengers equivalent in 1988 is 1,414,000
- The operating cost per-person = 83,469.5 x 1,000,000/1,414,000 = Rp. 59,030.7
- The estimated fare for passengers in 1988 is Rp. 59,000; in 1998 is Rp. 55,000

Table 5.3.1
SENSITIVITY ANALYSIS TABLE
(in Rupiahs)

	Estimated	*Estimated Fares:*		*Breakeven Fares:*		*Necessary Subsidy:*	
Iteration	Number of Craft	Per Person	Per Car	Per Person	Per Car	Per Car	Per Person
1	2	25,000	37,500	59,000	88,500	34,000	51,000
2	2	15,000	22,500	65,000	97,500	50,000	75,000
3	1	45,000	67,500	124,000	186,000	79,000	118,500
4	1	32,500	48,750	52,000	78,000	19,500	29,250
5	3	20,000	30,000	67,000	100,500	47,000	70,500
6	2	22,000	33,000	51,000	76,500	29,000	43,500

Source: Appendix D

The results of the six iterations show that the estimated fares for one hovercraft with a Rp.32,500 fare will require the least subsidy in 1988.

Chapter 6 INDIRECT IMPACT ANALYSIS

6.1. INTRODUCTION TO THE INDIRECT IMPACT ANALYSIS:

The indirect impact for the users and non-users of the improved ferry service is divided into two categories (shown in Figure 2.2. at Chapter II) :

i) *Traffic Impacts*

ii) *Economic Impacts*

The improvement of transportation service at Sunda Straits would reduce the travel time for passengers and freight. The time savings for passengers using the high speed surface vehicle is approximately one hour and 10 minutes for hovercraft. The comparison between the existing ferry and the improved ferry service is shown in Table 6.1.1.

Table 6.1.1.
COMPARISON OF THE EXISTING FERRY SERVICE AND THE PROPOSED HOVERCRAFT JAKARTA-TANJUNGKARANG (round trip).

Type of Service	Total Travel Time	Ferry Serv. Travel Time	Percentage of Avg. Trip	Generalized Cost (High Inc.)
Car and existing ferry	18 hrs.	7 hrs.	52.6%	Rp.185,400
Car and hovercraft	12.5hrs.	1.5hrs.	25.0%	Rp.159,333
Airway	4 hrs.	——	——	Rp.212,400

Source: Derived from Appendix A.

From Table 6.1.1 above, it is shown that the total trip time by a passenger using a car and the proposed hovercraft servicewill be two-third of the time spending by using the existing ferry. The generalized cost using the improved service is approximately 30.4% the generalized cost spend for using the existing ferry service. However, this service is less efficient compare to the airway service. The time for travel by air is much shorter and the generalized cost is less than that of the travel time and generalized cost of the total trip using the improved ferry service.

The indirect impact on traffic of the improved ferry is an increase in mobility. High income people and businessmen would use the hovercraft because they could afford the fare which is estimated to be less than the value of their time saved (discussed at Chapter IV). The rest of the travelers (part of middle income people and all of the low income people) can still use the existing ferry boats which would then have more capacity, since some of the passengers from high to medium income group shift to the high speed ferry.

The possibility of using cross-subsidies between the high speed ferry and the existing ferry would increase the options of people who are willing to travel but cannot afford to buy the tickets. The passenger trips would increase as discussed in Chapter IV. The movement of goods would not change significantly by adding the ferry service with hydrofoils because thiese carry passengers only. However, considering the capacity of the hovercraft, it would be possible to transport cargo, especially for highly valued cargo. The traffic impact would include the increasing of government's services, for example the service in education, medical, and banking.

The economic impact is seen in the time savings for passengers and freight. The labor force for people increased since they have reduced the travel time. The utilization of the improved ferry service would make the markets more accesible. Traders and businessmen could make several round trips from Java to Sumatra in a day while consumers could easily reach markets on another islands. The increase in mobility provides an increase in the movement of goods, especially agricultural products from Sumatra to Java, and manufactured products from Java to Sumatra. This would induce income expansion for planters, farmers, and traders. As the income of people increases, saving and investment are also increasing.

6.2. TRAFFIC IMPACT:

The construction of ferry ports and addtion of high speed craft in the expansion of the Merak and Bakahuni ferry services would contribute an increased mobility of people between Java and Sumatra. This project takes an essential part as transport facilities connecting economic activities of 14.2 million people in Southern Sumatra and 38.6 million people in West Java and Jakarta. The total trips and trip rate from both direction (Java and Sumatra) is shown in Table 6.2.1.

The direct impact of this improvement is the reduction in travel time. This generates an increase in the mobility of the people in Sumatra and Java. As discussed in chapter IV, the increase in mobility is seen in the increase in passenger trips (with approximately 8% of the average annual growth). The result of this increasing number of passenger trips caused an excess demand for ferry transport. The implementation of the improved ferry service is needed as a follow-up to the completion of Trans-Sumatra Highway. The objective for these improvements at the ports and in the ferry service is to solve the congestion problem at the ports connecting Java and Sumatra.

Table 6.2.1
ESTIMATED POPULATION AND TOTAL TRIP
BETWEEN JAVA AND SUMATRA
1985, 1988,1998

	1985	1988	1998
Total Population (000)	52,124	60,064	85,374
Total Trips (000)	4,472	5,668	10,866
Trip Rate (per 000)	86	94	127

Source: Derived from Appendix C.

The benefit of these improvements would be experienced by the travellers, especially the high and middle income people who can afford the hovercraft fares. The rest of travellers benefit also by the expanded ferry capacity. The existing ferry boats would have more space for passengers and cargo after this improvement, because some of the passengers would move to the hovercraft. Cross subsidy between the proposed hovercraft and the old ferry is needed to reduce the fare of the old ferry. This would increase opportunities for low income people to travel across the Sunda Straits.

