Fleet Planning Scenarios as an Impact of Changing the Export Policy on Cost, Insurance and Freight: A Case Study of Indonesian Coal Export

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Abstract: Indonesia is one of the world's largest coal producers and exporters with total number of production and export in 2017 are 271 million ton (rank-5) and 17,9 million ton (rank-2) respectively. However, Indonesian coal export has been dominantly carried by foreign vessels, so that it effects on decreasing national fleets usage in the export activities. In order to enhance the participation of national fleets on the export activities, Indonesian government created a policy to change the terms of delivery on coal export from free on board (FOB) to cost insurance and freight (CIF). Therefore, the coal export should be transported by national fleets. The problem is total national fleets could merely control 3% of total coal export transportation. Hence, this study aims to compare FOB and CIF term on Indonesian coal export and to determine the optimum fleet planning required to support national fleets with three scenarios: (1) ship chartering, (2) second-hand ship purchasing, and (3) new ship building. The method used for determining new ship building is optimization by finding the optimum vessel size that produces the cheapest required freight rate (RFR). The analysis result obtained that for the coal export from Muara Pantai to Port of Guangzhou with total demand of 9,360,000 tons per year, it required 6 bulk carriers of 67,452 DWT with the lowest RFR of $. 4.26 per ton.

1 INTRODUCTION

Indonesia is one of the world's largest coal producers and exporters with total number of production and export to China, India and Japan in 2017 are 271 million ton (rank-5) and 17.9 million ton (rank-2) respectively.

The government establishes regulations through the Minister of Trade regarding the export and import activities of certain commodities. Export activities are listed in the Regulation of the Minister of Trade of the Republic of Indonesia no. 82 of 2017 article 3 paragraph (1) which requires exporters of coal or Crude Palm Oil (CPO) to use sea transportation controlled by national sea transportation companies and in article 4 paragraph (1), exporters in insuring coal export commodities or CPO are obliged to use insurance from a national insurance company (Permendag, 2017). Sea transportation controlled by a national sea transportation company is sea transportation owned by a national shipping company and has an Indonesian flag, not under a lease from a foreign shipping company. This regulation was enacted on 26 October 2017 and will be implemented 6 (six) months later, namely on 26 April 2018. If exporters do not comply with these rules, they will be subject to administrative sanctions in the form of suspension of permits or revocation of permits. This regulation is the government's effort to increase the competitiveness of the national shipping industry in the international world.

Responding to this, the Indonesian Coal Mining Association (APBI) considers this regulation to be burdensome for coal export activities. According to Hendra Sinadia (Chairperson of APBI), the use of national vessels can hamper coal exports because the availability of export transportation is still limited and coal companies use more foreign ships with a free on board (FOB), accounting for 80% of Indonesia's coal export activities (Benarto, 2016).

Currently, national shipping companies only control 3% of coal export transportation (Yunianto, Lazuardi, & Hadi, 2018). Due to the high number of Indonesian coal exports, while the use of the national

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fleet is still limited, it is necessary to plan a vessel so that the national shipping company is able to meet the demand of coal exports.

2 METHODOLOGY

The first analysis compares the existing FOB to the projected CIF. Both apply the identical term, Free on Board (FOB). There are four phases of analysis

1. Selecting the port of origin (Mara Pantai Port, East Borneo) and the port of destination (Guangzhou Port, China),
2. Comparing FOB to CIF that obtained through required freight rate (FRF),
3. Obtaining RFR of FOB from the coal mining company and RFR of CIF from the calculation,
4. Determining the total shipping cost of CIF on the certain route. In fact, the total shipping cost of CIF equals to FOB due to the similar shipping cost components.

The second analysis conducts a calculation on fleet planning for coal export, as follows

1. Collecting the existing national ship data that serve coal export activities,
2. Gathering the second-hand ship data, which serve coal export activities,
3. Calculating the ship's main size in order to obtain the optimum RFR through optimization method,
4. Computing cost and RFR calculation for each scenario,
5. Determining the number of ships where have the lowest RFR,
6. Conducting the sensitivity analysis.

