Analysis Of Inland Waterway Transport For Container Shipping: Cikarang To Port Of TanjungPriok

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Abstract. Industry's development which is in the center of Cikarang's industrial estate causes a considerable increase from 7% to 13% of container's flow from and to Port of Tanjung Priok per year. Therefore, those obstacles rise the number of traffic congestion and transport cost. This research aims to analyze the potential alternative of transportation in order to transport containers at the route of Tanjung Priok to Cikarang utilizing Inland Waterways Transport through Cikarang Bekasi Laut (CBL) river. This research will be conducted by comparing component of total logistic cost that emerging caused by container trucks and vessels. Self Propelled Container Barge (SPCB) is a pointed alternative transportation in which it is used to transport containers through the waterways. The result of analysis obtained that the capacity of Cikarang Bekasi Laut river is 18,558 roundtrip per year. Furthermore, the collaboration of 3 SPCB operations, as well payload 32 TEUS can decrease the amount of road traffic congestion/density of Cikarang-Port of Tanjung Priok as much as 18.6%. The cost of containers shipping per unit transported by truck is IDR 2.2 Million per TEUs, whereas containers shipping transported by Inland Waterways cost only IDR 1.8 Million per TEUs.

1. Introduction

Development in the economic sector of Indonesia increased significantly in recent decades. Therefore, the trading activities is one of main elements that support economic development increased rapidly because it has been able to independently and actively operating. Cikarang Industrial Estate, West Java, is an area of major traders in the domestic and global market in Indonesia.

However, logistics activities have an impact on the trading activity in the area of Jakarta and West Java, especially in the Cikarang industrial estate. There are 11 industrial estate with total 3,115 units industry. Distance with land transport between Port of Tanjung Priok and Cikarang industrial estate are 60 kilometers[1].In 2015, the amount of container shipped from the port of Tanjung Priok and vice versa are 642,829 TEUs. Compared with the previous years, the average number of shipped containers increased by 10% each years[2]. So as a result of year-on-year traffic congestion in Jakarta continues to increase, especially at Port of Tanjung Priok lanes toward Cikarang. This traffic congestion due to growth of volume truck raised sharply accompanied by growth in cargo volumes. In addition to causing congestion, also cause other effects such as increased road maintenance costs.
As a result of all is a high cost on the land transport. Logistics costs in Indonesia are the highest among the countries in Southeast Asia, which ranged between 25% - 30% of GDP [3]. Therefore, efforts are required which leads to the suppression of logistics costs. Nowadays, cargo from the port of Tanjung Priok to the Cikarang transported by container trucks. From this fact came up an idea to divert land transport modes using transport services through the river. It is necessary to do an analysis of the modes are most competitive in the service and the price paid by users for these services from the Port of Tanjung Priok to the Cikarang Industrial Estate and vice versa.

2. Literature Review

2.1. Inland Waterway Transport

Inland Waterway Transport (IWT) is a commercial transport that utilizes canal to move commercial cargoes from the main port to the hinterland that is connected with the canal. IWT is defined as a commercial transportation by ships that have not crossed the oceans [4]. IWT concept has been implemented in Europe, especially Northern Europe, as well as some countries in the Americas. The applications of the concept of IWT, in various countries have successfully overcome some of the problems caused by the implementation of freight transport. Port of IWT can be divided into several types, such as:

1. General Purpose Port, a combination of several users of IWT and various other modes of transportation such as trains and other modes of land.
2. Dedicated Cargo Terminal, made to transport the cargoes, sometimes combining the other modes but most do not occur modal transfer.
3. Industrial Port, which is generally the end of the path of IWT, and directly transporting raw materials and carry semi-finished goods from industrial estate.

IWT makes the distribution of cargoes to be more effective and efficient in the country which had applied. In addition, the implementation of IWT has succeeded in improving the movement of goods, lower levels of air pollution, lowering shipping costs and lower infrastructure costs that must be paid by the government.

2.2. Fleets Sizing

There are several approach method included in this research to determining the fleets capacity.

2.2.1. Canal Dimensions Approach. Dimensions of the river is used as a constrain in determining the ship's main dimensions. Ships draft should be sufficient to operate at the lowest water level with the fully loaded condition. The width of the river affects the the ship breadth that can cross the river, also
including many lanes available to the width of the river[4]. The curve’s angle of the river affects to ships length which able cross the river[5]. The bridge that cross the river to be a constrain for the ship height that can be through the river.