6.3. ECONOMIC IMPACTS:

The economic benefits of the improved ferry service would be seen in the increased market opportunities. At first, the investment would be spent in constructing the ports. The amphibious character of the hovercraft needs special but low cost requirements for the landing space at the port. The construction of the terminals at Merak and Bakahuni requires the purchase of construction materials and wage payments to construction employees. This need for construction materials causes production growth by giving rise to procurement, and as a result, firms increase their business profits and employees increase their income in proportion to the growth.

The completion of the docking terminals at Merak and Bakahuni would increase the capacity for ferry operations. The improved ferry operation would provides quick transport service, especially for road users. The passenger time savings as a direct impact of this improvement simplified communication between people in Java and Sumatra. This would reduce the economic and social differences between the two islands and equalize the standard of living among provinces.

Time saved by ferry utilization has the effect of enhanching the productive forcc in the local community. People who utilize the ferry service for business can increase their production, consequently increase their income by reallocating the time saving. The improved ferry service would also generate an increase in tonnage freight from agricultural products due to the enlarged capacity. This would induce the access to the international market for exports of commodities.

The rise in income is achieved by the travel cost saving which would appear in various ways. Some of which are described below.

Case 1:

Firms and households that directly utilize the ferry service would increase their consumer surplus by saving the travel time cost. This could also lead to an increase in business profit and wages.

Case 2:

Reduction of travel costs across the Sunda Straits would decrease the cost of production for the perishable and high valued goods. This would contribute to benefits for firms and consumers.

Case 3:

Private car owners could increase their disposable income by saving fuel cost and waiting time cost, because the improved ferry service would reduce congestion in the port areas.

Case 4:

The improved facility would also increase non-business trips, including leisure trips by the tourists. Tourism would generate an increase in income for the local people who benefit from the purchasing power of the tourists.

The indirect economic impact on regional saving and investment, is difficult to measure because there is no suitable method to evaluate future investment in terms of money since this project has not yet to be implemented. Furthermore, the object of this evaluation is limited to passengers. The impact of saved time is allocated to business trips and non-business tirps. There is no information about the ratio between travellers and non-travellers. As an approximation to measure the level of investment after the operation of improved ferry service, an estimation of induced production will be used for further evaluation.

The high shares in agricultural sector reflects a high share of laborers who were employed in this sector. This indicates the region's low income level, because people working in the agricultural sector tend to be under-employed. The completion of the improved ferry system would create a transportation adjustment and change the distribution pattern of employment. This would indicate to the laborers in the agricultural sector that with increased mobility, they would be more likely to have the opportunity to work in non-agriculture sectors.

Chapter 7 **FINDINGS AND CONCLUSIONS**

The objective of this study is to propose a high speed surface vehicle as an alternative on improving the ferry service between the Merak-Bakahuni ports. In order to test the idea, this proposal requires three essential points to be proven. They are:

1) The proposed high speed surface vehicle would reduce the travel time.
2) The proposed high speed surface vehicle is feasible.
3) There would be a positive impact from this improved service.

The first point is obviously proved by definition of high speed surface craft. More detail information is presented in Chapter III. This chapter provides some information on the special characteristics of the two craft that are proposed in this study (hydrofoil and hovercraft). Both craft have the capability of higher running speed compared to the existing ferry (shown in Table 7.1.1.).

Table 7.1.1.
PERFORMANCE COMPARISON
BETWEEN HIGH SPEED CRAFT AND DIESEL FERRY

Type of vehicle	Pass. Capacity	Vehicle Capacity	Average Speed per Hour
Diesel Ferry	500	30	25 km/hr.
Hydrofoil	250	0	80 km/hr.
Hovercraft	400	60	120 km/hr.

Source: Derived from the information in Chapter III.

Table 7.1.1. shows that both hydrofoil and hovercraft have a much higher average speed compared to diesel ferry. The hovercraft, in particular, offers better convenience for passengers because it is capable of carrying cars. Due to the fact that most of the expected passengers for this proposed craft would be the high income people who travel by car, it is more efficient to focus this study on the feasibility of hovercraft only.

In order to calculate the feasibility of hovercraft operation in the Merak-Bakahuni route, some estimations of the demand for transport has been made to predict the market size. These calculations are contained in Chapter IV. The basic information found in these calculations are:

a) The forecast of passenger-trip by mode.
b) The forecast of population and total trip by income group.
c) The forecast of passenger trip by modal split.

a) The forecast of passenger-trip by mode:

These calculations are based on information from the existing modal split in 1985. By dividing the model split into three income groups, it was determined that there was an increase in the estimated passenger trip by mode especially for high income passengers (7 percent per annum).

b) The forecast of population by income group:

The calculation in this section is made in order to estimate the number of passenger for the proposed hovercraft. The results of this estimation include the shifting in group of income as a result of increase in per capita income. These results are used as basic information in forecasting the passenger trip by modal split. An estimation was made for the segment of the total population most likely to utilize ferry service. Five provinces were selected and their populations broken down into high, middle and low income groups for the years 1985, 1988 and 1998. The results of this analysis revealed that the high income portion of all provinces was small in comparison with the two other income groups (14.3 percent), but would grow more rapidly (6.7 percent per year) in twenty years. Therefore, it is reasonable to believe that upgraded ferry service would require smaller subsidies by the government.

c) The forecast of passenger-trip by modal split::

The final series of calculations are made by adapting demand model for predicting ferry route. This model is based on the logit method which was calibrated in Chapter IV, the results of probability choices between the modal split gave a basic information for forecasting the total number of passenger using each transportation means. The analysis revealed that almost 47 percent of passengers using the proposed ferry service come from high income groups (Table 4.3.3.). For those passengers in the middle income group, only 16 percent would be able to afford the new service compared to 84 percent using the existing ferry service. Lastly, the low income passengers will primarily be the drivers of the cars for high income passengers.