The scenario analysis conducted on the study

1st Scenario: Ship chartering

The number of national shipping as the main object is 20 units in various size. In this scenario, the RFR calculation includes time charter hire (TCH), voyage cost, and cargo handling cost. In addition, the charter rate depends on the fixed costs; both capital and operational cost (Lazuardi, 2017).

2nd Scenario: Second-hand ship purchasing

Purchasing 15 unit of ships in various size. The capital cost is obtained through the price and their size (Blank, 2008). Furthermore, the ship price is various depended on their size and year of establishment.

3rd Scenario: New ship building

The total cost of new ship building consists of capital cost, operational cost, voyage cost and cargo handling cost (Stopford, 2009). Ship building calculation is required when the capacity of existing ships unmet the demand. The ship size: Length between Perpendicular (Lpp) is optimized using the Nonlinear Programming method (Santosa & Willy, 2011). There are three main components in optimization model, the objective function, constraints and decision variables. Therefore, Solver in Microsoft Excel is used to find the optimal solution.

Mathematical Model

With the development of formulations, the following is a mathematical model that is created and must be implemented in the software in the Microsoft Excel called Solver. The equation used to determine the total cost is as follow:

$$TC = FC + VC + PC \quad (1)$$

Objective Function

$$\text{Min } RFR = \frac{TC}{D} \quad (2)$$

Where:

$$FC = S_C + P_C \quad (3)$$

$$Sc = \frac{(P_{ST}(LPP \times B \times D_A \times C_{ST})}{UE} \quad (4)$$

$$Pc = D_C + Pi_C + EM_C + R_eM_C + \text{Tax} \quad (5)$$

$$Vc = S_{oC} + S_{vC} + P_O \quad (6)$$

$$S_{oc} = n(S_{EMC} + TD + FW_c) \quad (7)$$

$$S_{vc} = ME_C + AE_C \quad (8)$$

$$ME_c = n(MCR \times SFOC \times t_S \times P_{MFO}) \quad (9)$$

$$AE_c = n(MCR \times SFOC \times (ts + tp) \times PDMO \quad (10)$$

$$PO_c = n\,(ABM_C) \quad (11)$$

Decision Variable

LPP (Length between Perpendicular)

Constraints

Operational efficiency and effectiveness of ports or

$$LPP > 0;\ LPP \in 1, 2, 3 \ldots$$
$$x_{ij} \geq Dh_j \times (t_S + t_P)$$
$$Ts \leq LWS$$

$$LPP \geq LPP\ min$$
$$LPP \leq LPP\ max$$
$$D \leq Ka \times Fd$$

Descriptions:
RFR : Required Freight Rate
TC : Total cost in a year
D : Demand (ton/year)
T : Ship Draft (meter)
Tp : Port Draft (meter)
Ka : Cargo Handling Capacity (ton)
Fq : Frequency

3 GENERAL AND LITERATURE REVIEW

3.1 Coal Mining Industries

Coal production in Indonesia is dominated by Low to Medium Calories coal, such as bituminous, sub bituminous, and briquettes. The tendency of coal production is increasing during the past 10 years. The highest amount of coal production was in 2013, 474 million ton. Most of the use of the coal was providing the export demand. In 2017, the amount of coal production reached 97 million ton, climbed 7.2% by the previous year and surged to 364 million ton, 5% increasing in 2016. The Indonesia's Ministry of Energy and Mineral Resources said that the production level in 2018 rocketed was caused by many small-scale business licenses that have been in the exploitation period.