![Figure 3. The width and curve angle of the river affects ship dimensions [5](image)](image)

![Figure 4. River depth affects to ship draft [4](image)](image)

2.2.2. *Parametric Design Approach.* Every different country, even on a different river also has different ship characteristics of inland waterway transport. Ship design method to be operated on CBL river used spiral design method. Ship design process has a repeating cycle characteristics the most commonly described by spiral design [6].

2.3. *Ship Investment*

Long-term investment policy be considered as the issue of capital budgeting. Investment also means as an expense at the moment with the expected results of the spending will be received over the next 1 year. The main task in the investment policy is to make an estimate of expenditures and receipts of money to be received from these investments in the future. As these estimates include, Capital Cost, Operational Costs, Voyage Costs, Cargo Handling Costs, and Revenue [7]. Comparison of the value of the investment to the value of the future cash flow is used as the investment policy guidelines. The results of this comparison will be information to measure financial feasibility of an investment. In assessing the investment profit there are several criteria are used:

1. Criteria for investment based on the concept of profit / profit is the interest rate of return (IRR).
2. Criteria for investment based on the concept of cash flow does not take into account the time value of money or non-discounted cash flow which is the payback period method. The concept of the cash flow of the value of time and money or discounted cash flow, among other things, the Net Present Value (NPV), and Break Event Point (BEP).

2.4. *What-if Analysis*

Analysis about how if the assumptions used in these calculations change and how it affects feasibility conditions. With a what-if analysis, decision makers can determine the level of sensitivity of the decisions taken on the possibility of changes that occur in the used variables or assumptions [8]. If the sensitivity analysis performed on all the variables involved, the decision-making process will occur misleading precisely because too many what-if analysis that considered.

3. **Methodology**

3.1. *Research Scope*

There are two scopes and limitations to obtain the main objective in this research, as follows:

- This research steps analyze the supply side first, then known percentage of the total demand can be serviced with supply capacity.
This research does not cover the ship design arrangement and port plan design.

Dredging volume and dimensions of the river using data from Regional Bureau of Ciliwung-Cisadane River Basin (BBWS Ciliwung-Cisadane).

4. Inland Waterway Transport Analysis

4.1. Ship Dimensions

Identify supply capacity by analyze ship dimensions. Ship dimensions describes about particular dimensions such as payload, draft, length, breadth, high, service speed, deadweight and cargo handling equipment.

| Item    | Value | Unit | Item    | Value | Unit |
|---------|-------|------|---------|-------|------|
| $L_{WL}$ | 44.75 | m    | Power ($P_B$) | 261 | kW  |
| $L_{PP}$ | 43.03 | m    | Total crew | 7 | Crew |
| $B$    | 10.53 | m    | Fuel capacity | 2.38 | ton |
| $H$    | 5.46  | m    | Payload | 54 | TEUs |
| $T$    | 3.64  | m    | Gross Tonnage | 167.1 | ton |
| $V_s$  | 5     | knots | Net Tonnage | 38.7 | ton |
| $C_B$ | 0.828 | DWT | 1192.0 | ton |
| $L_{WT}$ | 356.97 | ton | Trim | 0.7 | m |

4.2. Voyage Calculation

In order to calculate the total costs, we firstly determine the operational costs, fuel costs, port dues and terminal handling charges. Moreover, we obtain the total costs by adding these costs.

| Item                                      | Unit  | Total         |
|-------------------------------------------|-------|---------------|
| Capital costs                             | Rp/year | 2,170,144,715 |
| Operational costs                         | Rp/year | 6,460,498,179 |
| Voyage costs                              | Rp/year | 9,798,599,174 |
| Cargo handling costs                      | Rp/year | 12,209,400,000 |
| Costs per ship                            | Rp/year | 30,638,642,068 |
| Capacity                                  | TEUs/year | 34,887 |
| Trucking costs                            | Rp/TEUs | 600,000 |
| Stevedoring inland port                    | Rp/TEUs | 427,000 |
| Unit costs                                | Rp/TEUs | 1,905,230 |