The preliminary cost analysis is presented in Chapter V to evaluate the financial feasibility of the proposed ferry service. The financial feasibility is measured by estimating the passenger fare, car fare, and how much subsidy is needed for the operation of hovercraft. For this purpose, six different combination of passenger fares and car fares are assumed in the iterations of the annual operating cost. The best estimation of fare per person is calculated between the range of Rp. 22,000 - Rp. 32,500 because it required the least subsidy in 1988 (shown in Table 5.2.3.).

The indirect impact analysis is divided into traffic impact and economic impact. The traffic impact analyzed the benefit of the improved ferry system by passengers and cargo. The economic impact analyzed the effect of investment that spend in this project during the construction of the ports until the operation of the ferry. The time saved by utilizing the improved ferry has a positive impact of the productivity in the local community.

Table A.1.
COST FOR TYPICAL ROUND TRIP JAKARTA -TANJUNGKARANG BY INCOME GROUP: BASE CASE

	Car trip with the existing ferry	Bus trip with the existing ferry	Car trip with the improved ferry	Bus trip with the improved ferry	Airline
Jakarta-Merak Toll Road:					
Distance (km)	80	80	80	80	
Cost or fare (Rp)	20,000	3,500	20,000	3,500	
Time (hours)	6	6	6	6	
Toll (Rp)	5,000	0	5,000	0	
Merak-Bakahuni Ferry Servcie:					
Distance (km)	75	75	75	75	
Cash payment (Rp)	10,000	0	0	0	
Fare (Rp)	100,000	30,000	225,000	5,000	
Waiting time (hours)	2	2	0	0	
Loading and unloading time (hours)	2	2	1	1	
Cruising time (hours)	3	3	0.5	0.5	
Total time (hours)	7	7	1.5	1.5	
Bakahuni-Tanjungkarang Road:					
Distance (km)	72	72	72	72	
Cost or fare (Rp)	18,000	3,500	18,000	3,500	
Time (hours)	5	6	5	6	
Toll (Rp)	0	0	0	0	
Total time Jakarta-Tanjungkarang (hours)	18	19	12.5	13.5	4
Jakarta-Tanjungkarang air fare (Rp)	0	0	0	0	150,000
Out-of pocket cost:					
Total cost (Rp)	153,000	37,000	268,000	57,000	150,000
Cost per passenger (Rp)	51,000	37,000	89,333	57,000	150,000
High income passenger:					
Destination taxi cost (Rp)	0	40,000	0	40,000	40,000
Time value cost per hour (Rp)	5,600	5,600	5,600	5,600	5,600
Total generalized cost (Rp)	185,400	21,700	159,333	172,600	212,400
Middle income passenger:					
Destination taxi cost (Rp)	0	500	0	500	
Time value cost per hour (Rp)	750	750	750	750	
Total generalized cost (Rp)	69,000	56,250	98,708	67,625	
Low income passenger:					
Destination taxi cost (Rp)	0	500	0	500	
Time value cost per hour (Rp)	240	240	240	240	
Total generalized cost (Rp)	56760	43500	240	240	

(Cont.)

(Cont.)
Assumptions:
Waiting time cost = 4 * the value of time.
Ferry fare for the existing service = Rp. 15,000 per passenger, Rp. 5,000 per car.
Ferry fare for the improved service = Rp. 25,000 per passenger, Rp. 30,000 per car.
One car carries 3 passengers (i.e. the cars with drivers are not specified).

From the calculation at Appendix A, the difference in generalized cost is calculated for model callibration in Appendix B.

Table A.2.
DIFFERENCE IN GENERALIZED COST
(in Rupiahs)

	High Income	Mid. Income	Low Income
Existing Ferry compare to Air Service	-27,000	0	0
Improved Ferry compare to Air Service	-58,067	0	0
Existing Ferry compare to Improved Ferry:			
Car Trip	31,067	-24,708	-30,573
Bus Trp	44,400	-11,375	-17,240
Weighted Average	33,733	-22,042	-27,907

Source: Derived from Table A.1.

APPENDIX B **CALLIBRATION FOR THE DEMAND MODEL**

General Formula :

$$P = \frac{1}{1 + \exp\ (a + b\ \Delta\ GC)}$$

Assume: Percentage of using the improved ferry service:

Fare Level *(Rp.)*	**High Income (H.I.)** *(%)*	**Middle Income (M.I.)** *(%)*
45,000	0.62	0.09
25,000	0.75	0.15
15,000	0.79	0.20

Fare Level	**Existing Ferry Generalized Cost**		**Improved Ferry Generalized Cost**		**Difference in Generalized Cost Existing - Improved**	
(Rp.)	*H.I.*	*M.I.*	*H.I.*	*M.I.*	*H.I.*	*M.I.*
45,000	185,400	69,000	179,333	118,708	6,607	- 49,708
25,000	185,400	69,000	159,333	98,708	26,607	- 29,708
15,000	185,400	69,000	149,333	88,708	36,607	- 19,708