3.2 Coal Importer Countries

The countries in Asia that yield the highest amount of coal are China, Japan, India, Korea, and Taiwan. The biggest importer is China that yielded 255 million tonnage in 2016. In addition, the importers for Indonesia are China, Japan, South Korea, and

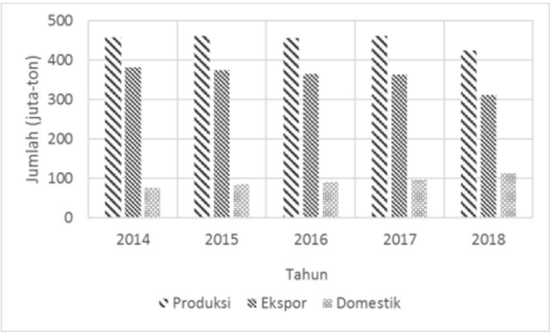

Figure 1: The amount of coal production in Indonesia.

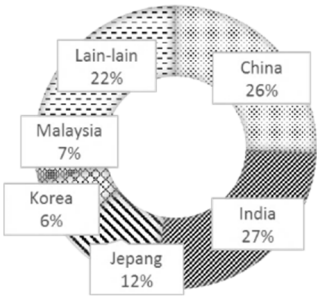

Figure 2: Importer countries for Indonesia (tonnage per year).

Malaysia (International Trade Centre, 2015). According to The Indonesia's Ministry of Energy and Mineral Resources, in 2017, China, India, South Korea and Malaysia imported 31.5 million tonnage, 40 million tonnage, 7.7 million tonnage and 7.8 million tonnage, respectively.

3.3 Coal Exporter Country

According to the International Energy Agency in 2017, Australia is the top country that yields 389 million-ton coals (26.5% out of world's total coal production). The second country is Indonesia, 370 million ton (24% out of world's total coal production). In the third place, Russia yields 171 million ton. Lastly, in 2016, the 10 biggest coal exporters contribute 95% of coal production in the World. The amount of coal export in Indonesia increased by 0,9% in 2016, from 368 million ton to 365.7 million ton.

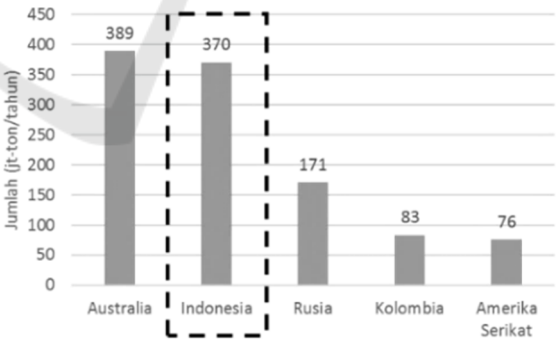

Figure 3: Coal exporter.

3.4 Coal Fleet by National Company

Currently, the number of carriers in Indonesia is 27,500 units according to the Ministry of Transportation. The Indonesian ship such as dry bulk and barge have been continuously operated to fulfil the domestic demands. In consequence, Indonesian ship has the small percentage of fulfilling the export demand, since there

are few numbers of ships, 50 units. Recently, only 3% of national fleet are operated for coal carrier while the rest, 97%, managed by international ship (Yunianto, Lazuardi, & Hadi, 2018).

3.5 The Port of Origin and Port of Destination

The study case on this research is the export of coal from Muara Pantai, East Borneo to Guangzhou port, China. There are three mining areas, Sambarata, Lati, and Binungan. From Lati, Coal are produced for brand Agathis and Sungkai. The coal reserved in this area is 465 million ton. Coal is excavated with a hydraulic excavator and loaded on trucks. From this mining area, the coal is transported to the installation, 11 km, through a well-established road on any weather, then stocked in the stockpile before loaded into the barge.