4.3. Feasibility of Ship Investment

As these estimates include, Capital Cost, Operational Costs, Voyage Costs, Cargo Handling Costs, and Revenue. Comparison of the value of the investment to the value of the future cash flow is used as the investment policy guidelines. The results of this comparison will be information to measure financial feasibility of an investment.
Table 3. Indicator of ship investment feasibility analysis

| Item       | Units     | Value  | Criteria | Min | Annotation               |
|------------|-----------|--------|----------|-----|--------------------------|
| NPV        | Million-Rp| 32,413 | OK       | 0   | Positive Incr. Wealth    |
| NPVI       | Time      | 0.75   | OK       | 0   | Null                     |
| IRR        | %         | 17%    | OK       | 8%  | MARR                     |
| IRRI       | Time      | 2.09   | OK       | 0   | Null                     |
| BEP        | years     | 7      | OK       | 1   | Construction Period      |
| Cashflow on BEP | Million-Rp | 7,365 | OK       | 0   | Positive Accum Cash      |

![Figure 5. graph of ship investment feasibility analysis](image)

4.4. Comparison with Land Transport
The results of operational analysis of the inland waterway transport compared with land transport by truck container. The components are compared include transportation costs, time, capacity, and fuel consumption.

Table 4. Table of comparison between inland waterway transport and land transport

| Comparison              | Land transport | Inland waterway transport | Units               |
|-------------------------|----------------|---------------------------|---------------------|
| Transport time          | 18-20          | 10                        | Hours / roundtrip   |
| Dimension               | 256            | 51.6 (LoA)                | Meter / 54 TEUs    |
| Fuel consumption        | 5.184          | 2.377                     | Liter / 54 TEUs    |
| Unit Cost               | 2.150.000      | 878.23                    | Rupiah / TEUs      |
| Double Handling Cost    | -              | 1.027.000                 | Rupiah / TEUs      |

4.5. Market Analysis
Firstly, we identify the market condition by analysing from supply sides. The supply side describes an overview about capacity of fleets and port occupancy, then known percentage of the total demand can be serviced with supply capacity.
Table 5. Channel capacity of Cikarang Bekasi Laut

| Item                  | Unit          | Value  |
|-----------------------|---------------|--------|
| Roundtrip days        | Days/roundtrip| 1      |
| Commision days        | Days/year     | 330    |
| Roundtrip per annum   | Roundtrip/year| 323    |
| Channel capacity      | Roundtrip/year| 32,211 |
|                       | TEUs/year     | 1,739,394 |

Table 6. Cargo transported with inland waterway transport

| Item                  | Unit         | Value  |
|-----------------------|--------------|--------|
| Port time Cikarang    | Hours/trip   | 7.20   |
| Voyage time           | Hours/trip   | 5.06   |
| Port time Priok       | Hours/trip   | 7.20   |
| Voyage time           | Hours/trip   | 5.06   |
| roundtrip hours       | Hours/roundtrip| 24.52  |
| Berth occupancy       | Ship/days    | 3      |
| Berth                 | Units        | 3      |
| Cargo transported     | TEUs/year    | 313,981|

Figure 6. Graph of comparison between supply and demand

4.6. What-if Analysis

In this sensitivity analysis were considered significant variable is the value of service speed and the load factor of the container to be transported on NPV and the unit cost.

Figure 7. The effect of ship speed and the load factor variable of the NPV

5. Result

CBL channel capacity reached 32,211 roundtrip/ year or 1,739,394 TEUs/ year. Total cargo transported with 9 units SPCB 54 TEUs payload reached 313,981 TEUs/year. Based on the analysis of container shipping costs (port to port), unit cost through the inland waterway transport is by IDR 1.9 million/ TEUs lower when compared with land transport IDR 2.15 Million/ TEUs. With delivery time through the river to 10 hours/ trip and land transport 18-20 hours/ trip. The capacity of river channels reached 13.7% of the total cargo truck serviced. Inland waterway transport worthy to be selected as a mode of transportation that connects the Port of Tj. Priok - Cikarang. Known to the NPV of the investment SPCB are 32 billion rupiah and BEP at seventh year with IRR value 17%.
Figure 8. The effect of ship speed and the load factor variable of the unit costs and compared with unit costs of land transport

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