High Income:

$$0.62 = \frac{1}{1 + \exp\ (\ a + 6{,}607\ \ b\ )}$$

$\exp\ (\ a + 6{,}607\ \ b\ )\ =\ 0.613$

$a + 6{,}607\ \ b = -\ 0.489$ (1)

$$\mathbf{0.75 = \frac{1}{1 + \exp(a + 26{,}607\ b)}}$$

$$\exp(a + 26{,}607\ b) = 0.333$$

$$a + 26{,}607\ b = -\ 1.099 \quad (2)$$

$$\mathbf{0.79 = \frac{1}{1 + \exp(a + 36{,}607\ b)}}$$

$$\exp(a + 26{,}607\ b) = 0.266$$

$$a + 36{,}607\ b = -\ 1.325 \quad (3)$$

$$a + 6{,}607\ b = -\ 0.489 \quad (1)$$

$$a + 26{,}607\ b = -\ 1.099 \quad (2)$$

$$-\ 20{,}000\ b = 0.610$$

$$b_1 = -\ 0.0000305$$

$$a_1 = -\ 0.304$$

$$a + 26{,}607\ b = -\ 1.099 \quad (2)$$

$$a + 36{,}607\ b = -\ 1.325 \quad (3)$$

$$-\ 10{,}000\ b = 0.226$$

$$b_2 = -\ 0.0000226$$

$$a_2 = -\ 0.510$$

$$\mathbf{b_{average} = -\ 0.0000256}$$

$$\mathbf{a_{average} = -\ 0.407}$$

$$\mathbf{P_{High\ Income} = \frac{1}{1 + \exp(-\ 0.407 - 0.0000256\ \Delta\ GC)}}$$

Middle Income

Assume: same slope b = - 0000256

$$0.09 = \frac{1}{1 + \exp(a - 49{,}708\ b)}$$

exp (a - 49,708 b) = 10.11

a - 49,708 b = 2.314

a_1 = 2.313 - (- 49,708 x - 0.0000256) = 1.041

$$0.15 = \frac{1}{1 + \exp(a - 29{,}708\ b)}$$

exp (a - 29,708 b) = 5.667

a - 29,708 b = 1.735

a_2 = 1.735 - (- 29,708 x - 0.0000256) = 0.974

$$0.20 = \frac{1}{1 + \exp(a - 19{,}708\ b)}$$

exp (a - 19,708 b) = 4

a - 19,708 b = 1.386

a_3 = 1.386 - (- 19,708 x - 0.0000256) = 0.881

$a_{average}$ = **0.965**

$$P_{Middle\ Income} = \frac{1}{1 + \exp(0.965 - 0.0000256\ \Delta GC)}$$

Assume: coefficient a is a function of time value, therefore $a = a_1 + a_2 V$

	a	**V**
High Income	- 0.407	5,600
Middle Income	0.965	750

$- 0.407 = a_1 + a_2 (5,600)$

$0.965 = a_1 + a_2 (750)$

$- 1.372 = 4850\ a_2$

$\mathbf{a_2 = - 0.000283} \qquad \mathbf{a_1 = 1.177}$

$$\mathbf{P_{improved} = \frac{1}{1 + \exp\ (1.177 - 000283\ V - 0000256\ \Delta\ GC)}}$$

Assuming the equation is the same for the modal split between air service and ferry service.

$$\mathbf{P_{air} = \frac{1 - Po}{1 + \exp\ (1.177 - 000283\ V - 0000256\ \Delta\ GC)} + Po}$$

P air = 0.51 (from Appendix A)

$$0.51 = \frac{1 - Po}{1 + \exp\ (1.177 - 000283\ (5,600) - 0.0000256\ (-27,000))} + Po$$

$$0.51 = \frac{1 - Po}{1 + \exp\ (0.2834)} + Po$$

$(0.51 - Po)\ (2.3276) = 1 - Po$

$1.1871 - 2.3276\ Po = 1 - Po$

$- 1.3276\ Po = - 0.1871$

$\mathbf{Po = 0.141}$

$$\mathbf{P_{air} = \frac{0.859}{1 + \exp\ (1.177 - 000283\ V - 0000256\ \Delta\ GC)} + 0.141}$$

Appendix C

POPULATION AND TRIPS GENERATION BY INCOME GROUP

Population by Province (000) in 1985	High Income	Middle Income	Low Income
Jambi	239	1,033	456
South Sumatera	1,290	3,023	1,099
Bengkulu	121	395	420
Lampung	149	2,586	2,752
Jakarta	2,832	4,264	732
West Java	2,824	12,686	15,223
Total Population (000)	7,455	23,987	20,682
Total Trips (000)	855	2,143	1,474
Trip Rate (000)	115	89	71
Population by Province (000) in 1988			
Jambi	277	1,191	525
South Sumatera	1,532	3,154	1,127
Bengkulu	175	516	530
Lampung	272	2,689	2,728
Jakarta	3,736	5,173	882
West Java	3,952	14,814	16,790
Total Population (000)	9,944	27,537	22,583
Total Trips (000)	1,240	2,677	1,751
Trip Rate (000)	125	97	78
Population by Province (000) in 1998			
Jambi	399	1,696	748
South Sumatera	2,602	4,299	1,536
Bengkulu	354	826	847
Lampung	869	4,533	4,599
Jakarta	6,198	7,480	1,276
West Java	7,618	18,512	20,982
Total Population (000)	18,040	37,345	29,989
Total Trips (000)	2,979	4,807	3,080
Trip Rate (000)	165	129	103

Assumption:
Elasticity of trips to income = 1.08

Source: Derived from the calculation in Chapter IV.