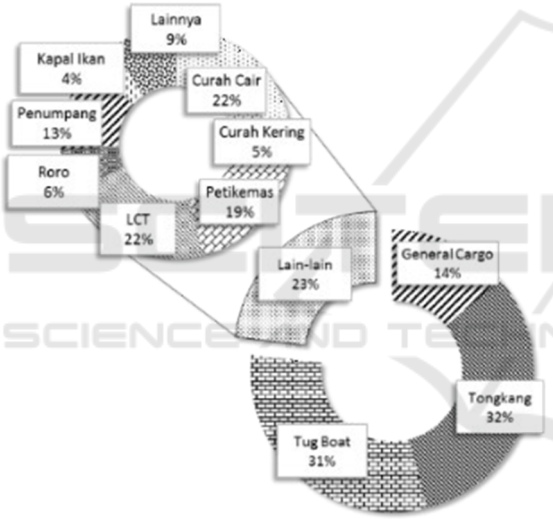

Figure 4: The percentage of Indonesian fleets.

The destination port in China, Guangzhou port which established in 2004, has 14 coal terminals, with the result that it could manage 60 million ton in a year. In 2010, the port could handle 410 million ton of cargo in which it was nominated as the 5th busiest port for non-container handling and the 7th best port for container handling (UNCTAD, 2015). Moreover, one of terminal is Xinsha (14,4-meter depth) on the fresh water. So that, the ship that aim to conduct loading and discharging is restricted to the maximum of 85,000 DWT.

4 ANALYSIS AND RESULTS

4.1 Introduction

The result of this research on the coal trade is the optimum fleet planning in terms of cost analysis on charter, ship building and second-hand ship through national shipping company which fulfils the international coal demand.

4.2 Existing Coal Export in Indonesia

In today's world, 80% of shipping contract apply the FOB as the term of delivery in where the exporter pays the cost of marine freight, insurance, discharging and transportation from the arrival port to the final destination. Besides, the CIF term in export- import increases the role of companies with Indonesian legal status and assists increasing foreign exchange through taxes.

Coal export in Indonesia is carried by bulk carrier from Muara Pantai, East Borneo to Guangzhou port, China for 1,424 nm. The loading-discharging activities in Muara Pantai utilises the floating transfer solution (speed 40,000 tonnage/day). In addition, dry bulk carrier is operated to transport coal using the FOB delivery term. The size of the dry bulk carrier is 65,000 DWT with RFR $4-$4.5 per tonnage.

4.3 FOB and CIF Comparation

Calculation model used in this research can be utilized to calculate freight on other routes on domestic coal demand. The freight excludes the profit margin, called require freight rate (RFR).

Ship operations determine the cost required in the transportation process. There are 2 (two) types of time, when ship is berthing and sailing. The vessels time conducting activities in the port is called port time, whereas the time spent vessel on the sea (origin to destination) is called sea time. Port time includes waiting time, approaching time, and berthing time. Sea time calculation is obtained from the division between the distance travelled (s) with the speed of the vessel (v). Meanwhile, the speed of the ship is determined by laden and ballast condition. Port time distance travelled (S) and sea time (s) are the time are required to export the coal in one roundtrip.

Table 1:Roundtrip time.

Sea time (roundtrip)		219.08	Hours
		10.00	Days
Port time	*Origin*	38.71	Hours
		2.00	Days
	Destination	57.71	Hours
		3.00	Days
Roundtrip		315.5	Hours
		14.00	Days

The demand (D) of coal in China is 9,360,000 ton per year and the payload is 64,519 ton. Therefore, the trip frequency (Fd) can be counted by 146 times (divided payload by demand) and the operation days (Ho) in a year is 330 days, 1 ship is required (RTD) 14 days in one roundtrip. So that, the frequency (Fa) of the ship obtained by divide Ho by RTD is 24 times. Besides, to count the number of ships required, 7 unites with the size of 65,000 DWT; 80% of utilization, can be counted by divide Fa by Fd in a year.

Furthermore, charter rate can be found through some calculations: capital cost, operational cost and freight. Time charter charged the charterer in the time charter scheme during certain period, 1 (one) year in this study. The total of capital and operational cost is $ 157,224,261. The total cost is charged in each year and is added by the profit of time charter hire, $ 19,291,286 in a year.

The shipping cost is the component that take into account when RFR is calculated. The amount of the shipping cost depends on the distance and the type of the ship. As well as the bunkers and port charges. Through the considered routes from Muara Pantai to the Guangzhou Port, the Fa can be counted by determined the number of roundtrips. The bunker cost is divided by two types, the fuel for main engine, $ 14,847,480 per year and the fuel for auxiliary engine $ 3,704,362 per year. In addition, the port charge is divided into 4 parts: anchorage, berthing, pilot service and tug assistance cost, $ 2,841,124 per year. Moreover, the cargo handling cost using the CIF term where the exporter is responsible to the cargo loading cost in the origin port. There are 9,360,000 tonnage cargo carried that cost $ 742,543 per year.

The freight in which the analysis that applied CIF terms is the RFR excluded the profit. RFR can be counted by divide the number of Demand in a year (D) to Total Cost (TC). The total cost includes Time charter hire, shipping, and cargo handling cost. Then, the total cost of coal export to China is $ 41,426,796 per year. At last, after knowing all the total cost, RFR can be calculated by divide demand (D) to total cost, $ 4.43 per tonnage.

Table 2: Existing cost.

Tittle	Amount ($)	Unit
Time Charter Hire	19,291,286	/year
Shipping Cost	21,392,967	/year
Cargo Handling Cost	742,543	/year
Total Cost	41,426,796	/year
RFR	4.43	/ton

In summary, the minimum RFR is using the FOB term, $ 4.0 per tonnage which is $ 0,43 per tonnage lower.

4.4 The First Scenario: Ship Charter

Bulk carriers owned by shipping company are in the limited numbers. According to INSA, their national vessels are able to satisfy only 3% of the total amount of coal export in Indonesia, 370 million tonnage per year. In terms of national charterer, there are 20 alternative vessels that could be operated.

The model used to calculate the charter vessel is MV Victory Union 65,000 DWT, its payload is 64,509 ton, so that, in order to meet the demand from China, 146 frequencies (Fd) are required. The operation days (Ho) in a year is 330 days, 1 ship is required (RTD) 14 days in one roundtrip. So that, the frequency (Fa) of the ship obtained by divide Ho by RTD is 24 times. Thus, 7 ships, 87% of utilization, can be counted by divide Fa by Fd in a year.

Table 3: Existing charter cost.

Tittle	Amount ($)	Unit
TCH	20,768,631	/year
Shipping Cost	21,109,806	/year
Cargo Handling Cost	742,614	/year
Total Cost	42,621,051	/year
RFR	4.55	/ton

Furthermore, time charter hire can be found through some calculations: capital cost, operational cost and freight. Time charter charged the charterer in the time charter scheme during certain period, 1 (one) year in this study. The total of capital and operational cost is $ 157,224,261. The total cost is charged in each year and is added by the profit of time charter hire, $ 19,291,286 in a year.

Time charter hire is obtained by calculating the capital and operational cost, $ 108,882,197 and $40,923,057 respectively. Thus, TCH is $ 20,768,631 per year. The shipping cost consists of fuel and port cost, $ 18,263,645 per year and $ 2,846,161 per year respectively. Whereas the cargo handling cost is $ 742,614 per year.

In summary, the total time charter hire on MV. Victory Union is $ 42.621.051 per year, so that the RFR is $ 4,55 per ton

4.5 The Second Scenario: Buy Bulk Carrier

As mentioned previously, the number of bulk carriers owned by National shipping company is limited. So that, the alternative offered is buy the bulk carriers. In this research, there are 15 bulk carriers with various DWT. The existing method to calculate the RFR is applied to the MV. Hanton Trader II with 63,800 DWT. The payload is 63.321 ton, so that in order to meet the China's demand (D), 9,360,000 ton per year, 148 frequencies (Fd) are required. The operation days (Ho) in a year is 330 days, 1 ship is required (RTD) 14 days in one roundtrip. So that, the frequency (Fa) of the ship obtained by divide Ho by RTD is 24 times. Thus, 7 ships, 87% of utilization, can be counted by divide Fa by Fd in a year.