Table D.1.1.
ANNUAL OPERATING COSTS FOR THE IMPROVED FERRY SERVICE: BASE CASE
(in million Rupiahs)

		Variable Costs/hour per vessel	Annual Costs 1988	Annual Costs 1998
I)	Variable Costs:			
	1) Fuel	1.615	4,525.80	9,051.70
	2) Oil	0.094	263.60	527.30
	3) Rotable Maintenance: Engines, Propellers. etc.	0.627	1,757.60	3,515.20
	4) Spares and Skirt Maintenance	1.552	4,350.10	8,700.20
	Total Variable Costs		10,897.20	21,794.30
II)	Fixed Costs:			
	1) Annual Personnel Costs:			
	Captain		48.00	96.00
	Officers		48.00	96.00
	Stewardesses		96.00	192.00
	Crews (Deck Staff)		24.00	48.00
	Shorestaff		4.80	4.80
	Chief Engineer		12.00	12.00
	Mechanics		12.00	24.00
	Office Manager		12.00	12.00
	Administratif Officers		16.20	16.20
	Administratif Personnel		15.00	15.00
	Total Personnel Costs		288.00	516.00
	2) Other Fixed Costs:			
	Insurance		156.80	313.50
	Port Charges and Cargo Handling Costs		111.90	223.10
	Total Cost Recovery and Engine Overhaul		50,847.50	96,925.80
	General and Administratif Costs		10,280.80	19,595.70
	Total Other Fixed Costs		61,397.00	117,058.10
	Total Fixed Costs (II.1+II.2)		61,685.00	117,574.10
III)	Total Operating Costs (I + II)		72,582.20	139,368.40
IV)	Profit Margin at 15%		10,887.30	20,905.30
V)	Total Operating Costs and Profit Margin (III + IV)		83,469.50	160,273.70
VI)	Number of Passengers and Passengers Equivalent:			
	Total Passengers (000 passengers)		1,247.00	2,587.00
	Total Cars-Passengers Equivalent (000 passengers)		167.00	345.00
	Total Number of Passengers and Passengers Equivalent		1,414.00	2,932.00
VII)	Operating Costs per Passenger (in Rupiah) {(V / VI) * 1000}		59,030.76	54,663.61

Assumptions:
Down Time = 20% of the Expected Operating Hours (per 12 hours/day operation).
Type of Hovercraft: SR.N4.MK.III (SUPER 4).
1 Pounds Sterling = $ 1.9; $1 = Rp. 1,650; 1 Pounds Sterling = Rp. 3.135
Number of vessels in 1988 = 2; number of vessels in 1998 = 4
Port Charges for 2 vessels = 1% of total variable costs and personnel costs.
Administration and General Costs = 20 % of Total Personnel and Other Fixed Costs.

Source: Hoverspeed Limited, England.

Table D.1.2.
RESULTS FROM ITERATION I : BASE CASE

Inputs:		High Income	Mid. Income	Low Income
Time Value (Rp):		5,600	750	240
Estimated Number of Vessels:				
1988	2			
1998	4			
Estimated Ferry Fares (Rp):		Passenger	Car	
1988		25,000	37,500	
Outputs:				
Breakeven Fares (Rp):		Passenger	Car	
1988		59,000	88,500	
1998		55,000	82,500	
Necessary Subsidy (Rp):		Passenger	Car	
1988		34,000	51,000	
1998		30,000	45,000	

Source: Derived from Table 5.2.2.

Table D.1.3.
ESTIMATED PASSENGER TRIPS PER YEAR: BASE CASE

Year	High Income	Middle Income	Low Income	Total Passengers	Operat Hour	Ferry Trips	Number of Vessels	Number of Cars
1988	586,000	438,000	223,000	1,247,000	2,803	7,008	2	333,000
1998	1,408,000	787,000	392,000	2,587,000	5,606	14,016	4	690,000

Assumption: Low Income Passengers including drivers.

Source: Derived from calculation in Chapter IV.

Table D.2.1.
ANNUAL OPERATING COSTS FOR THE IMPROVED FERRY SERVICE: CASE TWO
(in million Rupiahs)

		Variable Costs/hour per vessel	Annual Costs 1988	Annual Costs 1998
I)	Variable Costs:			
	1) Fuel	1.615	4,525.80	9,051.70
	2) Oil	0.094	263.60	527.30
	3) Rotable Maintenance: Engines, Propellers. etc.	0.627	1,757.60	3,515.20
	4) Spares and Skirt Maintenance	1.552	4,350.10	8,700.20
	Total Variable Costs		10,897.20	21,794.30
II)	Fixed Costs:			
	1) Annual Personnel Costs:			
	Captain		48.00	96.00
	Officers		96.00	192.00
	Stewardesses		192.00	384.00
	Crews (Deck Staff)		48.00	96.00
	Shorestaff		4.80	4.80
	Chief Engineer		12.00	12.00
	Mechanics		12.00	24.00
	Office Manager		12.00	12.00
	Administratif Officers		16.20	16.20
	Administratif Personnel		15.00	15.00
	Total Personnel Costs		456.00	852.00
	2) Other Fixed Costs:			
	Insurance		156.80	313.50
	Port Charges and Cargo Handling Costs		113.50	226.50
	Total Cost Recovery and Engine Overhaul		50,847.50	96,925.80
	General and Administratif Costs		10,314.80	19,663.50
	Total Other Fixed Costs		61,432.60	117,129.30
	Total Fixed Costs (II.1+II.2)		61,888.60	117,981.30
III)	Total Operating Costs (I + II)		72,785.80	139,775.60
IV)	Profit Margin at 15%		10,917.90	20,966.30
V)	Total Operating Costs and Profit Margin (III + IV)		83,703.70	160,741.90
VI)	Number of Passengers and Passengers Equivalent:			
	Total Passengers (000 passengers)		1,130.00	2,149.00
	Total Cars-Passengers Equivalent (000 passengers)		151.00	287.00
	Total Number of Passengers and Passengers Equivalent		1,281.00	2,436.00
VII)	Operating Costs per Passenger (in Rupiah) {(V / VI) * 1000}		65,342.47	65,986.00

Assumptions:
Down Time = 20% of the Expected Operating Hours (per 12 hours/day operation).
Type of Hovercraft: SR.N4.MK.III (SUPER 4).
1 Pounds Sterling = $ 1.9; $1 = Rp. 1,650; 1 Pounds Sterling = Rp. 3.135
Number of vessels in 1988 = 2; number of vessels in 1998 = 4
Port Charges for 2 vessels = 1% of total variable costs and personnel costs.
Administration and General Costs = 20 % of Total Personnel and Other Fixed Costs.