The market price for the ship is $ 15,300,000. The capital cost that should be paid is $ 107,100,000. This cost is charged in each year with the value of weighted average cost of capital (WACC), 12%, thus the capital cost is $ 13,655,247 per year.

Table 4: Recapitulation of ship purchase cost.

Tittle	Amount ($)	Unit
Capital Cost	13,655,247	/Year
Operational Cost	6,581,359	/Year
Shipping Cost	20,905,138	/Year
Cargo Handling Cost	738,019	/Year
Total Cost	41,879,762	/Year
Unit Cost	4.47	/ton

The operational cost consists of the salary of crews, maintenance cost, consumable cost, insurance, lubricant, and fresh water. Thus, the total operational cost of Mv. Harton Trader II is $ 5,361,560 per year. The shipping cost consists of bunker and port cost. The fuel of main engine and auxiliary engine are $ 14,385,621 per year and $ 3,663,732 per year, respectively. In addition, the port cost is $ 2,855,785 per year.

In summary, the total cost for purchasing the MV. Hanton Trader II is $ 41,879,762 per year. The RFR on this scenario is $ 4,47 per ton in which it is 11% higher than the existing FOB term.

4.6 The Third Scenario: Building New Ship

The main size of the ship is obtained by conducting the optimization method. Since there are 9.360.000 ton per year demand (D) and the speed required is 15 knot, ship planning calculation is assigned. The calculation includes the displacement and ship tonnage. The optimization method is used to find the minimum value of RFR.

Table 5: Optimized vessel specifications.

Tittle	Amount	Units
LOA	226.78	m
LWL	218.38	m
LPP	209.98	m
B	31.91	m
H	18.77	m
T	13.12	m
DWT	67,452	ton
LWT	11,133	ton
GT	36,978	
NT	22,731	
Main Engine Power	12,270	hp
Auxiliary Engine Power	650	hp

The ship's payload is 66,995 ton that gained by reducing the DWT in consumable and crew weight. The frequency required, since the demand (D) is 9,360,000 ton and the payload is 66,955, is 140 times. The operation days (Ho) in a year is 330 days, 1 ship is required (RTD) 14 days in one roundtrip. So that, the frequency (Fa) of the ship obtained by divide Ho by RTD is 24 times. Thus, 6 ships, 97% of utilization, can be counted by divide Fa to Fd in a year.

The total cost is obtained by multiplying steel, machinery, equipment, and tools to the existing price of the steel. The ship building cost is $ 12,537,930. The building cost is added by 20% profit, 5% inflation, 10% taxes, hence the ship price is $ 19,926,206. The number of units required is 6, thus the total cost is $ 101,557,236. That capital cost is equally split through 30 years of ship's economically age and the WACC is 12%. Accordingly, the cost is $ 12,607,687 per year.

The operational cost consists of the salary of crews, maintenance cost, consumable cost, insurance, lubricant, and fresh water. Consequently, the total operational cost is $ 4,852,608 per year. The shipping cost consists of bunker and port cost. The fuel cost for both main engine and auxiliary engine depend on engine power, voyage duration, and the cost of the fuel in the market. The fuel of main engine and auxiliary engine for the new ship are $ 17,790,105 per year and $ 3,663,732 per year, respectively. In

addition, the port cost is $ 2,757,594 per year. The cargo handling cost is calculated when the ship in is in the origin. Hence, the cargo handling cost is $739,095 per year.

Table 6: Recapitulation of ship building cost.

Tittle	Amount ($)	Units
Capital Cost	12,607,687	/year
Operational Cost	6,071,169	/year
Shipping Cost	20,547,699	/year
Cargo Handling Cost	739,095	/year
Total Cost	39,965,650	/year
RFR	4.26	/ton

In summary, the total cost for building the new ships is $ 39,965,650 per year. Therefore, the RFR is $ 4.27 per ton which is 6% higher than using the FOB term.

4.7 The Comparison of RFR

The alternative term (CIF) for coal export is by chartering the national ship, or by building the new ships which can be the demand. The price reference of RFR in FOB for shipping from Muara Pantai to Guangzhou port (1,424 nm) is $ 4 - $ 4.5 per ton.

Table 7: Scenario comparison.

	Charter	Buy	Build
DWT (ton)	65,000	63,800	67,452
Ship (unit)	7	7	6
Annual Total Cost (Thousand $)	42,621	41,879	39,909
RFR ($/ton)	4.55	4.47	4.26

As shown in the table above, the amount of RFR in three scenarios are $ 4.55, $ 4.47, $ 4.26 which are allocated for charter, buy, and build the ship, respectively. Moreover, the time charter hire for 65,000 DWT requires 7 units of ship, buying ship on 63,800 DWT requires 7 units, and building ship on 67,425 DWT requires 6 units. To sum up, according to the result of the analysis, the scenario chosen is building 6 units of ship which have RFR $ 4.26 ton.

4.7 Sensitivity Analysis

Sensitivity Analysis provides the information in which variables affected by the chosen scenario.

The higher number of demands, the lower amount of RFR. There is a significant rise of the RFR in which it shows that there should be addition on the number of ship when the demand rise. At the 9,360,000 ton per year demand, building the ship gives impacts in a lower amount of RFR since the utility of the ship is 97%, meanwhile, the utility of time charter hire and buying ship is 87% and 88%, respectively. In the case of increasing the number of demands by 2%, the amount of RFR will decrease by 0.87%.

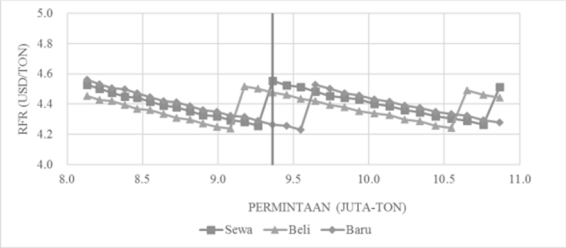

Figure 5: Sensitivity analysis on demands and RFR.

The sensitivity analysis is applied on other variables, such as speed, loading and discharge rate, load factor, distance, and currency. In this sensitivity analysis, for each variable is increased by 2%. This variation influenced the amount of SFR in which it is increasing by 0.53% (speed), decreasing by 0.08% (loading and discharge rate), decreasing by 1,1% (load factor), increasing by 0.93% (distance), and decreasing by 0.8% (currency).

5 CONCLUSIONS

According to the analysis and the result, there are summary need to be considered:

1. Indonesia is one of the biggest coal exporters in the world that export 364 million ton per year. The importer countries for Indonesia are China (22%), India (24%), Japan (11%), South Korea (6%) and Malaysia (6%). Terms of delivery (ToD) Free on Board (FOB) is massively used, 80%, in Indonesia where Indonesia as the exporter responsible to ship the coal to the origin port.
2. The amount of RFR and FOB on 65,000 DWT to export coal from Muara Pantai to Guangzhou Port (1.424 nm) in which demands 9.360.000 ton per year is $4-$4.5, while using the CIF term, the amount of RFR is $4.48 per ton, 11% higher than FOB term.
3. Fleet planning has been conducted in three scenarios, (1) time charter hire; (2) buying ship; and (3) building new ship.
   a. Time charter hire for 65,000 DWT requires 7 units of ship, the RFR amount is $ 4.55 per ton.
   b. Buying ship on 63,800 DWT requires 7 units, the RFR amount is $4.47 per ton, and

c. Building ship on 67,425 DWT requires 6 units, the RFR amount is $ 4.25 per ton

Thus, according to the result of the analysis, the scenario chosen is building 6 units of ship which have RFR $ 4,26 per ton.

4. Therefore, sensitivity analysis is conducted to determine the most sensitive variables; the sensitivity orders are: load factor (the most sensitive), distance, demands, currency, speed and loading and discharge rate (the least sensitive).

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