Source: Derived from Iteration I (Base Case).

Table D.2.2.
RESULTS FROM ITERATION II: CASE TWO

Inputs:		High Income	Mid. Income	Low Income
Time Value (Rp):		5,600	750	240
Estimated Number of Vessels:				
1988	2			
1998	4			
Estimated Ferry Fares (Rp):		Passenger	Car	
1988		15,000	22,500	
Outputs:				
Breakeven Fares (Rp):		Passenger	Car	
1988		65,000	97,500	
1998		66,000	99,000	
Necessary Subsidy (Rp):		Passenger	Car	
1988		50,000	75,000	
1998		51,000	76,500	

Source: Derived from Iteration I (Base Case).

Table D.2.3.
ESTIMATED PASSENGER TRIPS PER YEAR: CASE TWO

Year	High Income	Middle Income	Low Income	Total Passengers	Operat Hour	Ferry Trips	Number of Vessels	Number of Cars
1988	217,000	552,000	361,000	1,130,000	2,803	7,008	2	301,000
1998	522,000	992,000	635,000	2,149,000	5,606	14,016	4	573,000

Assumption: Low Income Passengers including drivers.

Source: Derived from Iteration I (Base Case).

Table D.3.1.
ANNUAL OPERATING COSTS FOR THE IMPROVED FERRY SERVICE: CASE THREE
(in million Rupiahs)

		Variable Costs/hour per vessel	Annual Costs 1988	Annual Costs 1998
I)	Variable Costs:			
	1) Fuel	1.615	2,262.90	2,262.90
	2) Oil	0.094	131.80	131.80
	3) Rotable Maintenance: Engines, Propellers. etc.	0.627	878.80	878.80
	4) Spares and Skirt Maintenance	1.552	2,175.00	2,175.00
	Total Variable Costs		5,448.50	5,448.50
II)	Fixed Costs:			
	1) Annual Personnel Costs:			
	Captain		48.00	48.00
	Officers		48.00	48.00
	Stewardesses		96.00	96.00
	Crews (Deck Staff)		24.00	24.00
	Shorestaff		4.80	4.80
	Chief Engineer		12.00	12.00
	Mechanics		12.00	12.00
	Office Manager		12.00	12.00
	Administratif Officers		16.20	16.20
	Administratif Personnel		15.00	15.00
	Total Personnel Costs		288.00	288.00
	2) Other Fixed Costs:			
	Insurance		156.80	156.80
	Port Charges and Cargo Handling Costs		57.40	57.40
	Total Cost Recovery and Engine Overhaul		29,925.30	34,159.10
	General and Administratif Costs		6,085.50	6,932.20
	Total Other Fixed Costs		36,225.00	41,305.50
	Total Fixed Costs (II.1+II.2)		36,513.00	41,593.50
III)	Total Operating Costs (I + II)		41,961.50	47,042.00
IV)	Profit Margin at 15%		6,294.20	7,056.30
V)	Total Operating Costs and Profit Margin (III + IV)		48,255.70	54,098.30
VI)	Number of Passengers and Passengers Equivalent:			
	Total Passengers (000 passengers)		343.00	715.00
	Total Cars-Passengers Equivalent (000 passengers)		46.00	96.00
	Total Number of Passengers and Passengers Equivalent		389.00	811.00
VII)	Operating Costs per Passenger (in Rupiah) {(V / VI) * 1000}		124,050.64	66,705.67

Assumptions:
Down Time = 20% of the Expected Operating Hours (per 12 hours/day operation).
Type of Hovercraft: SR.N4.MK.III (SUPER 4).
1 Pounds Sterling = $ 1.9; $1 = Rp. 1,650; 1 Pounds Sterling = Rp. 3.135
Number of vessels in 1988 = 1; number of vessels in 1998 = 1
Port Charges for 2 vessels = 1% of total variable costs and persomnel costs.
Administration and General Costs = 20 % of Total Personnel and Other Fixed Costs.

Source: Derived from Iteration I (Base Case).

Table D.3.2.
RESULTS FROM ITERATION III: CASE THREE

Inputs:		High Income	Mid. Income	Low Income
Time Value (Rp):		5,600	750	240
Estimated Number of Vessels:				
1988	1			
1998	1			
Estimated Ferry Fares (Rp):		Passenger	Car	
1988		45,000	67,500	
Outputs:				
Breakeven Fares (Rp):		Passenger	Car	
1988		124,000	186,000	
1998		67,000	100,500	
Necessary Subsidy (Rp):		Passenger	Car	
1988		79,000	118,500	
1998		22,000	33,000	

Source: Derived from Iteration I (Base Case).

Table D.3.3.
ESTIMATED PASSENGER TRIPS PER YEAR: CASE THREE

Year	High Income	Middle Income	Low Income	Total Passengers	Operat Hour	Ferry Trips	Number of Vessels	Number of Cars
1988	165,000	119,000	59,000	343,000	1,402	3,504	1	91,000
1998	398,000	214,000	103,000	715,000	1,402	3,504	1	191,000

Assumption: Low Income Passengers including drivers.

Source: Derived from Iteration I (Base Case).

Table D.4.1.
ANNUAL OPERATING COSTS FOR THE IMPROVED FERRY SERVICE: CASE FOUR
(in million Rupiahs)

		Variable Costs/hour per vessel	Annual Costs 1988	Annual Costs 1998
I)	Variable Costs:			
	1) Fuel	1.615	2,262.90	6,788.80
	2) Oil	0.094	131.80	395.50
	3) Rotable Maintenance: Engines, Propellers. etc.	0.627	878.80	2,636.40
	4) Spares and Skirt Maintenance	1.552	2,175.00	6,525.10
	Total Variable Costs		5,448.50	16,345.80
II)	Fixed Costs:			
	1) Annual Personnel Costs:			
	Captain		48.00	144.00
	Officers		48.00	144.00
	Stewardesses		96.00	288.00
	Crews (Deck Staff)		24.00	72.00
	Shorestaff		4.80	4.80
	Chief Engineer		12.00	12.00
	Mechanics		12.00	36.00
	Office Manager		12.00	12.00
	Administratif Officers		16.20	16.20
	Administratif Personnel		15.00	15.00
	Total Personnel Costs		288.00	744.00
	2) Other Fixed Costs:			
	Insurance		156.80	470.30
	Port Charges and Cargo Handling Costs		57.40	170.90
	Total Cost Recovery and Engine Overhaul		29,925.30	76,003.60
	General and Administratif Costs		6,085.50	15,477.70
	Total Other Fixed Costs		36,225.00	92,122.50
	Total Fixed Costs (II.1+II.2)		36,513.00	92,866.50
III)	Total Operating Costs (I + II)		41,961.50	109,212.30
IV)	Profit Margin at 15%		6,294.20	16,381.80
V)	Total Operating Costs and Profit Margin (III + IV)		48,255.70	125,594.10
VI)	Number of Passengers and Passengers Equivalent:			
	Total Passengers (000 passengers)		824.00	1,725.00
	Total Cars-Passengers Equivalent (000 passengers)		110.00	230.00
	Total Number of Passengers and Passengers Equivalent		934.00	1,955.00
VII)	Operating Costs per Passenger (in Rupiah) {(V / VI) * 1000}		51,665.63	64,242.51

Assumptions:
Down Time = 20% of the Expected Operating Hours (per 12 hours/day operation).
Type of Hovercraft: SR.N4.MK.III (SUPER 4).
1 Pounds Sterling = $ 1.9; $1 = Rp. 1,650; 1 Pounds Sterling = Rp. 3.135
Number of vessels in 1988 = 1; number of vessels in 1998 = 3
Port Charges for 2 vessels = 1% of total variable costs and personnel costs.
Administration and General Costs = 20 % of Total Personnel and Other Fixed Costs.

Source: Derived from Iteration I (Base Case).

Table D.4.2.
RESULTS FROM ITERATION IV: CASE FOUR

Inputs:		High Income	Mid. Income	Low Income
Time Value (Rp):		5,600	750	240
Estimated Number of Vessels:				
1988	1			
1998	3			
Estimated Ferry Fares (Rp):		Passenger	Car	
1988		32,500	48,750	
Outputs:				
Breakeven Fares (Rp):		Passenger	Car	
1988		52,000	78,000	
1998		64,000	96,000	
Necessary Subsidy (Rp):		Passenger	Car	
1988		19,500	29,250	
1998		31,500	47,250	

Source: Derived from Iteration I (Base Case).

Table D.4.3.
ESTIMATED PASSENGER TRIPS PER YEAR: CASE FOUR

Year	High Income	Middle Income	Low Income	Total Passengers	Operat Hour	Ferry Trips	Number of Vessels	Number of Cars
1988	412,000	275,000	137,000	824,000	1,402	3,504	1	220,000
1998	990,000	493,000	242,000	1,725,000	4,205	10,512	3	460,000

Assumption: Low Income Passengers including drivers.

Source: Derived from Iteration I (Base Case).

Table D.5.1.
ANNUAL OPERATING COSTS FOR THE IMPROVED FERRY SERVICE: CASE FIVE
(in million Rupiahs)

		Variable Costs/hour per vessel	Annual Costs 1988	Annual Costs 1998
I)	Variable Costs:			
	1) Fuel	1.615	6,788.80	11,314.60
	2) Oil	0.094	395.50	659.10
	3) Rotable Maintenance: Engines, Propellers. etc.	0.627	2,636.40	4,394.00
	4) Spares and Skirt Maintenance	1.552	6,525.10	10,875.20
	Total Variable Costs		16,345.80	27,242.90
II)	Fixed Costs:			
	1) Annual Personnel Costs:			
	Captain		72.00	120.00
	Officers		144.00	240.00
	Stewardesses		288.00	480.00
	Crews (Deck Staff)		72.00	120.00
	Shorestaff		4.80	4.80
	Chief Engineer		12.00	12.00
	Mechanics		12.00	20.00
	Office Manager		12.00	12.00
	Administratif Officers		16.20	16.20
	Administratif Personnel		15.00	15.00
	Total Personnel Costs		648.00	1,040.00
	2) Other Fixed Costs:			
	Insurance		156.80	261.30
	Port Charges and Cargo Handling Costs		169.90	282.80
	Total Cost Recovery and Engine Overhaul		71,769.80	117,848.00
	General and Administratif Costs		14,548.90	23,886.40
	Total Other Fixed Costs		86,645.40	142,278.50
	Total Fixed Costs (II.1+II.2)		87,293.40	143,318.50
III)	Total Operating Costs (I + II)		103,639.20	170,561.40
IV)	Profit Margin at 15%		15,545.90	25,584.20
V)	Total Operating Costs and Profit Margin (III + IV)		119,185.10	196,145.60
VI)	Number of Passengers and Passengers Equivalent:			
	Total Passengers (000 passengers)		1,581.00	3,248.00
	Total Cars-Passengers Equivalent (000 passengers)		211.00	433.00
	Total Number of Passengers and Passengers Equivalent		1,792.00	3,681.00
VII)	Operating Costs per Passenger (in Rupiah) {(V / VI) * 1000}		66,509.54	53,285.95

Assumptions:
Down Time = 20% of the Expected Operating Hours (per 12 hours/day operation).
Type of Hovercraft: SR.N4.MK.III (SUPER 4).
1 Pounds Sterling = $ 1.9; $1 = Rp. 1,650; 1 Pounds Sterling = Rp. 3.135
Number of vessels in 1988 = 3; number of vessels in 1998 = 5
Port Charges for 2 vessels = 1% of total variable costs and personnel costs.
Administration and General Costs = 20 % of Total Personnel and Other Fixed Costs.

Source: Derived from Iteration I (Base Case).

Table D.5.2.
RESULTS FROM ITERATION V: CASE FIVE

Inputs:		High Income	Mid. Income	Low Income
Time Value (Rp):		5,600	750	240
Estimated Number of Vessels:				
1988	3			
1998	5			
Estimated Ferry Fares (Rp):		Passenger	Car	
1988		20,000	30,000	
Outputs:				
Breakeven Fares (Rp):		Passenger	Car	
1988		67,000	100,500	
1998		53,000	79,500	
Necessary Subsidy (Rp):		Passenger	Car	
1988		47,000	70,500	
1998		33,000	49,500	

Source: Derived from Iteration I (Base Case).

Table D.5.3.
ESTIMATED PASSENGER TRIPS PER YEAR: CASE FIVE

Year	High Income	Middle Income	Low Income	Total Passengers	Operat Hour	Ferry Trips	Number of Vessels	Number of Cars
1988	693,000	586,000	302,000	1,581,000	4,205	10,512	3	422,000
1998	1,665,000	1,052,000	531,000	3,248,000	7,008	17,520	5	866,000

Assumption: Low Income Passengers including drivers.

Source: Derived from Iteration I (Base Case).

Table D.6.1.
ANNUAL OPERATING COSTS FOR THE IMPROVED FERRY SERVICE: CASE SIX
(in million Rupiahs)

	Variable Costs/hour per vessel	Annual Costs 1988	Annual Costs 1998
I) Variable Costs:			
1) Fuel	1.615	4,525.80	11,314.60
2) Oil	0.094	263.60	659.10
3) Rotable Maintenance: Engines, Propellers. etc.	0.627	1,757.60	4,394.00
4) Spares and Skirt Maintenance	1.552	4,350.10	10,875.20
Total Variable Costs		10,897.10	27,242.90
II) Fixed Costs:			
1) Annual Personnel Costs:			
Captain		48.00	120.00
Officers		96.00	240.00
Stewardesses		192.00	480.00
Crews (Deck Staff)		48.00	120.00
Shorestaff		4.80	4.80
Chief Engineer		12.00	12.00
Mechanics		12.00	30.00
Office Manager		12.00	12.00
Administratif Officers		16.20	16.20
Administratif Personnel		15.00	15.00
Total Personnel Costs		456.00	1,050.00
2) Other Fixed Costs:			
Insurance		156.80	391.90
Port Charges and Cargo Handling Costs		113.50	282.90
Total Cost Recovery and Engine Overhaul		50,847.50	117,848.00
General and Administratif Costs		10,314.80	23,914.60
Total Other Fixed Costs		61,432.60	142,437.40
Total Fixed Costs (II.1+II.2)		61,888.60	143,487.40
III) Total Operating Costs (I + II)		72,785.70	170,730.30
IV) Profit Margin at 15%		10,917.90	25,609.50
V) Total Operating Costs and Profit Margin (III + IV)		83,703.60	196,339.80
VI) Number of Passengers and Passengers Equivalent:			
Total Passengers (000 passengers)		1,443.00	2,976.00
Total Cars-Passengers Equivalent (000 passengers)		193.00	397.00
Total Number of Passengers and Passengers Equivalent		1,636.00	3,373.00
VII) Operating Costs per Passenger (in Rupiah) {(V / VI) * 1000}		51,163.57	58,209.25

Assumptions:
Down Time = 20% of the Expected Operating Hours (per 12 hours/day operation).
Type of Hovercraft: SR.N4.MK.III (SUPER 4).
1 Pounds Sterling = $ 1.9; $1 = Rp. 1,650; 1 Pounds Sterling = Rp. 3.135
Number of vessels in 1988 = 2; number of vessels in 1998 = 5
Port Charges for 2 vessels = 1% of total variable costs and personnel costs.
Administration and General Costs = 20 % of Total Personnel and Other Fixed Costs.

Source: Derived from Iteration I (Base Case).

Table D.6.2.
RESULTS FROM ITERATION VI: CASE SIX

Inputs:		High Income	Mid. Income	Low Income
Time Value (Rp):		5,600	750	240
Estimated Number of Vessels:				
1988	2			
1998	5			
Estimated Ferry Fares (Rp):		Passenger	Car	
1988		22,000	33,000	
Outputs:				
Breakeven Fares (Rp):		Passenger	Car	
1988		51,000	76,500	
1998		58,000	87,000	
Necessary Subsidy (Rp):		Passenger	Car	
1988		29,000	43,500	
1998		36,000	54,000	

Source: Derived from Iteration I (Base Case).

Table D.6.3.
ESTIMATED PASSENGER TRIPS PER YEAR: CASE SIX

Year	High Income	Middle Income	Low Income	Total Passengers	Operat Hour	Ferry Trips	Number of Vessels	Number of Cars
1988	652,000	523,000	268,000	1,443,000	2,803	7,008	3	385,000
1998	1,566,000	939,000	471,000	2,976,000	7,008	17,520	5	794,000

Assumption: Low Income Passengers including drivers.

Source: Derived from Iteration I (Base Case).

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